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Facial Surgery

Special Topic

Avoiding Complications With Aptos Sutures

Marlen Sulamanidze, MD, PhD; George Sulamanidze, MD, PhD;
Ivan Vozdvizhensky, MD, PhD; and
Constantin Sulamanidze, MD

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Abstract

Background: Over the past decade, several methods of minimally-invasive thread-mediated lifting have been widely adopted in aesthetic surgery. Early use of these methods met with great enthusiasm, and threadlifting was often performed without sufficient regard for proper indications, controls, or outcomes. Soon after, reports of early-relapse ptosis, complications, and other undesirable side effects began to appear in the literature.

Objectives: The authors describe the current best practices associated with threadlifting to ensure proper use and improved results.

Methods: The authors retrospectively reviewed their collective case data, analyzing the results of 12,788 face and neck threadlift procedures in 6098 patients over 12.5 years.

Results: The data showed inconsistent results and early relapse of deformity with the Aptos Thread and Aptos Thread 2G methods. Complications included thread visibility, migration, and exposure; linear bleeding along the needle course; skin dimpling; hypocorrection and hypercorrection; transient paresthesias; and a small number of cases of injury to major vessels, nerve branches, and parotid capsule/duct. As new devices were developed and the indications for each technique refined, soft tissue suspension became more effective and durable, and the incidence of complications correspondingly decreased in the latter part of the series.

Conclusions: Threadlifting is a relatively modern trend in aesthetic surgery that demands a similarly novel approach from surgeons. When performed properly, threadlifting is associated with minor and infrequent complications and is a helpful clinical alternative to traditional facial rejuvenation techniques.

Keywords

Aptos, lifting, suspension, complications, threads

Accepted for publication December 13, 2010.

Over the years, multiple methods of rejuvenating the aging face have been suggested, met with great fanfare and ardent proponents, and subsequently abandoned because of mounting complications and inadequate record keeping. Among the currently-available facial rejuvenation techniques—including those involving surgical treatment with barbed sutures—none can claim to completely address all aspects of an aging face at once, since most aim at improving a specific area.

Beginning in the late 1990s, a technique called *threadlifting* began to grow in popularity. Threadlifting is a minimally-invasive technique relying on Aptos (“antiptosis”) threads and sutures (Aptos Ltd., Moscow, Russia). The tools for performing Aptos lifts were easily available on the market, and the operative technique itself was relatively simple; so, many surgeons began incorporating threadlifting into their practices based on only a brief acquaintance with published reports or instructional videos. The method was applied large-scale to virtually all facial areas, neglecting the fundamental principles of topographic anatomy and physiology of

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the facial soft tissues. Inevitably, this disregard for proper indications and limitations of the technique led to early relapse of ptosis, major and minor complications, adverse events, and other side effects. Many surgeons then became disappointed with the threadlift method and ascribed the poor outcomes to the concept and tools rather than to inappropriate application of the technique.

In this report, we recount our experience with threadlifting in more than 6000 patients, detail our dissatisfaction with the original Aptos Thread model, trace the technologic evolution of the Aptos system, and describe the improved outcomes achieved with newer-generation Aptos tools. We analyze our failures, offer guidelines for the proper application of threadlifting techniques, and make recommendations for the prevention and treatment of complications during procedures performed with Aptos products.

METHODS

We retrospectively reviewed the outcomes of 12,788 procedures performed in 6098 patients by three of the authors (MS, GS, CS) with various generations of the Aptos suture system between January 1998 and June 2010. Before 2002, all patients in the series underwent lifting with the original Aptos Thread product. Between 2002 and 2004, we began to utilize the Aptos Thread 2G technique; after 2004, we added various permutations of the Aptos Needle and incorporated the Aptos Spring in expanded indications.

Our current operative techniques (using the latest generation of products) for each anatomic region to be corrected are described below. Several modifications are available for lifting the suborbital and buccozygomatic areas, depending on the degree of ptosis, the weight of the tissues, and the depth of the lacrimal groove; here, we describe the most common surgical technique with the most up-to-date products.

OPERATIVE TECHNIQUES

Central Midface

To treat the midface, the Aptos Needle 4/0 (a curved needle, 5 or 6 cm long, with a 45-cm Prolene thread; see Figure 1) is used to lift the soft tissues of the midface both independently and in combination with a classic or transconjunctival blepharoplasty.

Each patient is marked preoperatively (Figure 2). Along the course of one of the "crow's feet" wrinkles (Point 1), a 2- to 3-mm-long incision is made down to the periosteum at the orbital edge and then widened with a thin, mosquito-type clamp. The pointed end of the Aptos Needle 4/0 is inserted into the periosteum and then passed subdermally along a roughly triangular path to Points 2 and 3 while the surgeon pushes up on the suborbital and buccozygomatic areas with his or her free hand. The needle is brought out, rotated, and threaded back into the wound again at Point 1, where both ends are brought together and affixed to the orbital periosteum with several knots. The second (Points 4 and 5) and third sutures

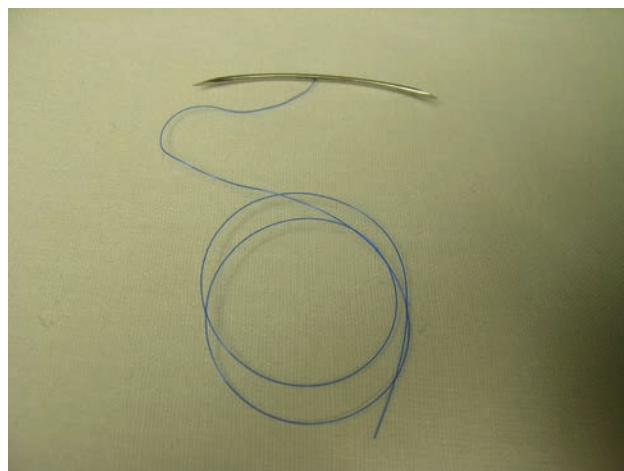


Figure 1. The Aptos Needle 4/0.



Figure 2. Skin markings for buccozygomatic and suborbital correction with the Aptos Needle 4/0 method.

(Point 6) are passed in a similar manner following the preoperative markings.

Anterior Cervical Region

To treat the anterior cervical region, the Aptos Needle 2/0 (a 15-cm-long straight needle with a 100-cm-long thread of 2/0 Prolene; Figure 3) is used to stitch through and lift the soft tissues of the submaxillary and cervical areas. The patient is marked preoperatively (Figure 4), and an incision up to 1 cm long is made bilaterally from the parotid area to the premastoid periosteum. "Holder" threads of 2/0 Prolene are placed on the periosteum, retaining the thread ends for later attaching of the threads supporting

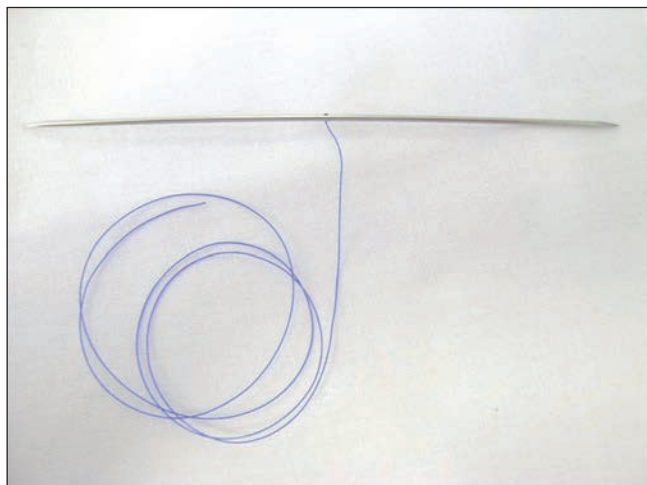


Figure 3. The Aptos Needle 2/0.



Figure 5. The Aptos Spring.

the submaxillary area. The Aptos Needle 2/0 is inserted through one of the incisions and passed subcutaneously along the course of the lowest marking line first. The needle is brought to the surface, turned, and reinserted until it appears on the opposite side, at which point it is brought out. The suture is then pulled to its fullest extent and tied to the holder threads. The procedure is repeated along the upper and middle marking lines of the anterior cervical area. Each time, the suture is secured to the holders for stable lifting of the submaxillary soft tissues.

Lower Face

Aptos Springs (Figure 5) can be used in lower face thread-lifts for buccal angle suspension and treatment of marionette lines. These devices are spring-twisted, specially-designed “shape-memory” polypropylene 2/0 threads. During manufacture, they are exposed to additional treatments that impart “springlike” characteristics to the suture material. The spring is rolled onto a 1.1- × 100-mm or 0.9- × 90-mm injection needle in its compressed state.

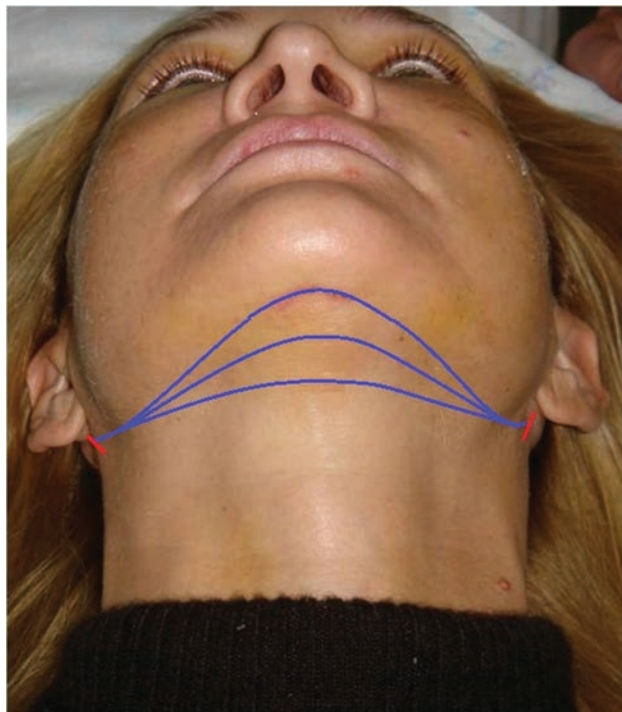


Figure 4. Skin markings for submaxillary and anterior cervical correction with the Aptos Needle 2/0 method.

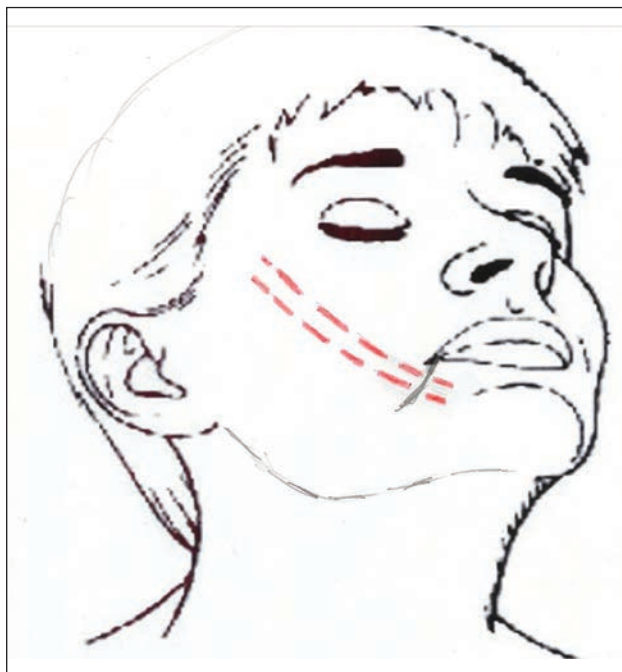


Figure 6. Skin markings for Aptos Spring insertion during labiomental fold correction.

Two lines are marked 1 cm from each other along the marionette lines (Figure 6) of the midface, perpendicular

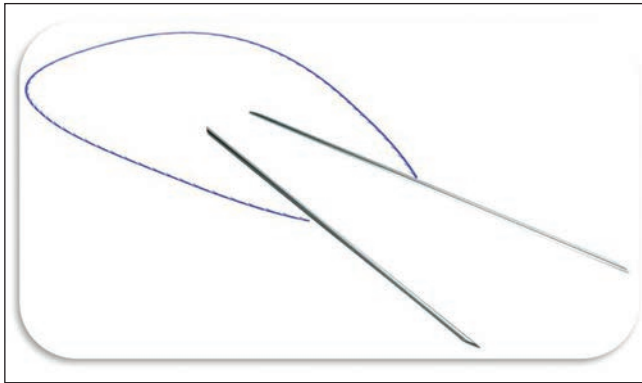


Figure 7. The Aptos Needle 2G.

to the labiomental fold. The needle is inserted at the upper end of the outer marking line and moved toward the fold. For the first half of the distance, the needle is passed deep to the SMAS, and at the halfway point it is tilted superficially to travel closer to the skin's surface. The needle is brought out approximately 1.5 cm after traversing the labiomental crease and removed, leaving the spring in the tissues. The ends of the spring thread are pulled lightly until the spring fills the entire marked area, and then the excess thread is cut off and buried in the dermis.

Eyebrow

The Aptos Needle 2G (Figure 7), consisting of a 50-cm-long Prolene 2/0 thread with oppositely directed barbs decreasing in size toward the middle, is used for treatment of the eyebrow and lateral midface. Two double-pointed needles are connected to the thread at its midpoint. Each needle is 10 cm long and has a triangular bevel that acts as a single spike when the needles are held together so that they may be inserted through a single puncture and separated at any time under the skin.

The coupled points of the Aptos Needle 2G are inserted into the temple according to the skin markings (Figure 8) down to the temporal muscle, where they are pulled apart. One needle is taken deep to bite the temporal fascia for anchoring before being directed back into the subcutaneous space. In turn, each needle is then passed along the marked lines toward the eyebrow. At the highest brow, the needles are brought to the surface, turned around, and reinserted to travel medially toward the glabella. In the upper glabella, both needles are brought to the surface together, and the suture ends are pulled until the eyebrow is lifted slightly more than desired. (Slight hypercorrection is indicated to compensate for expected sagging postoperatively.) Once the contralateral eyebrow has received the same treatment, the four suture ends are trimmed in the upper glabella, and the knots are buried in the subdermis.

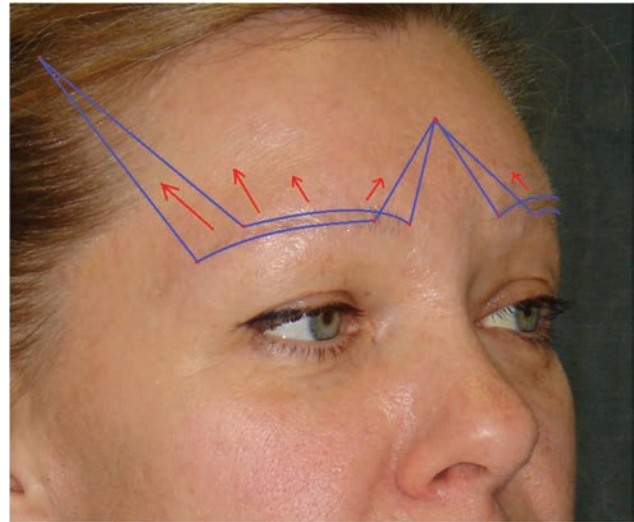


Figure 8. Skin markings for eyebrow lift with the Aptos Needle 2G technique.



Figure 9. Skin markings for buccozygomatic and malar suspension with the Aptos Needle 2G technique.

Lateral Midface

For treatment of the lateral midface, the coupled points of the Aptos Needle 2G are inserted into the periosteum of the zygomatic arch, detached from each other, and in turn passed anteriorly toward the fat pad of the cheek according to the skin markings (Figure 9). The needles are partly brought to the surface at the marked medial points and turned back toward the temple, where the sutures are once again anchored to the zygomatic periosteum. As the needles are passed and the threads moderately pulled, the surgeon pushes on the malar fat pad with the other hand

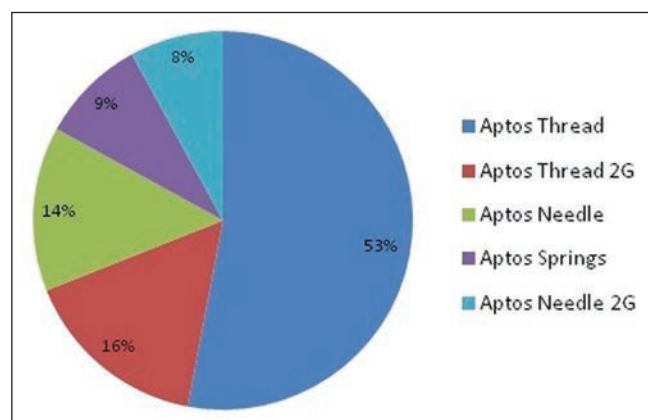


Figure 10. Relative frequency of various Aptos techniques in our series of 6098 patients treated between January 1998 and June 2010 (12,788 procedures).

to pile up the soft tissues in the suborbital and buccozygomatic areas, thus enhancing the lift effect. Where the needles emerge from the skin laterally, the suture ends are trimmed, and the knots are buried in the dermis. No sutures are necessary because the barbs along the length of the thread maintain its position.

A series of videos demonstrating each of these operative techniques is available at www.aestheticsurgeryjournal.com. You may also use any smartphone to scan the code on the first page of this article to be taken directly to the video on www.youtube.com.

RESULTS

Between 1998 and 2002, we utilized the Aptos Thread exclusively. Beginning in 2002, we changed our method to include Aptos Thread 2G, and in 2003, we added the Aptos Needle and Aptos Needle 2G methods. The next year, we started using the Aptos Spring method in selected cases (Figure 10). Of the 6098 patients, the majority were female (92.9%, $n = 5663$). The youngest patient was 16 years of age, and the oldest was 77 (mean, 46.5 years).

Table 1 shows our combined 12.5-year experience with the various generations of threadlifting methods according to anatomic area. The most frequently performed procedure was buccozygomatic lifting (45.5%), followed by correction of labiomental (17%) and submental (16.2%) deformities and eyebrow lifting (12.5%). Other anatomic areas (eg, preauricular, outer canthus, chin) account for the remaining 8.8% of procedures.

Postoperative discomfort, paresthesias (impaired movement of facial muscles), minor bleeding, edema, asymmetry, and contour irregularities (eg, shallow dimpling at sites of needle insertion) are common, transient sequelae of all surgical interventions on the face and were therefore not considered complications for the purpose of this report. Other, more serious events—such as inflammation and suppuration of wound edges, hematoma, and injury

Table 1. Relative Frequency of Correction by Anatomic Region

Area of Correction	Share of Total Procedures, %
Buccozygomatic	45.5
Labiomental	17.0
Submental/jowls	16.2
Eyebrow	12.5
Other	8.8

Table 2. List of Complications Experienced

Complication	Patients, ^a No. (%)
Immediate or transient	
Edema/swelling	141 (2.3)
Minor asymmetry	6098 (100)
Linear bleeding	152 (2.5)
Contour irregularity	6098 (100)
Allergic reaction	0 (0)
Late or persistent	
Inflammation/infection	1 (0.01)
Hematoma	14 (0.2)
Asymmetry	188 (3.0)
Contour irregularity	173 (2.8)
Thread migration or exposure	4 (0.06)
Visible needle tracks/skin retraction	64 (1.0)
Injury to vessel, nerve, or gland	2 (0.02)
Early relapse of ptosis	163 (2.7)

^aN = 6098.

to nerves, blood vessels, or parotid gland capsules or ducts—may occasionally follow any facial rejuvenation procedure, including those performed by any of the Aptos methods (Table 2).

Among the complications specifically associated with threadlifting techniques, we experienced cases of sustained overcorrection, undercorrection, asymmetrical appearance from localized weakening of the barbs, linear hemorrhage along the suture path, thread migration, thread exposure, skin retraction, and visible needle tracks (Table 2). Fortunately, instances of infection and accidental damage to vessels, nerves, and parotid gland were rare.

While thread-mediated lifts with the first-generation Aptos Thread were often accompanied by other minimally-invasive manipulations (eg, skin peels), the more recent

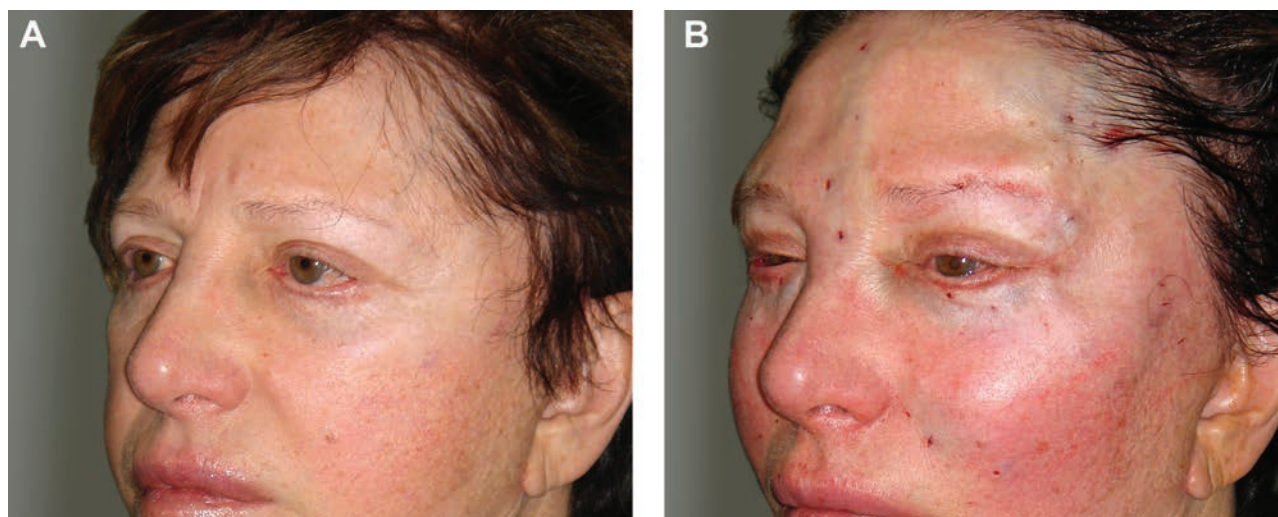


Figure 11. (A) This 57-year-old woman after having undergone unsuccessful blepharoplasty and facelift. (B) Immediately following eyebrow lift, midface suspension, and thread-assisted canthopexy with the Aptos Needle 2G technique.

Aptos techniques have been frequently combined with lipotransplantation and liposuction of the face and neck, classic facelift procedures, platysmaplasty, and blepharoplasty. Aptos procedures alone accounted for 46.6% of the cases in the initial part of our series, but in the last two years, the incidence of single surgeries has increased to 58.3%.

Clinical results are shown in Figures 11-14.

DISCUSSION

The first-generation Aptos Thread has bidirectional barbs and is placed into the subcutaneous tissues of the face by means of a special hollow needle. Although the thread ends are not sutured, the barbs serve to anchor the repositioned soft tissues without slipping.¹⁻³ We utilized this method for some four years for the correction of face and neck aesthetic deformities, but the results were not always satisfactory, especially in the submental and brow areas.

The second-generation Aptos Thread 2G features barbs twice as long as the original. A further modification, the Aptos Needle, fits two needles at the ends of the threads; the needles can be joined for single-point insertion and later separated subcutaneously to follow independent paths. After the intended lift is complete, the thread ends are cut and buried under the skin. An obvious advantage of this method is that the thread is anchored to periosteum or fascia at the point of insertion, making for greater stability of fixation than the first-generation method, which relies solely on the hook effect of the barbs. In addition, the thread's reach is effectively doubled with the two needles, yielding a more powerful and ultimately more stable suspension.⁴⁻⁷

The Aptos Needle and Aptos Needle 2G techniques are indicated when considerable shifting of the subcutaneous mass is required (eg, patients with pronounced ptosis of the malar fat pad) or a long-term effect is desired. The improved

strength of suspension and durability of results with the newer methods is reflected in the number of thread-mediated lifts that are performed alone, which has risen in the last few years as adjuvant interventions become superfluous. We have also managed to eliminate complications such as thread migration, weakening, and visibility.⁴⁻⁷

The Aptos Thread and Aptos Thread 2G techniques have been described.^{1-3,6} At this time, we have ceased using the Aptos Thread method and now apply the Aptos Thread 2G method in very few cases. Both techniques rely solely on the thread barbs for the lifting effect, which we believe weakens the whole construction and makes the result less stable. Published reports critical of our methods invariably address procedures performed with the outdated Aptos Thread technique.⁸⁻¹⁴

For the last two years of this series, we have used only newer-generation Aptos methods. The 1958 patients treated in those years (3577 procedures) were evaluated together with the earlier cases for the purpose of this series, but careful analysis of the later cases influenced our technique profoundly and led us to make the following recommendations regarding indications, surgical guidelines, and best management practices to minimize complications in facial threadlifting.

Preoperative Evaluation

During preliminary consultation, the patient should be frankly advised about possible complications and unfavorable events, with the point stressed that threadlifting is a surgical operation and not a simple procedure. The patient must hold no illusion regarding the absence of discomfort or downtime, and she or he must be prepared to face a one- to two-week period of curtailed physical and social activity. Likewise, it is important for the surgeon to correctly understand the patient's wishes and expectations. If

Table 3. Recommended Aptos Technique by Area of Correction

Anatomic Area	Suggested Aptos Technique				
	Thread	Thread 2G	Needle	Needle 2G	Spring
Eyebrow		+		+	
Buccozygomatic/ suborbital	+	+	+	+	
Perioral					+
Nasolabial (marionette lines)					+
Labiomental	+	+		+	
Chin		+	+	+	
Preauricular		+	+	+	
Submaxillary			+	+	

there is no mutual understanding between the physician and the patient, the surgeon may obtain a perfect result from his or her own point of view, but the patient may be unhappy because the procedure did not meet his or her expectations.

Indications

Former indications for threadlifting included patients under the age of 50 with moderately flabby cheeks. After development of the Aptos Needle, Aptos Needle 2G, and Aptos Springs, we began to operate on patients of virtually any age with more pronounced deformities.

One must be careful to choose the appropriate technique for the intended correction (Table 3), whether primarily lifting or perhaps redistributing the ptotic tissues, creating a new (or emphasizing an existing) lateral mid-face prominence by subcutaneous fat accumulation, or a combination of these. If the surgeon's aim is to lift the tail of the eyebrow, for example, a thread canthopexy with the Aptos Needle 2G is indicated (Figure 11). Alternatively, if the intent is to fashion a high-volume, elevated malar eminence, we recommend utilizing the Aptos Needle 4/0 method or the Aptos Needle 2G method. These techniques involve either a tiny incision (Aptos Needle 4/0) or no incision at all (Aptos Needle 2G). The subcutaneous tissues are lifted and suspended with knots (Aptos Needle 4/0) or by the overlapping loop design of the barbed thread and its periosteal anchors (Figure 12).

Thread Insertion, Depth, and Placement

To avoid complications with the Aptos Thread method, the surgeon should:

- select a needle of the correct size (1.1 mm × 10.0 cm);
- pass the thread cautiously through the needle lumen so that the barbs lie flat;
- place the thread so that the number of barbs on either side of the needle center is similar (Figure 15);
- confirm proper insertion and hooking of the barbs by tugging at the thread from both ends and then cut the thread ends at a level 1 to 2 mm deeper than the surface of the skin and allow them to retract; and
- place threads only where soft tissue layers can be freely mobilized without sharp dissection.

We regard facial ptosis as a focal process that lends itself to correction by localized thread-mediated lifting of discrete areas such as the brow, buccozygomatic, labiomental, and submaxillary regions (Table 3). The soft tissue layers in these regions are easily moved relative to one another but only in certain directions. Correction of kinetically-active zones, such as marionette lines, ptosis of the angles of the mouth, and pronounced labiomental folds, requires insertion of an elastic lifting device: the Aptos Spring (Figure 14).

Movement of soft tissues across two or more facial zones is difficult and usually unsuccessful. The facial zones are bordered by rigid structures, such as bone and dense fascia, that preclude subcutaneous repositioning. Attempts at soft tissue suspension with long threads anchored in the temporal or parietal area and extending to the lips or lower face are counterintuitive because at least the barbs, if not the whole thread, would be destroyed when the patient opens his or her mouth widely, purses the lips, and so forth. Likewise, reports of threadlifting from one side of the cranium to the other are fraught with complications from a tortuous thread passage across or near important craniofacial structures. We believe these to be risky, invasive procedures that should play no part in facial rejuvenation. Neither do we advise rigid thread-mediated lifting of the whole eyebrow or forehead (Figure 16), which ignores the action of the powerful frontal muscle that would promptly destroy the thread's barbs. Faced with such a case, we would consider correction with the Aptos Needle 2G and concomitant Botox injection.

Complications

Mild paresthesia/dysesthesia, linear bleeding along the thread path, discomfort, asymmetry, and shallow depression of needle tracks are not regarded as complications but as temporary conditions to be expected after threadlift procedures. Hypercorrection is a necessary element of the procedure to compensate for eventual relaxation of the tissues (Figure 14). Complications that may occur with any Aptos method include persistent asymmetry,



Figure 12. (A) This 32-year-old woman presented with ptosis of the malar fat pad. (B) One week after midface lift with the Aptos Needle 4/0 technique. (C) Six months and (D) 3.5 years postoperatively.

hypocorrection and hypercorrection, contour irregularities, visible threads, thread migration or exposure, hematoma, pain, paresthesia, and injury to a vessel, nerve, or salivary gland capsule or duct. Asymmetry from localized weakening of the barbs and thread migration/exposure are virtually nonexistent with the Aptos Thread 2G method. This technique, however, is intended only for unilateral fixation to solid structures.

Moderate impairment of facial movements—mimetic movements, chewing, talking, swallowing—may also occur after threadlifting but typically disappear within the first or second postoperative week. Rehabilitation may be accelerated by conventional physiotherapy and/or treatment

with prescription drugs, such as Traumeel (Heel, Inc.; Albuquerque, NM) and Troxevasin (SCBalkan Pharmaceuticals SRL; Moldova Republic, Chisinau).

Postoperative Care

Patients in this series who underwent first- and second-generation Aptos procedures were given minimal postoperative instructions other than to avoid excessive movement of the neck, lower jaw, perioral, and periorbital regions for two to three weeks. If the barbs of the threads were stressed, bent, or injured before they could be fully

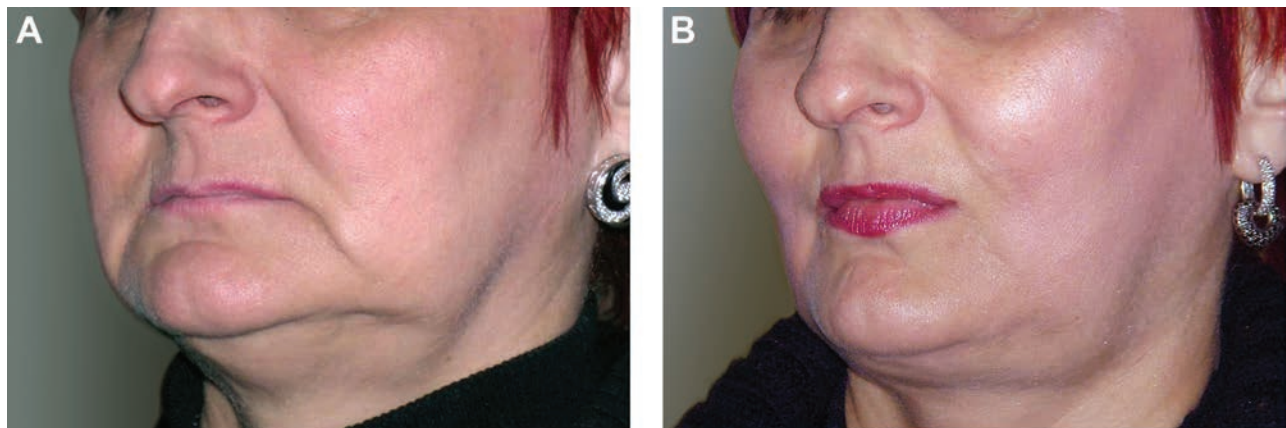


Figure 13. (A) This 58-year-old woman presented with pronounced labiomenal folds and ptosis of the midface. (B) One year after correction with Aptos Springs.



Figure 14. (A) This 34-year-old woman presented seeking “uptilt” of the outer canthi. (B) Immediately after thread-mediated canthopexy with the Aptos Thread 2G technique, the patient demonstrates intentionally-pronounced hypercorrection.

integrated into the tissues by fibrosis, early relapses of ptosis could be expected. Even the seemingly-strong Silhouette suture (NewSurg, Inc., Hilltown, Pennsylvania), when placed linearly with single-point rigid fixation, cannot withstand the wearing action of the facial muscles and will fail within a relatively short time. Other thread-related complications include thread migration and/or exposure, visible needle tracks on the skin, granulomas, and pustules.

The newer Aptos Needle and Aptos Needle 2G methods are not subject to damage by the surrounding musculature, because of deep periosteal or fascial fixation and multivector suspension in overlapping loops.

Common Pitfalls of Threadlifting

New practitioners of the Aptos methods may fall prey to the following mistakes, resulting from inexperience with the techniques:

- deceptive indications;
- insertion of long threads through two or more zones;
- insertion of tough threads in facial regions of strong muscular activity working against them;

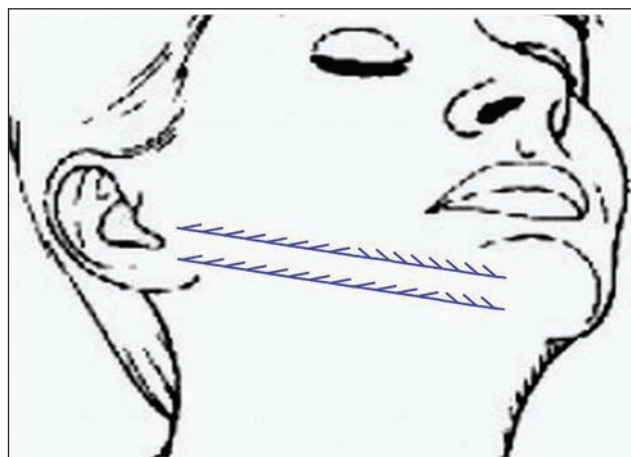


Figure 15. (Upper line) Correct placement of the Aptos thread with an equal number of opposing barbs on either side of the center point. (Lower line) Incorrect suture insertion.



Figure 17. Close-up of the glover's needle tip that we prefer for thread removal.

- poor surgical technique (barb misalignment, injury to vessels or nerves);
- hypocorrection or hypercorrection;
- excessively superficial course of the Aptos Needle or Aptos Needle 2G; and
- placement of inferior-quality threads.

Most complications associated with Aptos methods can be prevented as long as the surgeon has a thorough understanding of (1) the anatomy and physiology of age-related

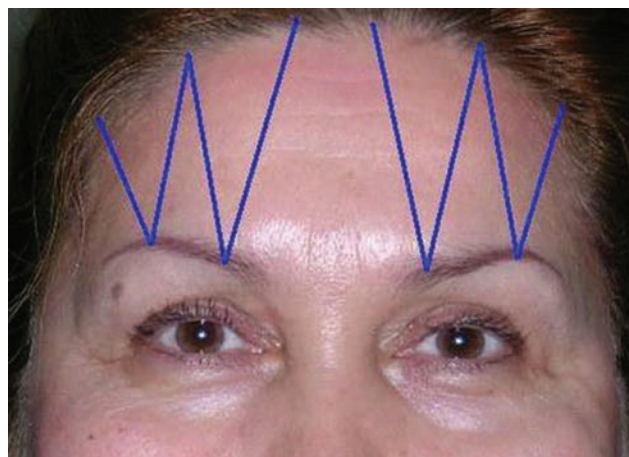


Figure 16. Scheme for rigid eyebrow and forehead lifting with the Aptos Needle 2G method.

and other contour deformities of the face, (2) the principles of thread-mediated lifting with the various Aptos products, (3) appropriate patient selection and indications for threadlifting, and (4) how to match the deformity to its proper corrective method. Other important factors in a successful threadlift involve precise, delicate handling of the equipment/tools and impeccable surgical technique.

Less-than-ideal outcomes can be improved by a number of manipulations, such as injection of fillers and/or insertion of Aptos Wires for smoothing uneven contours, removal of lax or misplaced threads, repeat thread-mediated or classical lifting, physiotherapy, and massage. When threads must be removed, we prefer noninvasive methods of thread location—ultrasonography, visualization by means of bright directed light, diaphanoscopy—followed by a small incision and thread retrieval with a special glover's needle, which has a hook (Figure 17).

CONCLUSIONS

Over the last 12 years, we have noted increased strength of our threadlifts along with improved safety and longevity by virtue of the newer-generation Aptos products. Threadlifts represent a new, progressive trend in facial-rejuvenating surgery that embraces straightforward, technically-undemanding procedures that spare operative time, are economical and minimally invasive, and offer short recovery times. Complications are few, typically minor, and relatively easy to avoid and correct. As a result of the safety and efficacy demonstrated with correct surgical technique, we believe that threadlifting methods deserve a place in the plastic surgeon's approach to facial rejuvenation.

Disclosures

Drs. Marlen, George, and Constantin Sulamanidze are co-owners of all patents held on Aptos products, which are described in this article.

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The Minimal Access Deep Plane Extended Vertical Facelift

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Abstract

Background: Modern facelift techniques have benefited from a “repopularization” of shorter incisions, limited skin elevation, and more limited dissection of the superficial musculoaponeurotic system (SMAS) and platysma in order to shorten postoperative recovery times and reduce surgical risks for patients.

Objectives: The authors describe their minimal access deep plane extended (MADE) vertical vector facelift, which is a hybrid technique combining the optimal features of the deep plane facelift and the short scar, minimal access cranial suspension (MACS) lift.

Methods: The authors retrospectively reviewed the case records of 181 patients who underwent facelift procedures performed by the senior author (AAJ) during a two year period between March 2008 and March 2010. Of those patients, 153 underwent facelifting with the MADE vertical technique. With this technique, deep plane dissection releases the zygomatico-cutaneous ligaments, allowing for more significant vertical motion of the midface and jawline during suspension. Extended platysmal dissection was utilized with a lateral platysmal myotomy, which is not traditionally included in a deep plane facelift. The lateral platysmal myotomy allowed for separation of the vertical vector of suspension in the midface and jawline from the superolateral vector of suspension that is required for neck rejuvenation, obviating the need for additional anterior platysmal surgery.

Results: The average age of the patients was 57.8 years. The average length of follow-up was 12.7 months. In 69 consecutive patients from this series, average vertical skin excision measured 3.02 cm on each side of the face at the junction of the pre auricular and temporal hair tuft incision (resulting in a total excision of 6.04 cm of skin). Data from the entire series revealed a revision rate of 3.9%, a hematoma rate of 1.9%, and a temporary facial nerve injury rate of 1.3%.

Conclusions: The common goal of all facelifting procedures is to provide a long-lasting, natural, balanced, rejuvenated aesthetic result with few complications and minimal downtime. The MADE vertical facelift fulfills these criteria and often yields superior results in the midface and neck areas, where many short scar techniques fail. Furthermore, this procedure can be performed under local anesthesia, which is a benefit to both patients and surgeons.

Keywords

facelift, superficial muscular aponeurotic system, minimal access cranial suspension lift, SMAS, MACS, deep plane facelift, sub-SMAS facelift, vertical facelift, short-scar facelift, facial rejuvenation

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Over the last 30 years, facelift techniques have progressed from a more limited skin elevation with no treatment of the superficial musculoaponeurotic system (SMAS)¹ to more extended elevation of the skin and

SMAS,² but more modern techniques have seen a resurgence of less invasive methods. Today, shorter incisions, limited skin elevation, and more limited dissection of the SMAS and platysma have become popular, with the goal

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of shortening postoperative recovery times and reducing surgical risk. At one end of the pendulum is an extended SMAS facelift; the surgical options become progressively less invasive from there, from a lateral SMAS-ectomy to SMAS plication and multiple microimbrications of the SMAS.³⁻⁵

Historically, because of the limited efficacy and longevity of less invasive facelifts, many anatomical studies were performed in an effort to understand the complex layered architecture of the face. One hallmark study was published by Mitz and Peyronie,⁶ who described the SMAS and sub-SMAS elevation surgical procedures. In this way, our evolution in anatomical understanding of the SMAS, platysma, and underlying facial structures—and the subsequent return to less invasive procedures—was fueled by the desire for more significant and durable results in the midface, jawline, and neck. These modifications from a traditional subcutaneous facelift to lifting of deeper structural elements yielded more substantial long-term results in those areas. They also resulted in minimal skin tension at the closure, which allowed for optimal healing of the incisions.²

With respect to the skin, techniques incorporating extended skin flaps were developed in an attempt to redrape redundancy in the jowl and neck, but these maneuvers can carry greater potential for complications such as subcutaneous irregularities, facial hematomas, and periauricular skin necrosis, especially in smokers and patients with compromised vascularity. To minimize those risks, deep plane facelifting evolved to rely on reduced subcutaneous dissection. Hamra popularized the traditional deep plane technique, lifting the SMAS and skin as a compound unit with a thicker, well-vascularized flap. In that procedure, the flap is elevated in a sub-SMAS dissection in the inferior cheek, transitioning to a supra-SMAS plane immediately superficial to the zygomaticus muscles in the superior medial cheek.^{7,8} This dissection releases the zygomaticocutaneous ligaments that limit vertical elevation of the midface and resuspension during facelift surgery.

The deep plane facelift resulted in a more youthful, natural restoration of the face by lifting the midface and lower face, producing a more harmonious balance between the upper and lower portions of the face. The inferior limit of the sub-SMAS dissection in a deep plane facelift is the inferior border of the mandible; this protects the marginal mandibular branch of the facial nerve. Inferior to the angle of the mandible, the face is lifted in a preplatysmal dissection extending 8 to 10 cm below the mandible. Following a preplatysmal dissection, all redundant anterior platysma is excised and closed via a submental incision, creating countertension in the neck as compared to the lower face. There is limited subplatysmal dissection in the lateral neck from the standard facelift incision. The SMAS and skin are suspended in a superolateral oblique vector. The incision of the deep plane rhytidectomy extends superiorly past the anterior temporal hairline and posteriorly into the postauricular hairline.

The minimal access cranial suspension (MACS) lift was developed to address concerns about large incisions, pro-

longed recovery due to extensive dissection in the face and neck, and the “lateral sweep” phenomenon, which occurs over time after a facelift procedure in which the skin and SMAS were lifted in a superolateral vector.^{9,10} The MACS lift rejuvenates the face by applying a vertical vector to the deep tissues and overlying skin. It is performed through a preauricular incision with a limited posterior limb. However, there is no release of the malar mound and SMAS; it utilizes three microimbrication sutures anchored to the deep temporal fascia to address the midface and the lower half of the face and the neck. The zygomaticocutaneous ligamentous attachments of the midface are not dissected and released with the MACS lift, thus limiting vertical release and suspension of the midface. The MACS lift is usually paired with submental liposuction to correct the cervicomental angle and any existing submental laxity, since there is no platysmal dissection in the neck. This has led to less aesthetic and less durable results in the neck, which has necessitated additional anterior platysmal work.¹⁰

In our practice, approximately one-third of facelifts are performed on patients who underwent a prior lateral SMAS-ectomy or MACS lift. These secondary procedures are designed to address early recurrent jowling and changes in the patients’ necks. Prado et al demonstrated that more than 50% of the patients on whom they performed a MACS lift or lateral SMAS-ectomy required a secondary “tuck-up” procedure within two years postoperatively to correct recurrent jowling and redundant skin.¹¹ The superiority of deep plane techniques over more limited SMAS plication and imbrication techniques has been demonstrated intraoperatively, with objective neck and jowl skin excision measurements at one year.^{12,13} In fact, Kamer et al noted that their revision rate was 71% but was less frequent following a deep plane facelift than after a SMAS facelift.¹⁴

We have experienced similarly-high revision rates with SMAS-only procedures, so we developed a minimal access deep plane extended (MADE) vertical vector facelift in an effort to rejuvenate the middle and lower thirds of the face and upper neck, utilizing a short scar with no posterior limb hairline incision. In this procedure, the incision extends 2 cm superior to the earlobe-facial junction along the posterior concha of the ear. This hybrid technique combines the optimal features of the deep plane facelift and a short-scar MACS lift.¹⁵ The deep plane dissection releases the zygomaticocutaneous ligaments, allowing for more significant vertical motion of the midface and jawline during suspension. As a result, the nasolabial groove is effaced, and the malar volume is positioned vertically higher, giving a more youthful appearance to the malar area. Additionally, our technique utilizes an extended platysmal dissection with a lateral platysmal myotomy, which is not traditionally included in the deep plane facelift. This deep plane dissection—combined with an extended lateral platysmal flap releasing it from the anterior border of the sternocleidomastoid muscle—allows for significantly-greater superolateral motion of the midline platysma in comparison to SMAS purse-string suture techniques. Furthermore, the lateral

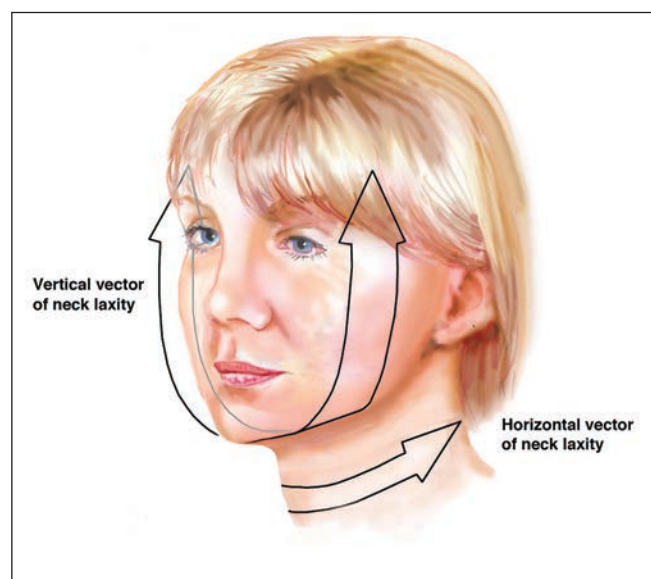


Figure 1. Horizontal and vertical neck vectors of skin laxity.

platysmal myotomy allows for separation of the vertical vector of suspension in the midface and jawline from the superolateral vector of suspension that is required for neck rejuvenation. This obviates the need for additional anterior platysmal surgery.

METHODS

Patients

Candidacy for a MADE-vertical facelift relies on a thorough physical examination of the patient. We have observed success of this procedure in patients from 40 to 70 years of age, even where there is significant anterior platysmal cording and submental skin excess. Anatomical variants that may predispose patients to failures in the submental region with this technique include retrognathia, a low anterior hyoid, and a short vertical height of the neck (for which more aggressive submental surgery is required). Additional procedures that can concurrently address unfavorable cervicomenal contour issues include submental liposuction, platysmal plication, subplatysmal fat excision, and anterior digastric plication.

Our physical examination procedure included an evaluation of how the patient's face and neck would "redrape" when traction was placed on the skin along the vertical vectors to be utilized in this facelift technique (Figure 1). This helped to determine whether the patient was a viable candidate in whom we could forego the posterior hairline incision of traditional facelifts. For this part of the exam, the surgeon placed three fingers at the deep plane entry point (the line coursing from the angle of the mandible to the lateral canthus) on both sides of the face and moved

the skin vertically (Figure 2) to assess whether the submental and platysmal skin laxity is corrected with this tension. If the submental area was corrected, no posterior hairline limb incision or any anterior platysmal surgery was necessary. If the patient still had significant horizontal neck skin excess with this maneuver and platysmal cording still existed, the abbreviated incision associated with our MADE lift was not advisable, as neck redundancy would persist or recur postoperatively. In those patients, a posterior hairline incision would be necessary to remove the horizontal neck laxity and anterior platysma plication for midline platysmal redundancy.

In retrospectively evaluating our cases, we found that 181 facelifts were performed over a two-year period in the senior author's (AAJ) practice. Of those, 28 (15.5%) were not candidates for the MADE vertical lift due to anatomical variants, including retrognathia, a low anterior hyoid, short vertical height of the neck, and excessive platysmal laxity and cording. The remainder (153 patients; 84.5% of the total caseload) underwent facelifting with the MADE technique.

Preoperative Marking

With the patient sitting upright, several important anatomical landmarks were outlined preoperatively, including the path of the temporal branch of the facial nerve and the deep plane entry point (which proceeds from the angle of the mandible to the lateral canthus). The anterior temporal hairline was marked beginning 1.5 cm above the tail of the eyebrow and tracked along the inferior hairline of the sideburn, into the hairless recess between sideburn and auricle, turning downward into the preauricular crease, continuing posttragally, and then following the crease of the lobule-facial junction. The mark was carried behind the earlobe-facial junction, superiorly onto the posterior concha for 2 cm.

Operative Technique

Anesthesia. The MADE vertical facelift can be performed under local anesthesia, conscious sedation, or general anesthesia. Approximately 20% of patients elected to undergo this procedure under local anesthesia (0.5% lidocaine with 1:200,000 units of epinephrine, mixed in equal parts with 0.25% bupivacaine with 1:200,000 units of epinephrine); the remaining patients chose intravenous sedation. The local anesthetic was infiltrated along the incision and over the entire area of subcutaneous and deep plane dissection.

Incision and undermining. The skin incision was made with a No. 10 blade. If the MADE vertical facelift was being performed as a sole procedure, the temporal incision was



Figure 2. (A) This 61-year-old woman presented with facial ptosis, platysmal cording, and submental laxity. (B) The patient is shown undergoing our preoperative maneuver demonstrating how the anticipated vertical vector elevation along a deep plane entry point in the face will treat platysmal cording and submental laxity. For this part of the exam, the surgeon places three fingers at the deep plane entry point (the line coursing from the angle of the mandible to the lateral canthus) on both sides of the face and moves the skin vertically to assess whether the submental and platysmal skin laxity is corrected with this tension. If the submental area is corrected, no posterior hairline limb incision or any anterior platysmal surgery is necessary. If the patient still has significant horizontal neck skin excess with this maneuver and platysmal cording still exists, the abbreviated incision associated with our MADE lift is not advisable, as neck redundancy will persist or recur postoperatively.

extended superiorly to a greater degree than more traditional facelifts. If this procedure was taking place concurrently with a lateral temporal lift, the anterior temporal hairline incision was shortened. The temporal hairline incisions were made in a trichophytic fashion perpendicular to the hair shafts, to allow hair regrowth through the scar once the facelift flap was trimmed and inset. The earlobe was held in a retracted position, for countertension. The incision was extended 2 cm superior to the earlobe-facial junction along the posterior concha of the ear, never crossing onto the mastoid skin. This maneuver conceals the incision even when the patient wears her hair in a ponytail postoperatively. The subcutaneous flap was initially dissected with a No. 10 scalpel and Brown forceps. The dissection was continued with facelift scissors, with the tines pointing upward. The surgeon consistently palpated the thickness of the flap for any

irregularities with his nondominant hand. The subcutaneous dissection was then continued anteriorly to the deep plane entry point and inferiorly 5 cm below the hyoid bone. The preplatysmal subcutaneous dissection extended into the neck below the angle of the mandible and up to the cervical midline (Figure 3).

An incision was then made through the SMAS with a No. 10 scalpel, extending from the angle of mandible to the lateral canthus (the deep plane entry point). From that point, the subcutaneous flap and SMAS were dissected bluntly as one compound unit anteriorly in a sub-SMAS plane in the inferior cheek. Facelift scissors were then inserted and spread perpendicular to the branches of the facial nerve. A lighted retractor was used to elevate in that plane. The plane of dissection was then advanced with a blunt dissector (model 502-5Z; Karl Storz, Tuttlingen, Germany) anteriorly to the level of the facial

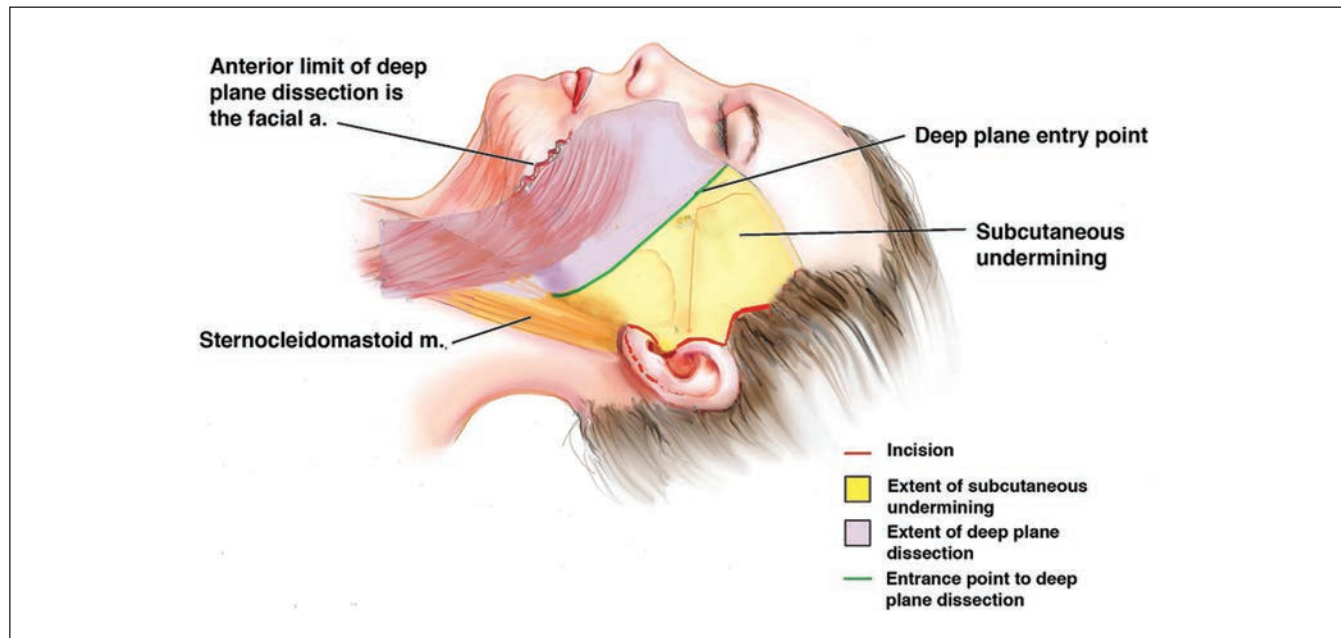


Figure 3. Intraoperatively, the incision at the anterior temporal hairline extends behind the tragus, around the lobule, and onto the posterior concha with no posterior limb hairline incision. The extent of subcutaneous undermining is shown. The subcutaneous undermining is extended in a preplatysmal plane 5 cm below the hyoid bone and extends to the cervical midline. The deep plane entry point starts from the angle of the mandible to the lateral canthus. The anterior limit of the deep plane dissection is the nasolabial fold superiorly and the facial artery inferiorly. The inferior limit of the deep plane dissection is subplatysmal 5 cm below the mandible.



Figure 4. This intraoperative photograph shows the deep plane flap elevated superior and inferior to the zygomaticocutaneous ligaments, which will later be dissected connecting the two pockets.

artery and inferiorly to 4 cm below the angle of the mandible. The zygomaticocutaneous ligaments were initially left intact in the midface, and blunt dissection was used to lift the tissues superior to these ligaments (Figure 4). This superior dissection plane was immediately superficial to the orbicularis oculi muscles and continued inferomedially in a plane that was superficial to the zygomaticus major and minor muscles, ending at the nasolabial fold medially (Figure 5).

At that point, the zygomaticocutaneous ligaments were carefully divided with vertical blunt spreading via facelift scissors, which remained in a plane superficial to the mimetic musculature, thus connecting the superior and inferior pockets. After the ligaments were released, this dissection yielded a thick musculocutaneous flap composed of skin and malar fat pad of the cheek superiorly and the SMAS and platysma inferiorly. This process released the malar mound, including the malar fat pad, and allowed the midface to be elevated vertically.

Attention was then turned to the dissection of the deep plane flap at the angle of the mandible. The SMAS, platysma, and anterior border of sternocleidomastoid muscle interface were dissected. An intraoperative marking was made from the deep plane entry point at the angle of the mandible, extending inferiorly along the fascial attachments of the anterior border of the sternocleidomastoid muscle to the platysma (Figure 6A and 6B). The fascial attachments were released with a No. 15 scalpel while the assistant held the edges of the tissue with Adson-Brown forceps. The dissection was continued under the platysma, 5 cm below the angle of the mandible. This important maneuver released the dense fascial attachments of the platysma from the sternocleidomastoid muscle, which allowed for greater vertical mobilization (Figure 6C). The last step before vertical suspension of the deep plane flap and extended lateral platysmal flap was dissection of a cuff along the deep plane entry point. This cuff facilitated suture suspension of the flap. The cuff was created with small snips of a facelift scissors.

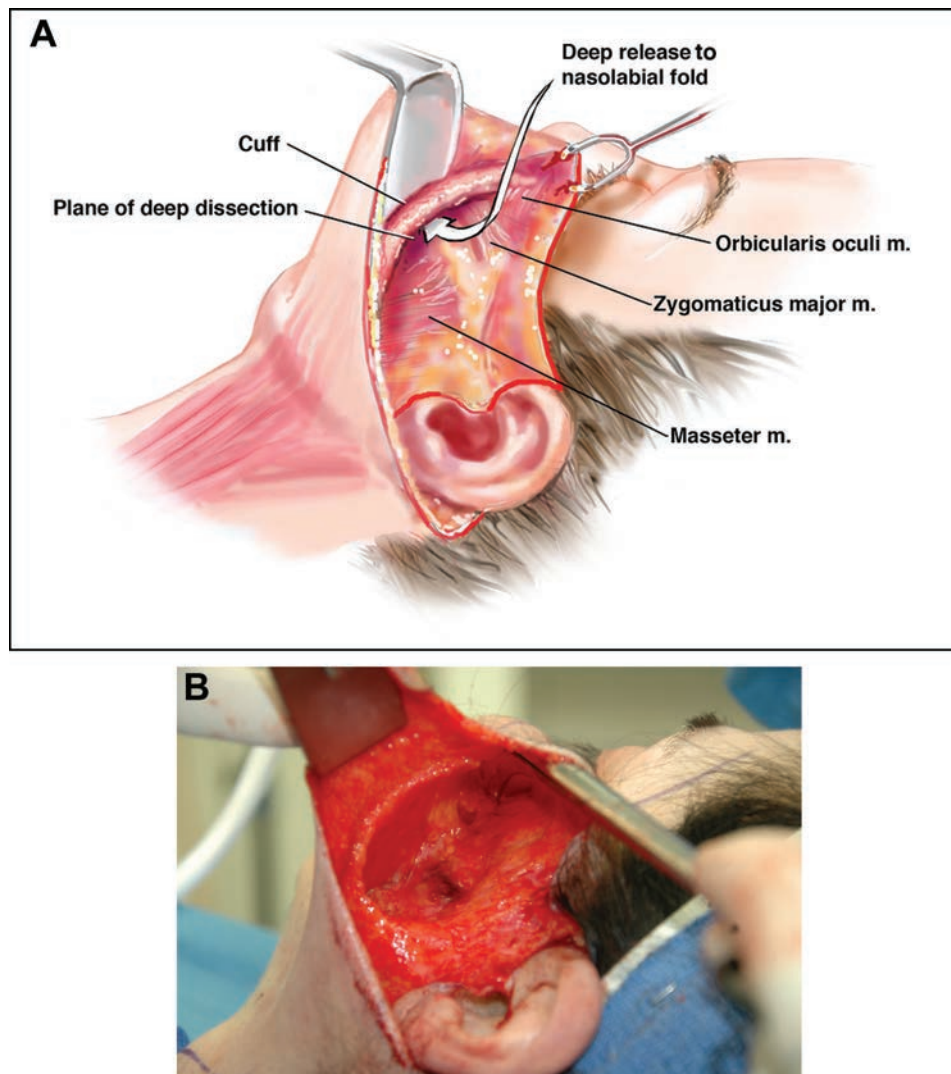


Figure 5. (A) Deep plane dissection is completed to the nasolabial fold medially, with the zygomaticocutaneous ligaments dissected. (B) The intraoperative photograph shows the same maneuver.

Intraoperatively, hemostasis was achieved with bipolar cautery, and the tissues were irrigated with gentamycin irritant. A No. 10 French Blake drain with a Jackson-Pratt bulb was placed into the patient’s upper neck, with the puncture site behind the ear.

Suspension sutures. A total of three 3-0 nylon suspension sutures were placed with a PS-2 needle to suspend the flap to the temporalis fascia such that the flap was advanced with a vertical vector with great tension on the SMAS but none on the skin. Firm bites 1 to 1.5 cm long and 0.5 cm deep were placed into the cuff of SMAS dissected earlier in the procedure. These three sutures were run from the leading edge of the composite flap at the deep plane entry point to the deep temporal fascia. There was no cabling of the suspension suture at these points.

This vertical redraping of the face above the mandible reduced vertical platysmal redundancy but limited the available platysma for superolateral redraping.

After vertical suspension, a lateral platysmal myotomy of 3 cm was performed approximately 1 cm below the mandibular angle, and the platysma was elevated off the sternocleidomastoid muscle. This allowed for separation of the vertical vector in the face from the superolateral vector on the platysma, which is required for durable neck rejuvenation. A fourth suspension suture was placed along the extended lateral platysmal flap. This suture was anchored to the mastoid fascia and pulled in a superolateral vector (Figure 7), which yielded a more aesthetic postoperative contour of the jawline. If we think of the vertical vector as representing an inverted bucket handle, the vertical suspension supports the submental region (Figure 1).

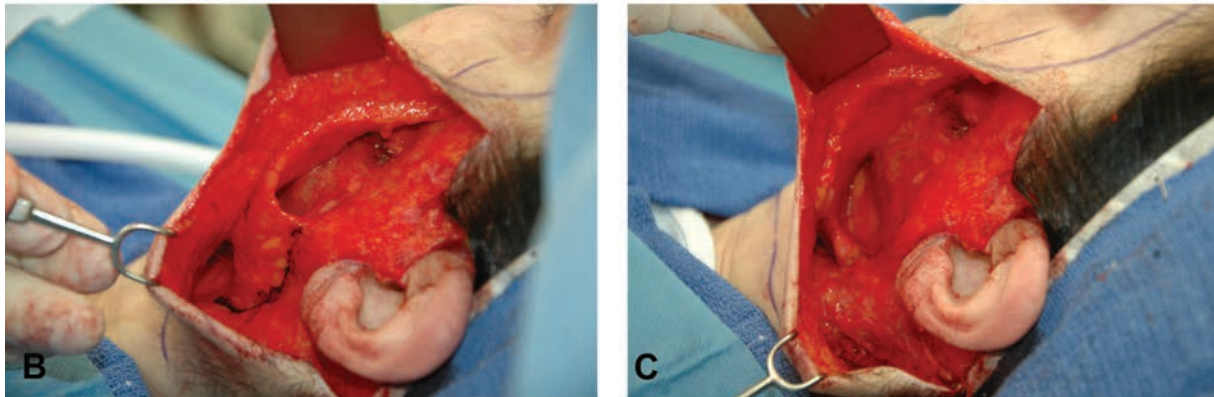
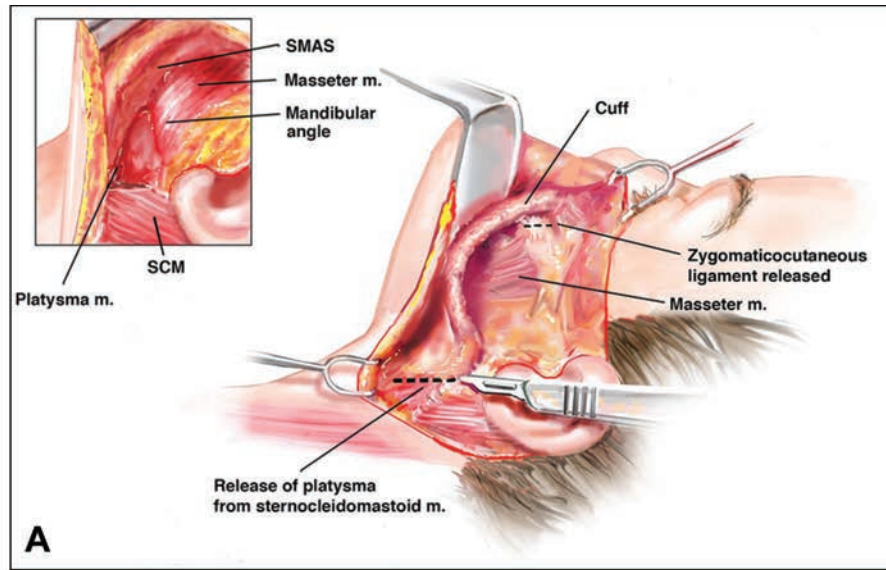


Figure 6. (A) The point of dissection and release of the platysma from the anterior border of the sternocleidomastoid muscle inferior to the angle of the mandible. The preplatysmal dissection plane in the neck can also be seen. (B) The intraoperative photograph demonstrates the same maneuver. (C) Another intraoperative photograph shows the platysma released from the anterior border of the sternocleidomastoid muscle and connected to the deep plane flap. The angle of the mandible is exposed, as demonstrated in Figure 6A.

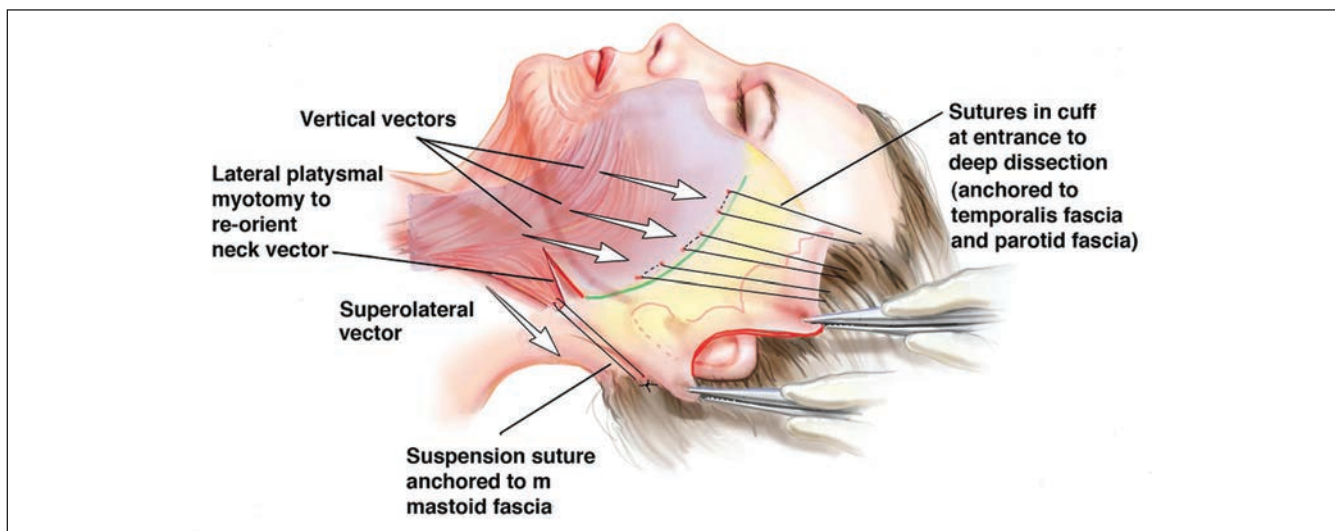


Figure 7. Three vertical face suspension sutures are separated by a lateral platysmal myotomy from the fourth superolateral neck vector suspension suture.

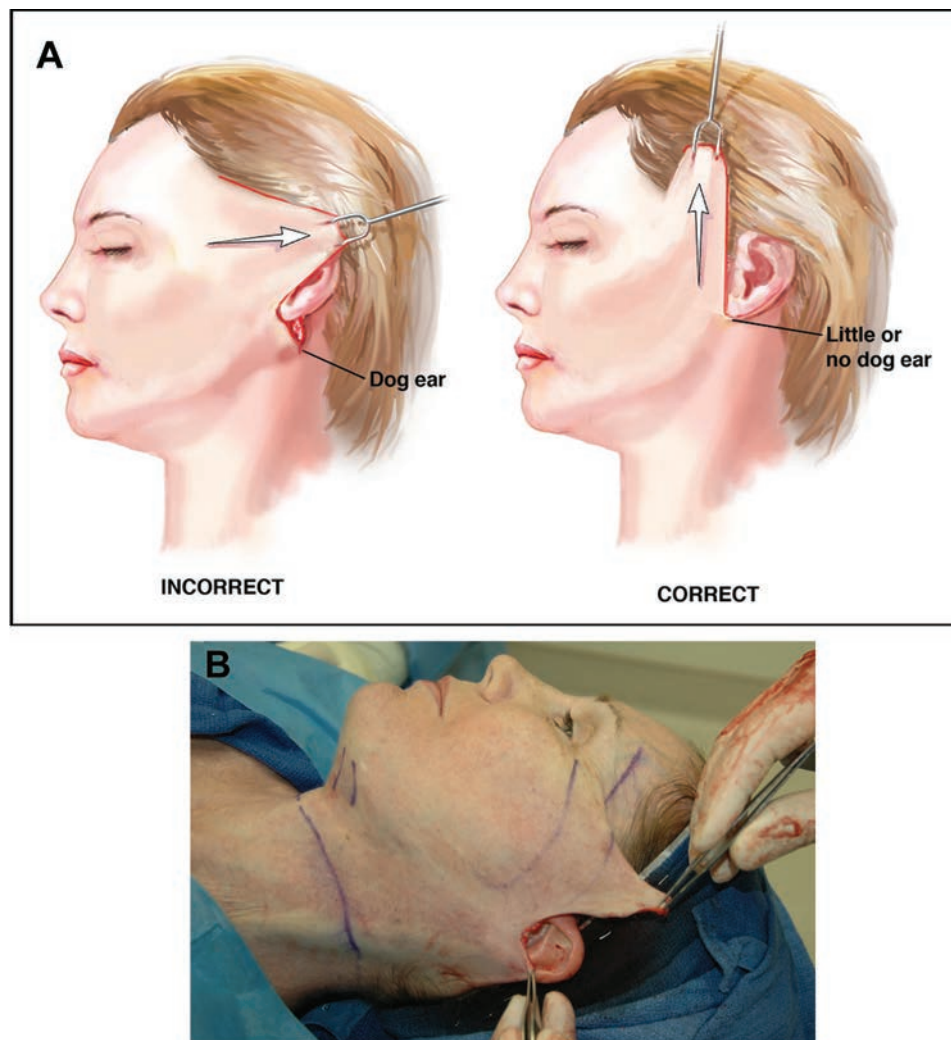


Figure 8. (A) Vertical skin redraping. Notice that the vertical skin redraping eliminates a dog-ear postauricularly so that no posterior limb hairline incision is necessary. (B) The intraoperative photograph shows the same maneuver.

Skin redraping and resection. Similar to the MACS lift, one of the most important features of the MADE vertical lift is vertical skin redraping. The traditional deep plane facelift has a superolateral component of skin redraping in the face, causing a skin excess in the postauricular and earlobe areas, which necessitates a posterior hairline limb incision for redraping. Alternatively, the skin redraping in our vertical technique places the majority of the excess skin anteriorly, with minimal skin excision required posterior to the lobule (Figure 8). Excising skin vertically on both sides has a tightening effect on the skin in the submental region, as shown in the marking photos (Figures 1 and 2). We routinely find that the deep plane entry point essentially merges with the newly-dissected incision line (Figure 9).

Intraoperatively, the skin resection of the cheek flap was carried out by following the anterior temporal hairline.

The earlobe was pulled upward and had to be set back with a small skin incision, to place it back in its natural position. The posterior neck skin was pulled up vertically behind the earlobe to support it postoperatively, preventing a “pixie” ear deformity and elongation of the earlobe. Again, this did not require a posterior limb hairline incision.

Vertical mattress sutures were placed in the anterior temporal hairline. The posttragal incision was closed with an interrupted 5-0 plain gut suture on a P-3 needle. The anterior facial incisions were closed with a 5-0 nylon suture on a P-3 needle, and the postauricular incisions were closed with a 4-0 nylon suture. For patients with more advanced aging and rhytidosis, some bunching of the skin in the superior portion of the anterior temporal hairline incision is expected but will settle

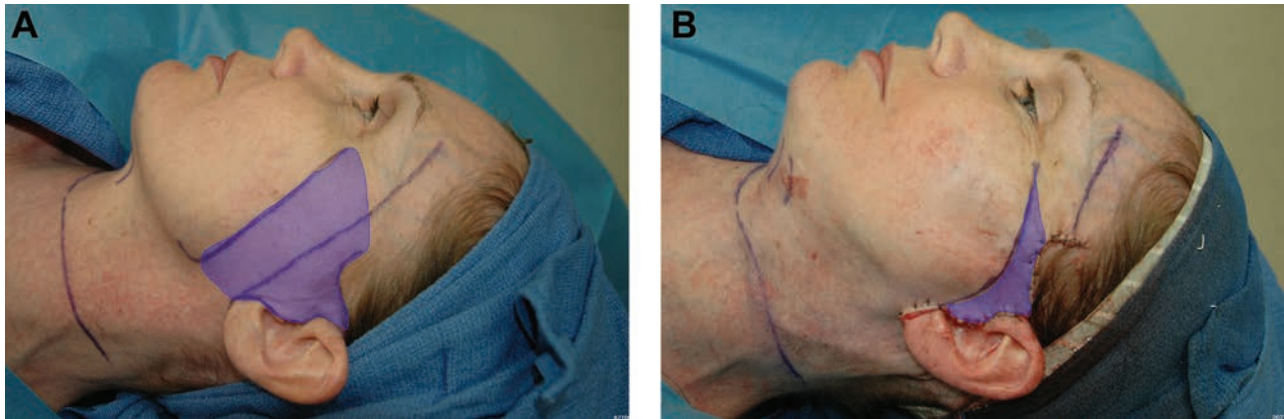


Figure 9. This patient preoperatively (A) and immediately postoperatively (B), demonstrating the area of skin removed during the MADE vertical facelift.

over time in several weeks. A video of the surgical procedure is available at www.aestheticsurgeryjournal.com. You may also use any smartphone to scan the code on the first page of this article to be taken directly to the video on www.youtube.com.

RESULTS

In this series, 153 consecutive patients (seven men and 146 women) were treated with a MADE vertical facelift. Their average age was 57.8 years (range, 36-75), and the average length of follow-up was 12.7 months. We examined the amount of vertical skin excision in 69 of these patients (138 operated facial halves) and found that an average of 3.02 cm was excised on each side of the face at the junction of the preauricular and temporal hair tuft incision, resulting in a total excision of 6.04 cm of skin.

Six patients (3.9%) from our series underwent a revision at one year postoperatively. Of the patients presenting for revision surgery, three required a “tuck-up” procedure; two patients required direct excision of submental neck skin; and one patient required submental liposuction. There were relatively few complications in this series. Three patients (1.9%) experienced hematoma, one of which required additional surgical intervention and two of which were managed conservatively with needle aspiration. Two patients (1.3%) had temporary nerve injury (one marginal mandibular and one temporal) that resolved within six weeks. There were no cases of permanent nerve injury. One patient required removal of one nonabsorbable 3-0 suspension suture due to palpability on the surface. We believe that this low incidence of suture show is due to the thickness of the deep plane facelift flap, but it is acceptable to use Mersilene (Ethicon, Inc., Somerville, NJ) or PDS suture (Ethicon, Inc., Somerville, NJ) as a substitute for the suspension sutures. Clinical results are shown in Figures 10-14.

DISCUSSION

The advantages of our MADE vertical lift lie mainly in its combination of the optimal features of the MACS lift and the deep plane facelift. The MADE procedure involves a short, anteriorly-based incision that curves immediately behind the ear/lobule, extending superiorly 2 cm onto the posterior concha but never crossing the mastoid skin, thus preventing the need for a posterior hairline limb incision. The MADE incision is approximately 2 cm longer than a traditional MACS lift incision, which stops on the anterior surface of the ear lobule. Therefore, the MADE vertical lift allows for more vertical release of the malar mound and a larger degree of vertical elevation of the aged face, made possible by release of the zygomaticocutaneous ligaments in the deep plane. This caudocranial vertical lift rejuvenates the midface by repositioning the malar fat pad. The procedure conserves facial volume by repositioning the deep facial tissues, as opposed to excising them (as in a SMAS-ectomy). It produces more significant neck rejuvenation by combining extended lateral platysmal dissection off the sternocleidomastoid muscle with a lateral platysmal myotomy; this allows for further release and redraping of the metalized platysma (Figures 10-12).

Several authors have advocated a lateral subplatysmal dissection with myotomy, but limited dissection can restrict the degree of neck mobilization, leading to recurrences of lateral platysmal bands.¹⁶⁻¹⁸ There are deep cervical retaining ligaments in the neck that anchor the platysma to the fascia of the sternocleidomastoid muscle, which limits its mobility. The MADE vertical facelift releases these ligaments, allowing the neck flap to be advanced superolaterally and thus obviating the need for a submental incision and central platysmal plication. The release and resuspension of the retaining ligaments in the neck yields a durable and long-lasting result.

Cadaveric studies were performed by the senior author (AAJ) to quantitatively analyze the superolateral motion



Figure 10. (A C, E) This 61-year-old woman presented with significant upper neck submental laxity, bilateral platysmal banding, jowls, marionette grooves, and midface ptosis. (B, D, F) One year after MADE vertical facelift under local anesthesia. Note the improved definition of the mandibular line. The patient's platysmal banding was flattened as a result of lateral platysmal redraping due to an extended lateral platysmal flap and platysmal myotomy. Rejuvenating effects in the middle one-third of the face included improvement in the nasolabial fold, vertical elevation of the cheek, and increased midface volumization.



Figure 10 (continued). (A C, E) This 61-year-old woman presented with significant upper neck submental laxity, bilateral platysmal banding, jowls, marionette grooves, and midface ptosis. (B, D, F) One year after MADE vertical facelift under local anesthesia. Note the improved definition of the mandibular line. The patient's platysmal banding was flattened as a result of lateral platysmal redraping due to an extended lateral platysmal flap and platysmal myotomy. Rejuvenating effects in the middle one-third of the face included improvement in the nasolabial fold, vertical elevation of the cheek, and increased midface volumization.

of the medial edge of the platysma after SMAS plication versus deep plane facelifting.¹² Measurements were taken of the lateral distraction of the medial edge of the platysma muscle during lateral tightening of the SMAS-platysmal complex. These measurements were taken for the following procedures: SMAS/platysmal plication, deep plane facelift, and deep plane facelift with inferior release of the platysmal edge below the angle of the mandible. The medial edge of the platysma was distracted 2.2 vs 9.4 mm when comparing SMAS/platysmal plication and deep plane facelift. The results showed that a traditional deep plane dissection allowed for 427% greater superolateral motion of the midline platysma in comparison to SMAS purse-string suture techniques because the maneuver redrapes and flattens anterior platysmal cording, obviating the need for concomitant platysmal plication in primary rhytidectomy, which is required for heavier necks with the MACS technique.¹⁰ We have been disappointed by the morbidity and poor long-term results of anterior corset platysmaplasty, as noted by Baker.⁵ One of the most common problems we have noticed with that procedure is submental fullness related to lateral volume transfer of the aged platysma to the midline of the neck.

The learning curve for the MADE vertical lift involves becoming facile with deep plane facelift flap elevation and becoming comfortable with tailoring the skin in the temporal region, as the majority of the skin is excised anteriorly instead of postauricularly (as in traditional lifts). Our overall incidence of temporary facial nerve injury was 1.3%, with no permanent nerve injury. We believe that our incidence of facial nerve injury is lower than that in other series because the entire deep plane dissection is performed bluntly without electrocautery or sharp dissection.¹⁹ In our practice, it takes approximately two hours to perform a MADE vertical facelift. This is a relatively short operative time because only one flap is elevated, instead of redraping the SMAS and skin separately, and the greater redraping of the platysma eliminates the need for anterior platysmal surgery.

Our experience is that patients heal quickly after a MADE vertical facelift. We believe that there is relatively little post-operative downtime because there is a more robust blood supply in the thicker deep plane flap as compared to the traditional subcutaneous flap and because the plane of dissection is subfascial and essentially bloodless (as compared to a subcutaneous plane, where much bleeding occurs due to the subdermal plexus) (Figure 13).



Figure 11. (A C, E) This 54-year-old woman presented with moderate upper neck and submental laxity, jowls, marionette grooves, and severe midface ptosis. (B, D, F) One year after MADE vertical facelift under local anesthesia. Note that the patient's nasolabial groove has faded and her malar volume is in a higher vertical position, giving a youthful malar augmentation effect, which can be best appreciated in the three-quarter view. In the lower third of the face, the patient demonstrates better definition of the mandibular line with reduced jowls and neck laxity.

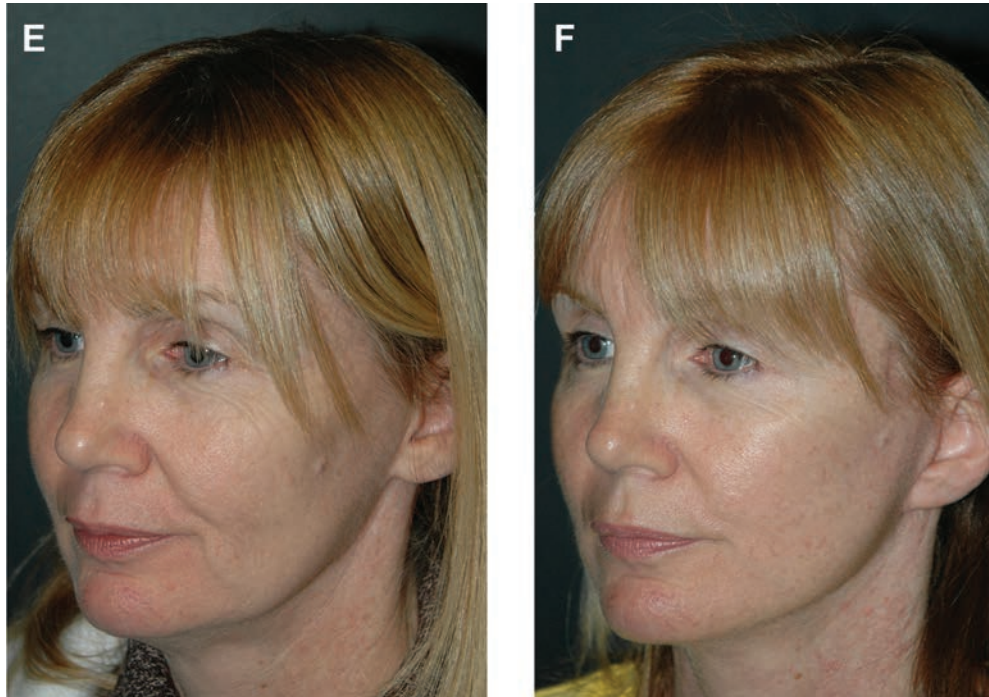


Figure 11 (continued). (A C, E) This 54-year-old woman presented with moderate upper neck and submental laxity, jowls, marionette grooves, and severe midface ptosis. (B, D, F) One year after MADE vertical facelift under local anesthesia. Note that the patient's nasolabial groove has faded and her malar volume is in a higher vertical position, giving a youthful malar augmentation effect, which can be best appreciated in the three-quarter view. In the lower third of the face, the patient demonstrates better definition of the mandibular line with reduced jowls and neck laxity.

The vertical vector in the MADE lift is paramount to achieving a natural-appearing result. Traditionally, facelifts have a superolateral vector of traction on the SMAS. The skin is often reoriented with an oblique vector that does not rejuvenate the face but makes it appear flatter. The “lateral sweep” phenomenon can occur over time because vertical ptosis of obliquely-redraped skin reoccurs, resulting in a curtain-like deformity.²⁰ The end of the more limited skin flap of SMAS rhytidectomies can also be seen as a subcutaneous irregularity, producing an unnatural result. Interestingly, since the deep plane entry point represents a virgin plane in the post-SMAS rhytidectomy patient, it is a great choice for reorienting the vertical vector of the face (Figure 14).

The debate regarding the “best” facelift technique is ongoing and involves experienced surgeons with different aesthetic and surgical philosophies. There will probably never be a definitive answer to this question because of the highly-subjective nature of aesthetics, variability among surgical techniques and patient anatomy, and specific patient desires. However, the common goal of all facelifting techniques is to produce a long-lasting, natural, balanced, aesthetic result with

few complications and reduced downtime. The MADE vertical facelift fulfills all these criteria.

CONCLUSIONS

The MADE facelift, which relies on a combination of the optimal features of the MACS lifts and deep plane facelifts, is distinguished by its use of a short, anteriorly-based incision that curves immediately behind the ear/lobule, extending superiorly 2 cm onto the posterior concha but never crossing the mastoid skin, thus preventing the need for a posterior hairline limb incision. This procedure can be performed under local anesthesia to concurrently rejuvenate the neck, submental area, jowls, lower third of the face, and the midface. It can be effectively combined with other minimally-invasive rejuvenative procedures such as autologous fat grafting, laser resurfacing, and lip augmentation. The authors believe that this procedure yields superior results in patients from 40 to 70 years of age, even when there is significant anterior platysmal cording and submental skin excess.



Figure 12. (A C, E) This 49-year-old woman presented with a significant obtuse neck angle, low anterior hyoid, short neck, and excessive subplatysmal laxity. (B, D, F) Eighteen months after MADE vertical facelift, chin augmentation, and submental liposuction under general anesthesia. Note the better definition of the mandibular line and submental contour. Rejuvenating effects in the middle one-third of the face include improvement in the nasolabial fold, vertical elevation of the cheek, and increased midface volumization. This patient experienced postoperative ear lobule deformity and flattening of the tragus, likely due to thick skin, severe facial liposis, and a heavy face.



Figure 12 (continued). (A C, E) This 49-year-old woman presented with a significant obtuse neck angle, low anterior hyoid, short neck, and excessive subplatysmal laxity. (B, D, F) Eighteen months after MADE vertical facelift, chin augmentation, and submental liposuction under general anesthesia. Note the better definition of the mandibular line and submental contour. Rejuvenating effects in the middle one-third of the face include improvement in the nasolabial fold, vertical elevation of the cheek, and increased midface volumization. This patient experienced postoperative ear lobule deformity and flattening of the tragus, likely due to thick skin, severe facial liposis, and a heavy face.



Figure 13. This 54-year-old woman is shown one day (A) and seven days (B) after undergoing a MADE vertical facelift.



Figure 14. (A) This 49-year-old woman presented after having undergone a lateral SMAS-ectomy procedure one year prior (performed elsewhere). Her preoperative photograph shows a “lateral sweep” deformity with subcutaneous irregularities. (B) One year after MADE vertical facelift, which reoriented the vertical vector of her face and corrected residual jawline and neck ptosis.

Disclosures

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The Role of Septal Cartilage in Rhinoplasty: Cadaveric Analysis and Assessment of Graft Selection

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Abstract

Background: In addition to providing nearly 50% of total airway resistance via the internal valve, the nasal septum provides support for the cartilaginous portion of the nasal dorsum, and it is responsible for determining the projection of the nasal tip. In modern rhinoplasty, septal cartilage plays an important role as a donor graft material.

Objectives: The authors evaluate the anatomy of nasal septal cartilage, identifying variations according to certain regions of the septum and proposing a correlation between the topography and morphology of septal cartilage and graft choice.

Methods: An anatomical study was performed on 14 fresh adult cadavers. The excised septal cartilage was placed on grid paper; digital images were taken; all septal cartilage was divided into nine equivalent quadrants; and quantitative measurements for length, height, and area were calculated and compared. Statistical significance was set at $P < .05$.

Results: The average length of the septum was 35.14 mm, while the average height was 32.5 mm. The average septal area was 933.11 mm². The septal thickness mean values were analyzed in nine quadrants, ranging from 1.04 to 1.71 mm. Statistically-significant differences in mean values were found in 13 of the 14 cadavers. Specifically, the central and cranial areas were thickest, and the area corresponding to the L-strut was thinnest.

Conclusions: Anatomical variations of the thickness of septal cartilage excisions were found to be statistically significant, and these differences play an important role in the proper selection of the septal grafts.

Keywords

rhinoplasty, septal cartilage, grafts

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The importance of nasal septal anatomy is related to the central support provided by this structure and its articulation with the upper lateral cartilage. This framework forms the internal valve, which is responsible for almost 50% of total airway resistance.¹⁻³ Cephalometric studies have also demonstrated the importance of the septum in the middle third of facial and nasal development.⁴ In modern rhinoplasty and nasal reconstruction, septal cartilage plays another important role—that of a donor graft material.⁵⁻¹⁰ The nasal septum provides support for the cartilaginous portion of the nasal dorsum and tip; it is also important in determining projection of the nasal tip.^{1-3,11} In an effort to strengthen the osseocartilaginous framework, thereby reducing the effects of unpredictable scarring, surgeons

are routinely performing conservative reductions and frequently utilizing grafts during rhinoplasty.^{12,13}

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The variety of grafts available for reconstruction of the nasal dorsum, for support of the internal and external valves, and for projection/definition of the nasal tip has led to a need for more cartilage donor sites. The septum is the primary nasal graft donor site and the first choice of most authors.^{7,9,12} Features that make it especially useful include the surgeon's ability to harvest the graft from the same operative site, a low rate of infection and absorption, and a ready supply of straight, strong cartilage in moderate amounts. When the necessary graft is larger than the available septal material—and in cases of secondary rhinoplasty, where the septum has already been tapped—costal cartilage and ear cartilage are alternatives.

The proper selection of donor grafts has a major impact on long-term results; proper thickness, sufficient length, and a low possibility of distortion (mainly in the costal cartilage) are essential features of the ideal graft.^{5,12} Although we know that the nasal septum provides strong and straight cartilage, few studies have assessed the appropriate thickness, length, and area of such cartilage to determine the ideal material and site for each type of nasal graft.

The purpose of this study was to evaluate the anatomy of nasal septal cartilage through precise measurements of height, length, area, and thickness in a cadaver series, identifying variations according to certain regions of the septum. Additionally, we propose a correlation between the topography and morphology of septal cartilage and graft choice.

METHODS

An anatomical study was performed on 14 fresh adult cadavers, 12 male and two female, with apparent ages ranging between 20 and 70 years. Although the medical histories were unavailable, any specimens with physical signs of facial trauma, nasal abnormality, or prior nasal surgery were excluded.

In each cadaver, an open-approach rhinoplasty was carried out, including step-by-step dissection with submucosal release of the upper and lower lateral cartilage connections and release of the osseocartilaginous adhesions (Figure 1). Septal cartilage dissection then proceeded in a subperichondrial surface, and the cartilage was removed in its entirety. When the bony structures accompanying the septal cartilage were reached, which ensured complete removal, they were carefully separated from the cartilage before measurements were taken. The excised septal cartilage was placed on grid paper; digital images were captured; and measurements of specific areas were made with ImageJ 1.42q software (National Institutes of Health, Bethesda, Maryland; software is open-source). The total area was calculated, along with the points of greatest length and height (measured with a millimeter ruler).

All septal cartilage was divided into nine equivalent quadrants by drawing two straight lines parallel to the nasal dorsum and two lines perpendicular to those markings. These quadrants were identified as A through I (Figure 2). A posterior division in septal zones was

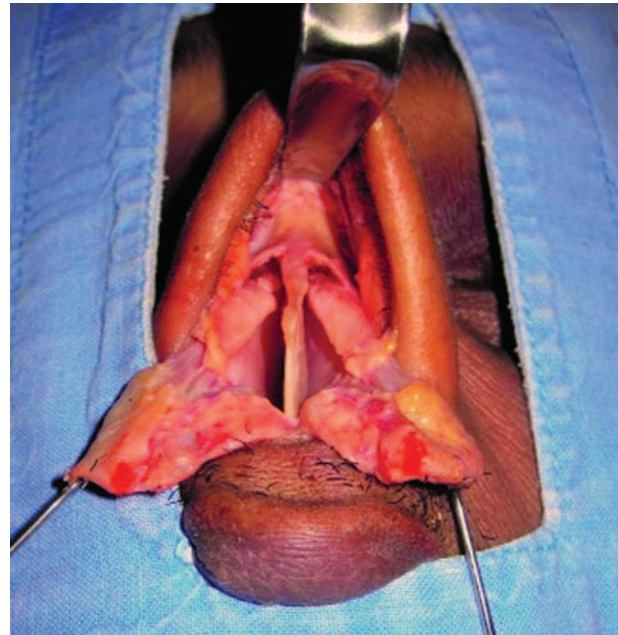


Figure 1. Nasal anatomy in a fresh cadaver. The retractor exposes the septal cartilage after dissection.

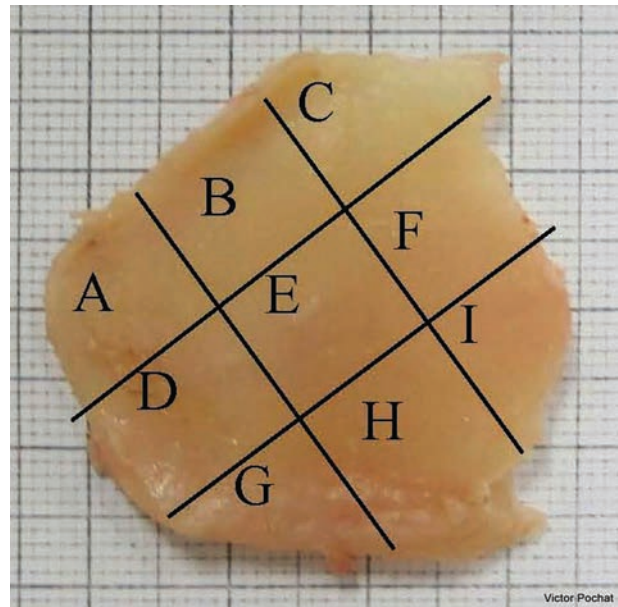


Figure 2. Excised septal cartilage is divided into nine equivalent quadrants. A posterior division in eight zones was proposed: dorsal septum = ABC, caudal septum = ADG, septal base = GHI, septal base remaining = HI, central remaining = EF, anterior to ethmoid = CFI, posterior to caudal septum = BEH, central = DEF.

performed to determine the new anthropometric measurements. The thickness was measured at the midpoint of each quadrant (Figure 3) with a Starrett 799 digital caliper (LS Starrett Company, Suzhou, China). This caliper has a



Figure 3. Cartilage thickness measured with a digital caliper.

resolution of 0.01 mm, and its accuracy provided an acceptably-low margin of error in the measurements.

We also performed a computer reconstruction of the average septal cartilage area, excluding the L-strut (10 mm); this was the remaining area available for graft harvesting. Analysis was performed with descriptive and inferential statistics, according to the nonparametric Kruskal-Wallis test and a subsequent Student-Newman-Keuls test (when applicable). Results were tabulated with BioStat 5.0 software (Microsoft Corp., Redmond, Washington). Statistical significance was assumed at $P < .05$.

RESULTS

The average length of the septum in the 14 cadavers studied was 35.14 mm (range, 24 to 50 mm), while the average height was 32.5 mm (range, 28 to 39 mm). The average septal area was 933.11 mm² (range, 594.44 to 1431.87 mm²) (Table 1). Mean septal thickness was measured in nine quadrants and ranged from 1.04 to 1.71 mm; the mean thicknesses were found to have statistically-significant differences in 13 cases (Tables 2 and 3). There were no statistically-significant differences ($P = .2205$) when only septal zones were analyzed (Table 4). Through computer reconstruction, we determined that the average remaining septal area (after exclusion of the L-strut) was 518.66 mm² and that the grafts could reach average lengths of 30 mm when constructed obliquely (Figure 4).

DISCUSSION

Nasal anatomy receives a great deal of attention in rhinoplasty literature.^{1,3,6,14-16} The intricate anatomy of the nose and its relationship to nasal support, respiratory function, and facial development have been well established.^{1-4,17} The placement of autogenous septal cartilage in rhinoplasty and complex nasal reconstruction has also been extensively discussed.^{6-9,12,13} However, studies regarding

Table 1. Anthropometric Measurement of Septal Cartilages

Septal No.	Sex	Height, mm	Length, mm	Septal Area, mm ²
1	Male	37	45	1431.87
2	Male	34	32	936.29
3	Male	35	35	964.42
4	Male	39	39	1064.54
5	Male	28	24	594.44
6	Female	28	30	624.49
7	Male	31	30	815.18
8	Male	35	50	1163.04
9	Male	30	42	975.34
10	Female	30	37	788.71
11	Male	33	34	1102.85
12	Male	30	34	912.11
13	Male	35	30	807.18
14	Male	30	30	883.13
Mean		32.5	35.14	933.11

Table 2. Nasal Septal Thickness* in Nine Quadrants^a

Quadrants	Mean	SD	CV, %
A	1.04	0.39	37.98
B	1.14	0.28	25.07
C	1.15	0.44	38.32
D	1.07	0.24	23.09
E	1.47	0.38	25.85
F	1.71	0.55	32.67
G	1.28	0.46	36.29
H	1.37	0.38	28.13
I	1.21	0.52	43.62

*In mm. ^aSee Figure 2 for quadrants. CV, coefficient of variation.

septal morphology and its relation to cartilage graft choice are rare.

Classically, it is estimated that a strut of L-shaped cartilaginous septum ranging between 8 and 10 mm, with its connections with the vomer and ethmoid bone intact, is sufficient to maintain nasal support.^{2,6} (Failure to place a sufficient graft may result in a saddle nose deformity.) The remaining septal cartilage harvested during L-strut

Table 3. Coefficients of Variation for Cartilage Thickness Between Quadrants

Area	P ^a
A × E	< .01
A × F	< .01
A × G	< .05
A × H	< .05
B × E	< .05
B × F	< .01
C × F	< .01
D × E	< .01
D × F	< .01
D × G	< .05
D × H	< .05
E × I	< .05
F × I	< .01

^aKruskal-Wallis nonparametric test, $P = .0011$; posterior Student-Newman-Keuls test, $P < .05$ (statistically significant).

Table 4. Nasal Septal Thickness in Eight Zones^a

Zone	Mean	95% CI	SD	CV, %
Dorsal septum	1.11	1.04-1.15	0.06	5.59
Caudal septum	1.13	1.05-1.20	0.13	11.50
Septal base (above the vomer)	1.29	1.23-1.34	0.08	6.44
Anterior to the ethmoid	1.36	1.15-1.54	0.30	22.52
Posterior to caudal septum	1.33	1.14-1.44	0.16	12.74
Central	1.42	1.07-1.63	0.32	22.75
Central remaining	1.59	1.47-1.59	0.16	10.52
Septal base remaining	1.29	1.21-1.29	0.11	9.05

^aKruskal-Wallis nonparametric test, $P = .2205$ (statistically nonsignificant). The eight zones/quadrants with statistically-significant differences are included here. CI, confidence interval; CV, coefficient of variation.

excision can be useful as a donor site for many other kinds of cartilaginous grafts.^{5,12} Miles et al¹⁶ determined that the cartilaginous portion of the septum accounted for 47.5%

of the total area of the nasal septum. Hwang et al¹⁴ evaluated septal cartilage thickness in 14 adult Korean cadavers and found that the septal base (anterior to the vomer) was the thickest area (range, 2.19 to 3.03 mm), while the thinnest was the area superior to the septal base (range, 0.74 to 0.97 mm). The mean septal cartilage height was 2.99 cm, and the mean length was 3.31 cm. In another study, Mowlavi et al⁶ examined 11 cadavers and identified the septal base as the thickest area (2.7 mm), the dorsal septum as having intermediate thickness (2.0 mm), and the central portion and the septal angle as the thinnest areas (1.3 and 1.2 mm, respectively). In their study, the authors suggested preserving a more generous L-shaped strut in the caudal septum.

Our study defined the central remaining zone as the thickest (Zone EF, 1.59 mm; Figure 2), with the central zone itself (Zone E, 1.42 mm; Figure 2) being the second thickest. The dorsal septum (1.11 mm) and the caudal septum (1.13 mm) were the thinnest areas. One possible explanation for this discrepancy between our results and those of previous studies is potentially more diversity in our cadaver population or even a different method of analysis. Furthermore, finding an ideal cadaver sample is difficult, given the disproportion between male and female specimens at our institute (as reflected in this study population). Since most patients who seek rhinoplasty are women, one could consider this inverse relationship a limitation of our study.

Data from this study suggest that the thinner portions of septal cartilage are precisely the areas that make up the L-strut, which is in line with the report from Mowlavi et al.⁶ Knowledge of these anatomical characteristics in the cartilaginous septum will allow the surgeon to more effectively plan rhinoplasty procedures in advance, since there will be a need for longer grafts in many cases (eg, extended spreader grafts, lateral crural strut grafts, and dorsal grafts).^{7-9,12} This knowledge may also have implications when multiple grafting procedures are planned, as nasal reconstructions requiring more than the estimated amount of septal cartilage will demand harvests from separate donor sites (eg, the ear and rib). Gunter et al^{8,17} emphasized that lateral crural strut grafts are effective only when they are approximately 3 cm in length and when they have an appropriate thickness to enable support of the lower lateral cartilage.

Given our measurements, we determined a suggested algorithm for utilizing specific zones of the nasal septum for certain applications. The central remaining zone (Zone EF; Figure 2) shows features that fulfill the demands of lateral crural strut grafts. However, such grafts may need to be harvested in an oblique fashion to achieve proper length. Spreader grafts have many applications, and thickness variations may allow surgeons to plan asymmetric grafts for the correction of septal deviation.^{9,13,18-23} The septal base remaining area (Zone HI; Figure 2) may be utilized when spreader grafts are being placed to maintain or design brow-tip aesthetic lines. Alternatively, surgeons should select thicker spreader grafts harvested from the central remaining zone for patients with a pinched or asymmetric middle nasal vault.



Figure 4. (A) A digital reconstruction shows the mean area of septal cartilage (red). (B) In this study, the mean area of the septal cartilage dissected was 933.11 mm². (C) The average septal remaining area (518.66 mm²) and the L-strut (10 mm).

Columellar struts must be harvested from the central remaining area to provide strong support to the nasal tip, whereas tip grafts should be harvested on the basis of the patient's anatomical demand for thicker versus thinner and smoother grafts. Zone I seems suitable for harvesting alar contour grafts. In non-Caucasian patients, the central remaining zone should be preserved; in this way, the necessity for rib grafting is avoided for mild dorsal augmentations, since the fabrication of a double-layered septal dorsal graft from the central area (which includes the central remaining area and the central zone) could achieve 3 mm in height by itself. A portion of the ethmoid bone (attached with the remaining septal area) can also be utilized as a batten graft or dorsal graft when the available amount of septal cartilage is overestimated preoperatively.

CONCLUSIONS

When divided into nine equal quadrants, cadaveric septal cartilage dissections were shown to have areas of varying thickness throughout. The central and cranial areas were thickest, while the area corresponding to the L-strut was the thinnest zone. These anatomical variations in thickness were statistically significant between quadrants in 13 cases. Prior knowledge of these measurements will allow the surgeon to better select the septal area most suitable for manufacturing the desired graft during rhinoplasty.

Disclosures

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Special Topic

The Lasso Vertical Technique

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Abstract

In this historical perspective article, the author outlines the evolution of his vertical scar technique, first developed in 1964. He describes the procedure and reports the results of his 42-year experience with a series of 2000 breasts.

Keywords

breast surgery, inverted T, vertical mammoplasty

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I was trained in the mammoplasty procedure described by Biesenberger in 1931,¹ which remained the most popular mammoplasty technique into the 1970s and 1980s. With this procedure, the skin is widely undermined from the gland (Figure 1A). After glandular resection (Figure 1B), the breast cone is reconstructed (Figure 1C and 1D); the skin is redraped over the new breast; and the excess skin is resected, resulting in an inverted-T scar (Figure 1E). While the immediate results obtained by this technique were good, bottoming out often occurred postoperatively because the technique relied on skin resection to shape the breast. Another (more worrisome) issue was the high incidence of complications immediately postoperatively, including seroma, hematoma, infection, skin necrosis, and gland and fat necrosis. A more serious consequence was partial or total loss of the nipple-areola complex (NAC). I recall that, during my years of residency, I was always concerned about whether the areola would be blue or pink when the dressing was removed on the day after surgery.

At the end of 1963, I had the opportunity to attend a meeting in Vienna where Dr. Skoog presented his new mammoplasty technique² in which skin, fat, and gland were removed “en bloc” with a Wise-pattern resection, without any skin or glandular undermining. With this technique, the NAC was transposed on dermoglandular flaps (bipedicle, medial, or lateral). This presentation was a revelation for me. Soon after my return to Nice, I tried the Skoog technique, which resulted in the terrible scars seen in Figure 2. Even though the patient was happy with the result, I was disheartened to have inflicted such a permanent stigma of surgery on a young woman, and I resolved

to never again finish a mammoplasty with an inverted-T scar. Also influencing this decision was the topless fashion taking hold in the 1960s on the Cote d’Azur; many candidates were presenting for mammoplasty and telling me that they wanted to avoid the “horrible scars” they had observed on other women on the beach.

EVOLUTION OF THE VERTICAL TECHNIQUE

Skoog was performing a Wise-pattern en bloc resection with a bipedicle flap to elevate the NAC and finishing with an inverted-T scar. I decided to follow his basic principles but to perform a conical wedge resection with a superior pedicle flap, finishing with a vertical scar (Figure 3A). At that time, I was unaware that Lötsch in 1923,³ Dartigues

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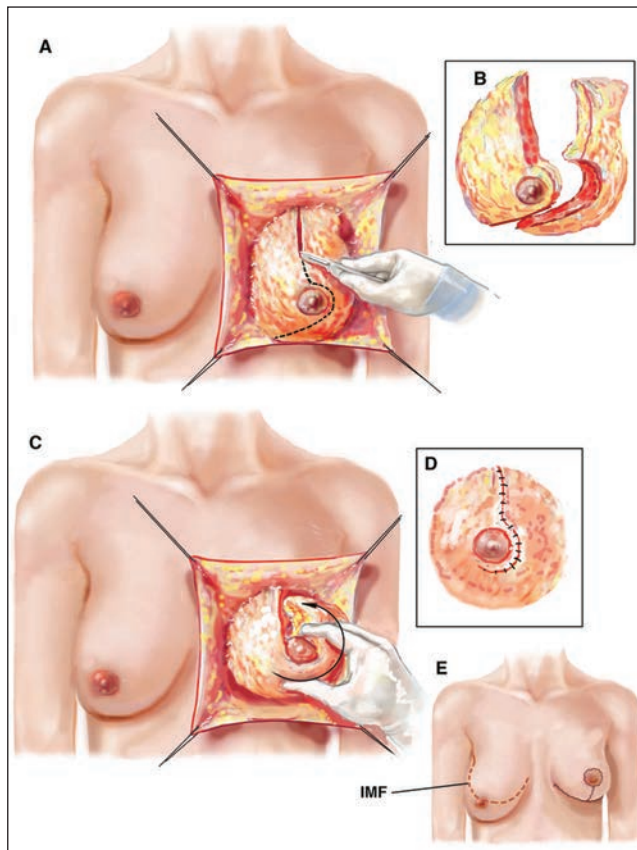


Figure 1. Mammoplasty with wide skin undermining. With this procedure, the skin is widely undermined from the gland (A). After glandular resection (B), the breast cone is reconstructed (C-D); the skin is redraped over the new breast; and the excess skin is resected, resulting in an inverted-T scar (E).

in 1924,⁴ Arie in 1957,⁵ and others had already described mammoplasties finishing with a vertical scar. My first operation addressed correction of a unilateral breast hypertrophy (Figure 3B and 3C). I was pleased with the first results, so I continued to employ this technique, confirming that I could achieve conical projected breasts (Figures 4 and 5). I first described the operation in the literature in 1969,⁶ followed by another article in 1970.⁷ In 1975, *Vogue* magazine⁸ published a good article about my technique, in which it was referred to as “the unique scar.” The term *vertical technique* later came into the vernacular, but I am uncertain who coined it or when it first appeared.

I did not market or promote my technique for several reasons. At that time, patients and plastic surgeons were focused almost exclusively on finding a safe means for reducing large breasts; that is, they were not as focused on the scar as we are now. Moreover, most plastic surgeons did not believe that it was possible to reduce large breasts with only a vertical scar. In fact, in those days, treating very large breasts with my technique involved a vertical scar that crossed the inframammary fold (IMF) (Figure 6).



Figure 2. Excessive scars resulting from my use of the Skoog mammoplasty technique, in which skin, fat, and gland are removed “en bloc” through a Wise-pattern resection.

Maintaining the Vertical Scar

To eliminate the drawback of a scar that crossed the IMF, I made the following modifications. When I first performed the procedure, the lower point of the resection area defined in the preoperative markings (henceforth, Point B) was located at the crossing of the vertical axis of the breast with the IMF. In the early 1970s, I decided to move this point 3 cm above the IMF (Figure 7). In doing so, I finished with a shorter vertical scar. However, at that time, I still naïvely believed in the dogma decreeing that a vertical scar must never be longer than 5.5 cm. To comply with this rule, I resected a triangle of skin (Figure 8A) so that I could finish my mammoplasty with a 5.5-cm-long vertical scar plus a short horizontal scar (Figure 8B and 8C). I presented this technique in 1977 in Tokyo⁹ then in 1978 in Köln¹⁰ and published it in an article that appeared in 1981.¹¹ These were the first descriptions of a short horizontal scar technique.

After I had performed a large number of short horizontal scar techniques,¹² I noticed that some months after surgery, the horizontal scar had moved above the IMF (Figure 9) and was appearing at the lower pole of the breast, which had dropped, resulting in ptosis. Measurements of young women with ideal breasts documented that the actual distance from the lower border of the areola to the IMF could vary significantly and be as much as 9 cm or more.¹³

This observation led me to reject theories about limiting the size of the vertical scar.¹⁴ In patients who had undergone any kind of inverted-T scar technique, it was noticeable—months or years postoperatively—that the horizontal scar (short or long) was located well above the IMF. Why? With these techniques, the glandular resection is achieved with the Wise pattern, which means that a large proportion of the resection is horizontal and performed above the IMF, resulting in a new IMF located above the previous one. However, the breast is not attached to the pectoralis fascia; it glides over it until stopped by the initial IMF, which is solid and fixed. The same phenomenon occurs when liposuction is performed

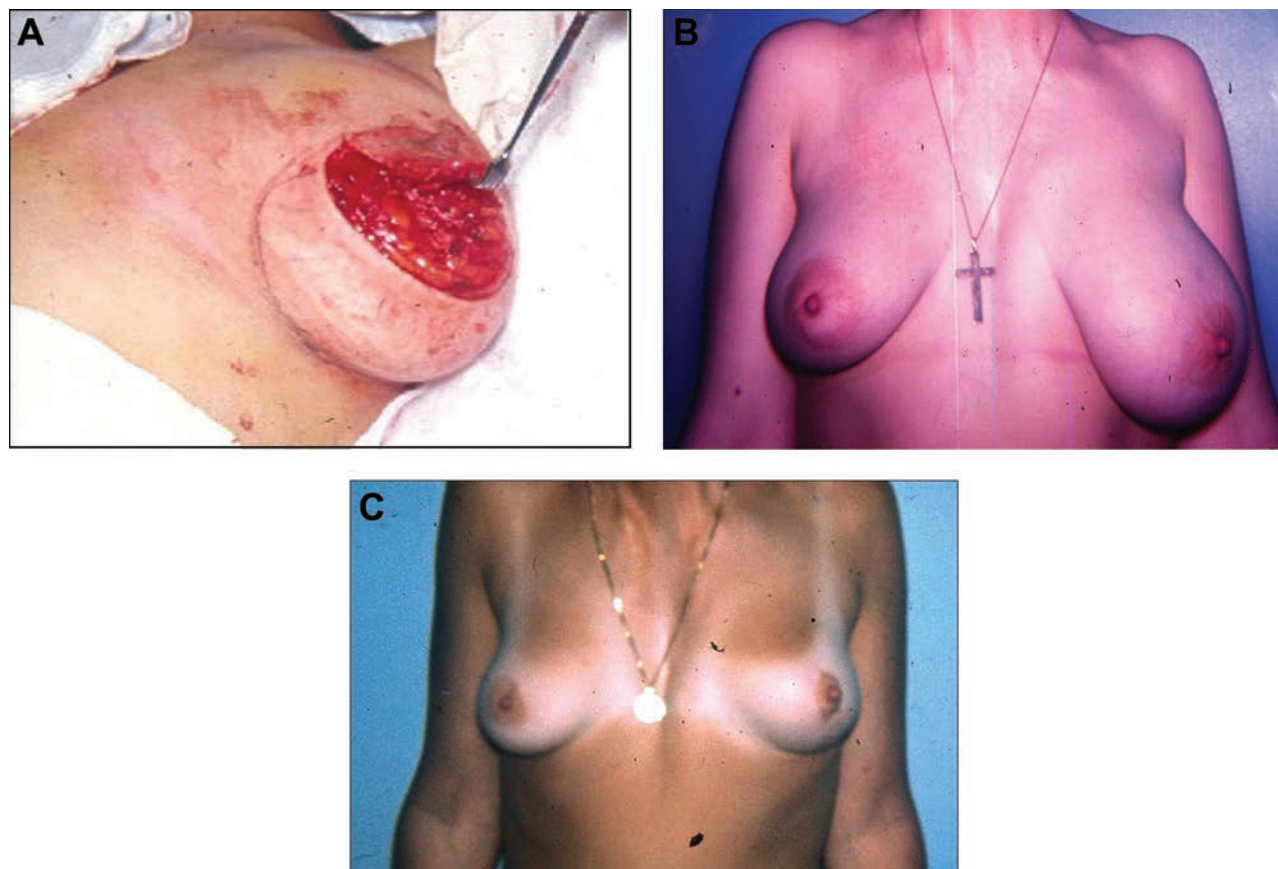


Figure 3. (A) In my first case, I performed a conical vertical wedge resection with a superior pedicle flap. (B) The patient in part A is shown preoperatively, with unilateral breast hypertrophy. (C) Two years after vertical mammoplasty.

to remove tissue above the IMF in mammoplasties finishing with a vertical scar. In both cases, the gliding of the breast results in a flat upper pole, hyperfullness at the lower pole, and ptosis. In other words, the IMF position can be changed only temporarily. This is why low-breasted patients cannot be transformed into high-breasted patients, which is in turn why one of my key maxims is to stick to the original IMF for long-lasting results. I emphasize again that the initial position of the IMF cannot and must not be changed.

The Conical Vertical Wedge Resection

The second and most important concept of my technique is reduction of the breast size with a conical vertical wedge resection. Pinching the medial inferior aspect of the breast with the fingers produces a projected breast with a full upper pole (Figure 10). To achieve the same result surgically, I performed a conical vertical wedge resection (Figure 11). After resection, the lateral parts of the remaining breast were brought toward the midline to reconstruct the breast (Figure 12A and 12B); this maneuver achieved exactly the same result as pinching the medial inferior aspect of the breast



Figure 4. Immediate postoperative results from my initial modification of Skoog's principles. The mammoplasty was carried out with a conical wedge resection with a superior pedicle flap, finishing with a vertical scar and achieving the goal of conical, projected breasts.

with the fingers (Figure 12C). In my opinion, this resection is crucial for achieving fully-projecting breasts with a full upper pole for the following reasons.

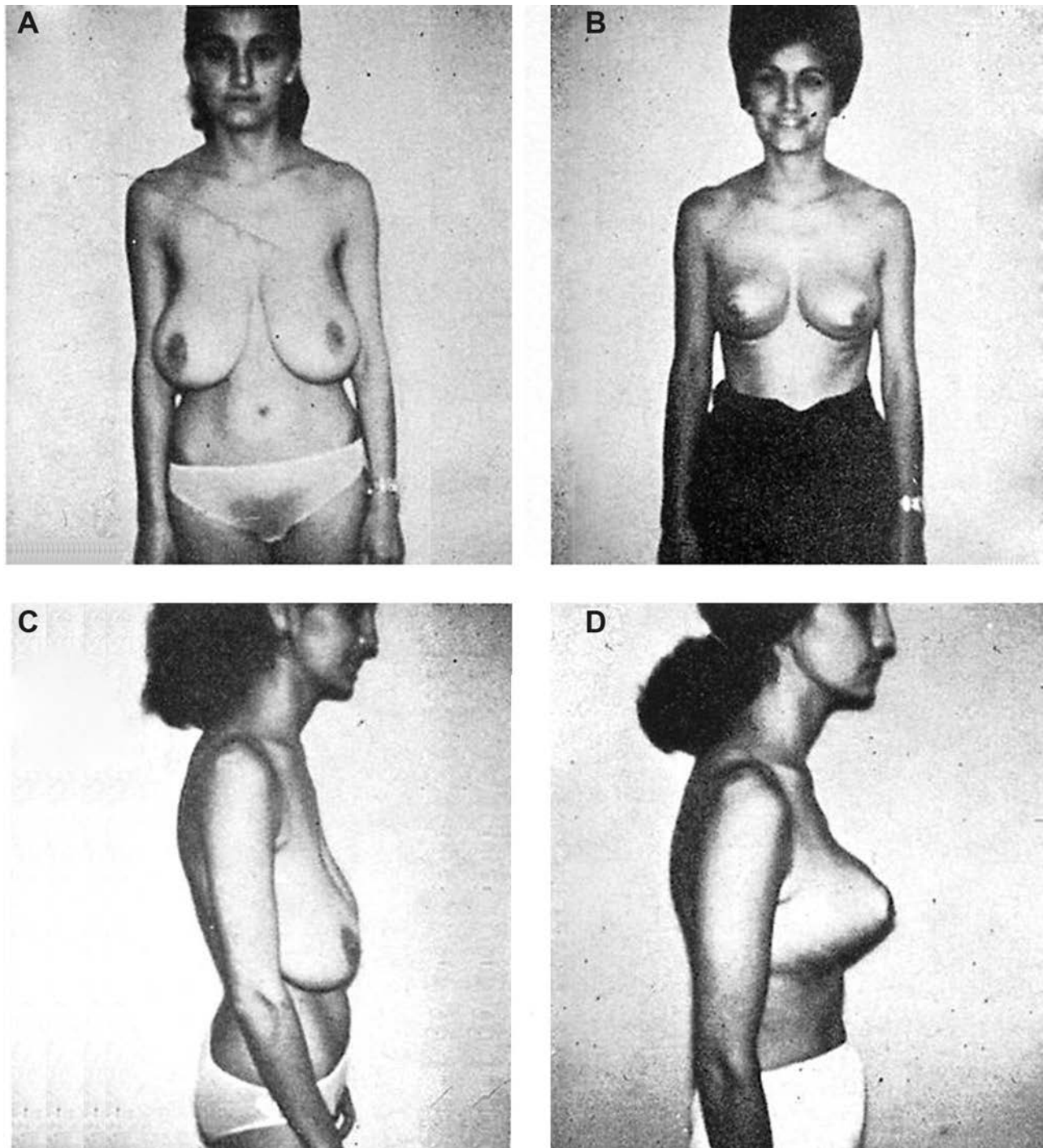


Figure 5. These results, from my fifth case, represent my first attempts at correcting breast hypertrophy with my vertical technique. Originally published in Lassus.⁶

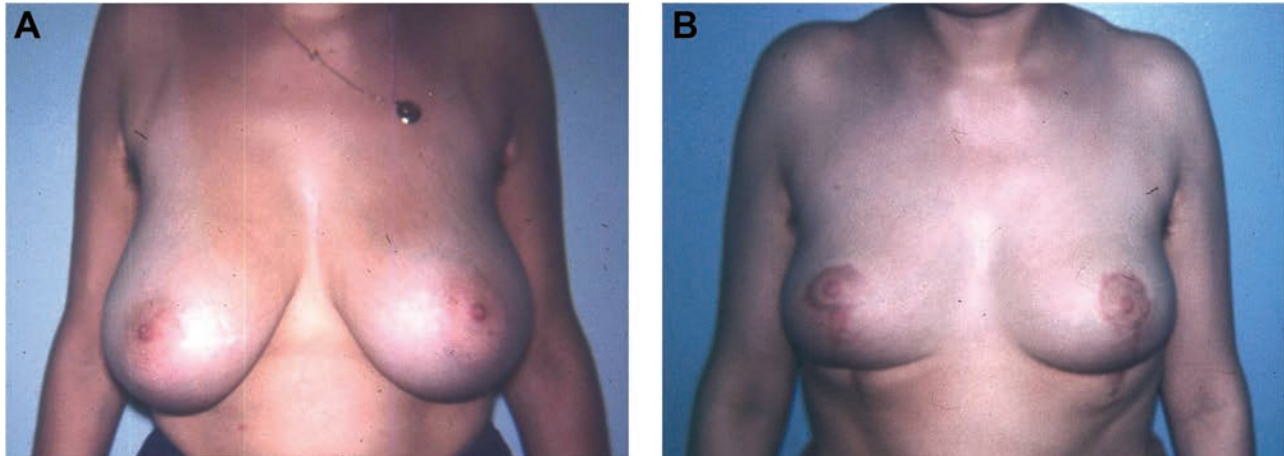


Figure 6. (A) This 18-year-old woman presented for correction of breast hypertrophy. Her very large breasts were reduced with a vertical scar crossing the inframammary fold. (B) One year after vertical mammoplasty (my second case).



Figure 7. Initially, I defined the lower point of the resection area at the crossing of the vertical axis with the inframammary fold (lower B marking). In the early 1970s, I modified my technique to move the point upward, 3 cm above the inframammary fold (B').

First, the closure of the defect resulting from this type of resection reduces the diameter of the breast base. Second, breast volume at the upper pole remains unchanged after the resection; consequent to the reduction of the base, breast contraction produces more fullness at the upper pole. Third, the closure of the defect pushes the lateral and inferior portions of the breast upward and forward. Fourth, the IMF remains unchanged in my technique, which maintains the breast in its new position. Fifth, the ptotic portion of the breast is eliminated by the resection. Last, the upper pedicle flap adds volume at the top of the cone. All of these factors combine to ensure that the achievement of projecting breasts with a full upper pole will be maintained over the long term.

Finishing With a Vertical Scar That Does Not Cross the IMF

Suturing the lateral parts of the breast on the midline after performing vertical wedge resection produces two dog ears. One is located at the upper extremity (Point A); this dog ear allowed me to inset the NAC without any preoperative marking. The other one is located at the lower extremity of the vertical scar (Point B; Figure 13A), which presents a problem. I was able to remove it with a full-thickness elliptical resection (Figure 13B and 13C). This elliptical resection elongated the scar. If Point B was positioned at the intersection of the IMF with the vertical axis of the breast, the scar would cross the IMF (as described previously), so I began to position Point B above the IMF. Its exact position depended on the size of the dog ear, which in turn depended on the size of the breast. In small hypertrophic ptotic breasts, the dog ear was small, so Point B was positioned 3.5 cm above the IMF. In average hypertrophic ptotic breasts, the dog ear was larger, so Point B was positioned 5 cm above IMF. In large hypertrophic ptotic breasts, the dog ear was correspondingly large, so Point B was positioned at 7, 8, or 9 cm above the IMF.

After the elliptical resection, the shape of the breast was rarely satisfactory; therefore, it was necessary for me to reshape the breast with skin sutures until a satisfactory form was achieved. This step could also lengthen the scar; consequently, the end of the vertical scar after the elliptical resection has been performed must be at 1 cm above the IMF in cases involving small breasts, 2 cm in those involving average-sized breasts, and 3 cm in cases involving large breasts. Respecting these guidelines enabled completion of the procedure while maintaining the vertical scar above the IMF.

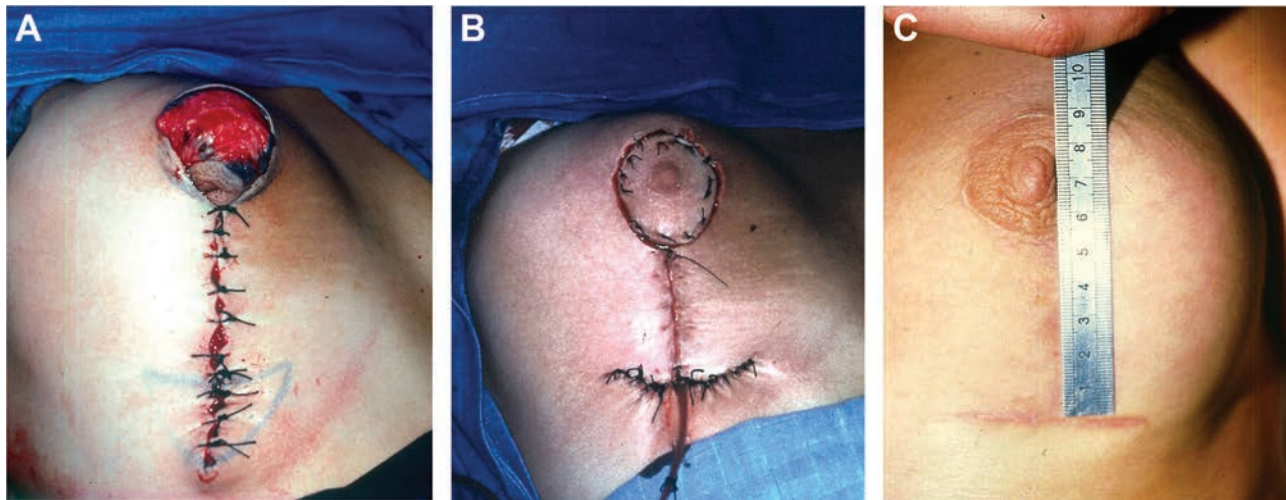


Figure 8. In my early technique, I adhered to the maxim cautioning that a vertical scar should never be longer than 5.5 cm. (A) A triangle of skin is resected to allow the scar to remain within the guidelines. (B) The vertical scar crosses with a short horizontal scar. (C) The vertical portion of the scar is 5.5 cm.



Figure 9. After performing a large number of operations with the short vertical scar shown in Figure 8, I noticed that patients' scars were moving above the inframammary fold and appearing at the lower pole of the breast, which had dropped.

OPERATIVE TECHNIQUE

Working on breasts, like working on the nose, is sculptural in that it involves work in three dimensions. Sculptors rely on landmarks to achieve their work; they never use a pattern. Similarly, I relied on landmarks



Figure 10. Pinching the medial inferior aspect of the breast with the fingers demonstrates a projected breast with a full upper pole, similar to what is surgically achieved through conical wedge resection.

rather than a preoperative pattern to perform my technique, focusing on two key points: Point A, which marked the new position of the upper border of the areola, and Point B, which marked the lower point of the estimated area of resection.

Markings

The midline and the vertical axis of the breasts were first marked. The distance between the acromion and the olecranon was then measured. I marked the mid-point and another point located 2 cm below it. From

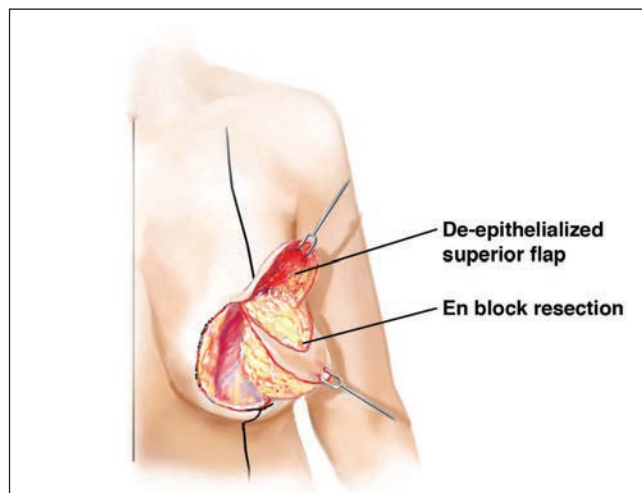


Figure 11. The surgical technique for conical wedge resection.

this last point, I drew a horizontal line that crossed the vertical axis of the breast. The intersection of the line and the vertical axis marked the new position of the upper border of the areola (Point A)—not the new nipple position (Figure 14). Placing this mark avoided the mistake of positioning the nipple too high. Point B was located on the vertical axis of the breast above the IMF; the exact distance above the IMF varied, according to the degree of ptosis, as explained previously (Figure 15). Once these two points were defined, I drew the *estimated* area of resection: I emphasize the word “estimated” because it was impossible to preoperatively estimate the exact amount of tissue removal necessary to achieve a correct reduction of breast volume. I performed these markings as I did in my original procedure, by pushing the breast laterally and joining Point A to Point B, then pushing the breast medially and joining A to B (Figure 16). To complete the markings, I drew the upper pedicle flap or the medial flap.

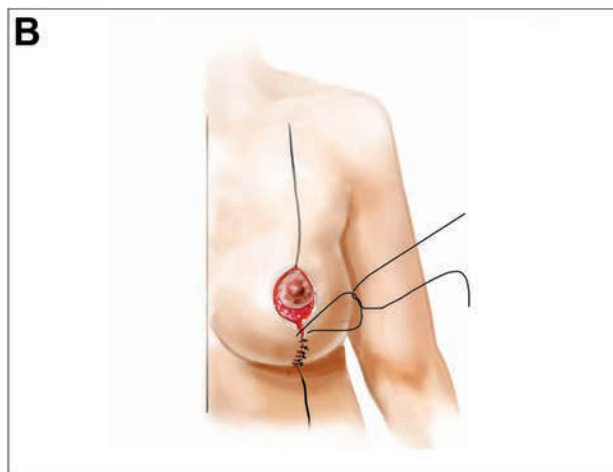


Figure 12. (A) After a conical wedge resection, the lateral parts of the remaining breast are brought toward the midline to reconstruct the breast. (B) The closure of the defect pushes the lateral and inferior portions of the breast upward and forward. (C) Postoperatively, the shape is conical and projecting, achieving nearly the same shape as pinching the breast with the fingers (shown in Figure 10).

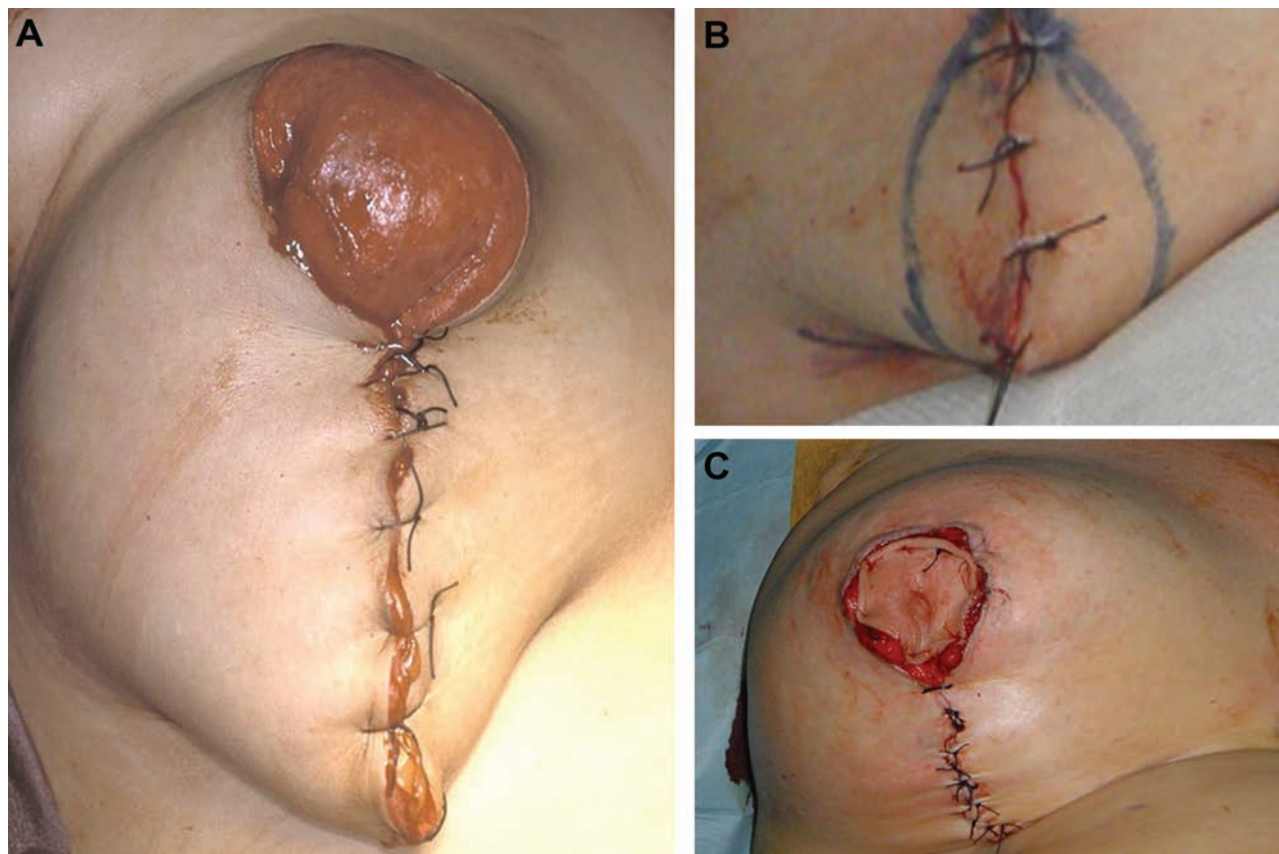


Figure 13. (A) My vertical wedge resection produces two dog ears. (B) The dog ear at the lower extremity of the vertical scar is removed with a full-thickness elliptical resection (C). After reconstruction of the breast, the vertical scar finishes at the level of the IMF.

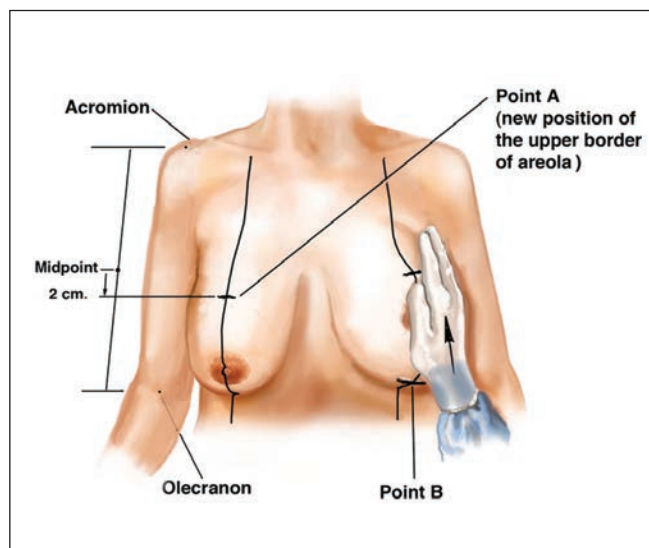


Figure 14. Preoperatively, the midline and the vertical axis of the breast are marked. The distance between the acromion and the olecranon is measured, and two marks are made: one at the midpoint and another 2 cm below it. From this last point, a horizontal line is drawn that crosses the vertical axis of the breast. The intersection of the line and the vertical axis marks the new position of the upper border of the areola (Point A). Note that Point A is not the new nipple position.

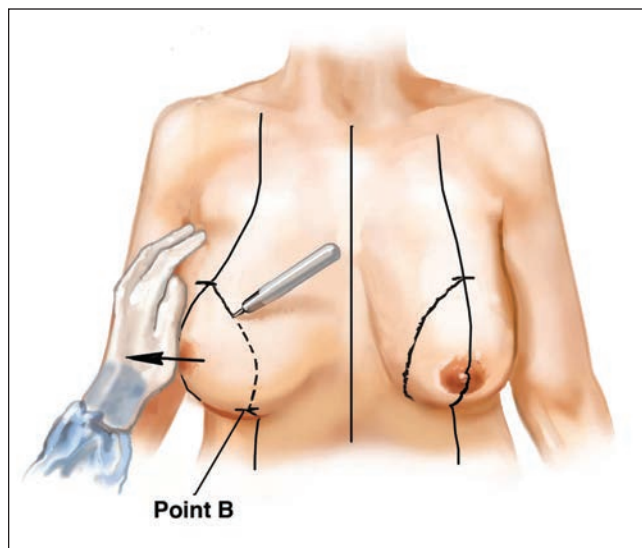


Figure 15. In the preoperative markings, Point B is located on the vertical axis of the breast, above the inframammary fold. The exact distance above the IMF varies according to the degree of ptosis.

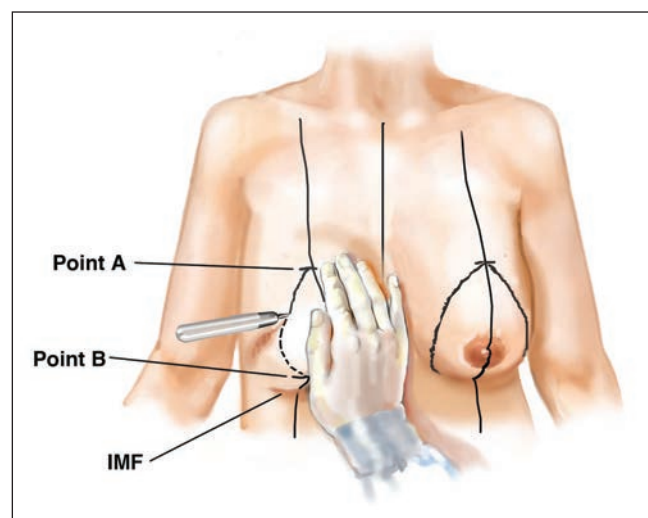


Figure 16. Once Point A and Point B have been defined in the preoperative markings, the area of resection is *estimated*. (It is impossible to preoperatively estimate the exact amount of tissue removal necessary to achieve a correct reduction of breast volume.) The estimated resection markings are made by pushing the breast laterally and joining Point A to Point B, then pushing the breast medially and joining A to B.

After the preoperative markings were complete, the patient was placed on the operating table in a semisitting position with the arms along the body. This positioning allowed me to check the volume of the breasts, their symmetry, the symmetry of the nipples, the length of the vertical scar, and the shape of the breasts throughout the course of the operation.

Surgical Procedure

Patients were placed under general anesthesia. Following de-epithelialization of the superior flap, the lateral-margin markings below the nipple flap were incised to the pectoralis fascia (Figure 17A). This lower central part of the breast was elevated from the chest wall at the level of the submammary fold (Figure 17B). The inferior border of the areolar flap was cut to a depth of 7 to 8 mm, and dissection proceeded upward to Point A, leaving a glandular lining underneath the flap (Figure 17C). Resection was completed by cutting the lateral-margin markings of the glandular tissue located underneath the areolar flap.

The central wedge resection was then performed. The resection was divided in two portions: an inferior

portion composed of the en bloc resection (skin, fat, and gland) and a superior portion composed of fat and gland only (Figure 17C). No further undermining was performed—this is a key feature of the technique. The skin remained attached to the gland, and the gland is attached to the pectoralis (Figure 17C). These principles ensured the safety of the vertical technique. The breast was then reshaped by drawing together the lateral portions of the amputated gland, with skin-framing stitches made downward to upward. This maneuver yielded an inferior dog ear, which was removed as previously described.

At that point in the operation, the form of the breast was suboptimal. It was therefore reshaped with skin stitches until a satisfactory shape was obtained. Once this was accomplished, the new suture line was marked with methylene blue: three or four horizontal lines were marked on both sides and numbered, with the numbers corresponding for each side (Figure 17D). The skin stitches were cut, and the new marking delineated the complementary full-thickness resection to be performed. After that, the skin remained attached to the gland, and the gland was attached to the pectoralis (Figure 17E). The skin edges were then approximated, uniting Point 1 to 1, 2 to 2, 3 to 3, and so on (Figure 17F). This method saved time and avoided any mistakes in the reshaping of the breast. Suturing was performed in two planes: one row of inverted stitches of a permanent monofilament into the deep dermis and a second row of subcuticular sutures (Monocryl 2/0, Ethicon, Inc., Somerville, New Jersey). This technique joined together two composite blocks of skin, fat, and gland. Because no undermining was performed during the procedure, drainage was not necessary. Patients were discharged the same day as surgery or the next morning. The intradermal running sutures were removed three weeks later. Patients were instructed not to wear a brassiere for three months, until the breasts assumed their final shape.

Postoperative healing produced a solid fibrous band, which supported the breast in a fashion analogous to the way a whalebone provides support in a corset, yielding good breast projection and durable results. The vertical technique does not rely on the skin to play the role of a brassiere in supporting the breast and consequently avoids the scar dehiscence that can be associated with reliance on skin redraping for breast support.

A video demonstration of the author's technique. A series of videos demonstrating each of these operative techniques is available at www.aestheticsurgeryjournal.com. You may also use any smartphone to scan the code on the first page of this article to be taken directly to the video on www.youtube.com.

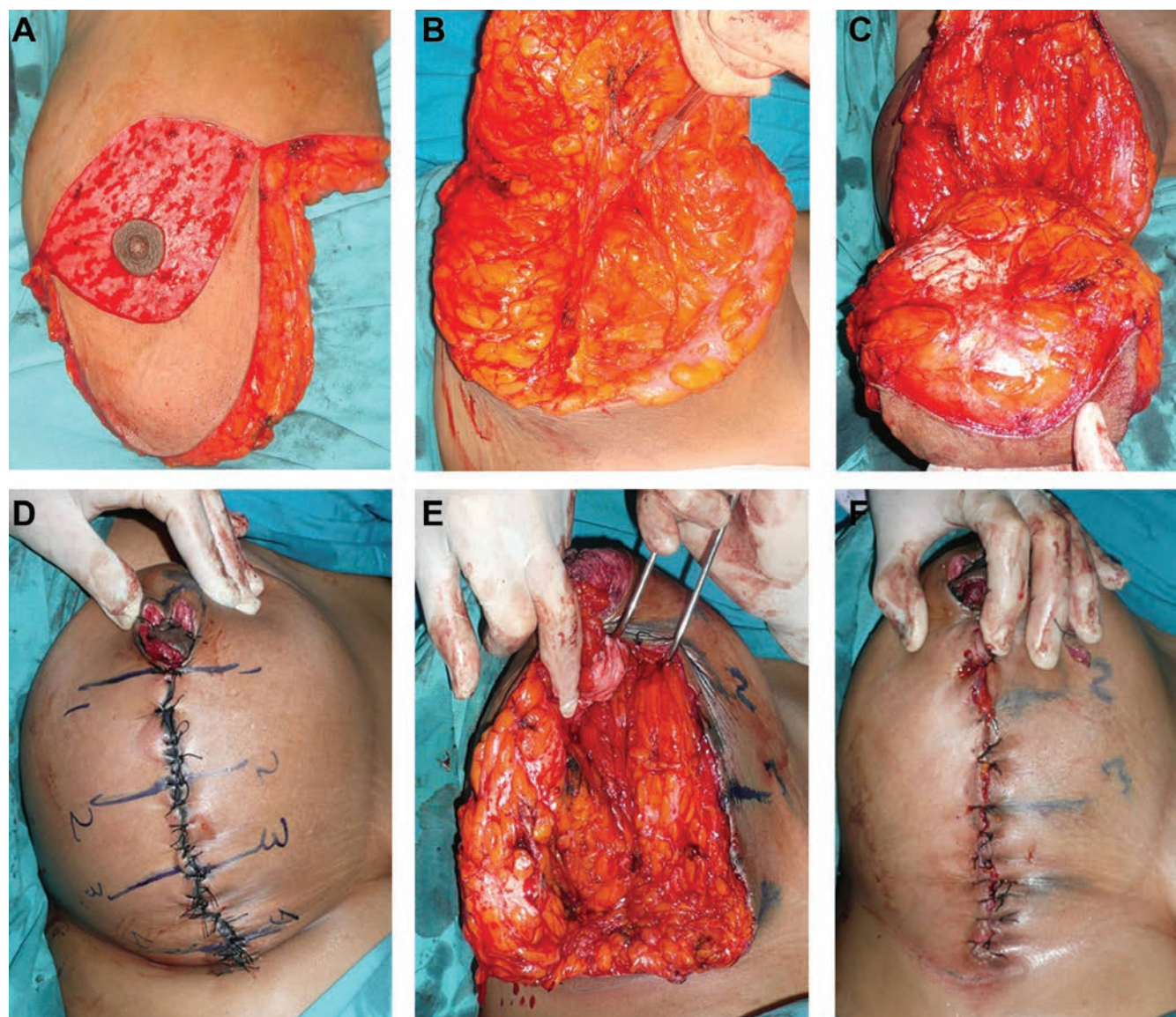


Figure 17. (A) The lateral-margin markings below the nipple flap are cut to the pectoralis fascia. (B) The lower central part of the breast is elevated from the chest wall at the level of the submammary fold to Point A. (C) The inferior border of the areolar flap is cut to a depth of 7 to 8 mm, and dissection proceeds upward, leaving a glandular lining underneath the flap. Following central wedge resection, the superior portion is shown (fat and gland only). (D) After reshaping with skin stitches, the new suture line is marked with three or four horizontal numbered lines. (E) Following complementary resection, the skin remains attached to the gland, and the gland is attached to the pectoralis. (F) The skin edges are approximated according to the numbered lines: Point 1 to Point 1, 2 to 2, 3 to 3, and so on.

COMPLICATIONS AND OUTCOMES

As outlined by Mejia and Nahai,¹⁵ vertical mastopexy has a low incidence of complications. Those that do occur can vary, depending on the patient's body mass index and the amount of resection performed, since large resections can lead to scar enlargement and

other problems.¹⁶ However, providing data on postoperative complications is not always easy. Although most of my patients were followed for six weeks postoperatively, a large number of patients were lost to follow-up after this time. Furthermore, some patients who were disappointed with their results may have sought out another surgeon without informing me of any problem.



Figure 18. Postoperative hypertrophic scarring.



Figure 19. Postoperative periareolar scar dehiscence caused by excessive suture tension.



Figure 20. Postoperative volume asymmetry.

Consequently, it is much easier to report on immediate postoperative complications than it is to report on those that develop over the long term.

Between 1964 and 2006, I treated a series of 2000 breasts with six months of follow-up. Since patient population demographics can affect the number and type of complications, I asked some of my colleagues for information on their results—namely, Lacotte, who practices in the Caribbean, and Djemal, in Tunisia.^{17,18} Both authors have presented their results and provided information to me in personal communications.

In my series, I encountered the following complications. One patient experienced a seroma after vertical wedge resection with cautery. After I resumed use of the blade to perform resections, no other cases of seroma occurred. Two cases of hematoma occurred in this series—one three days postoperatively and one five days postoperatively. There were no cases of infection nor any

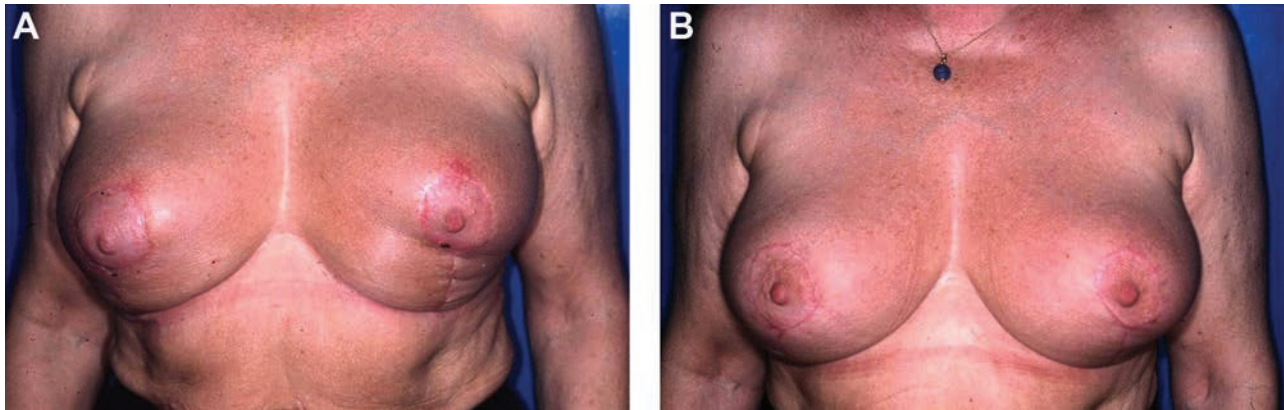


Figure 21. (A) Inadequate postoperative breast shape two weeks postoperatively. (B) Two months postoperatively, without any revision. Given results like these, I believe that it is wise to wait at least two months before undertaking any revision.

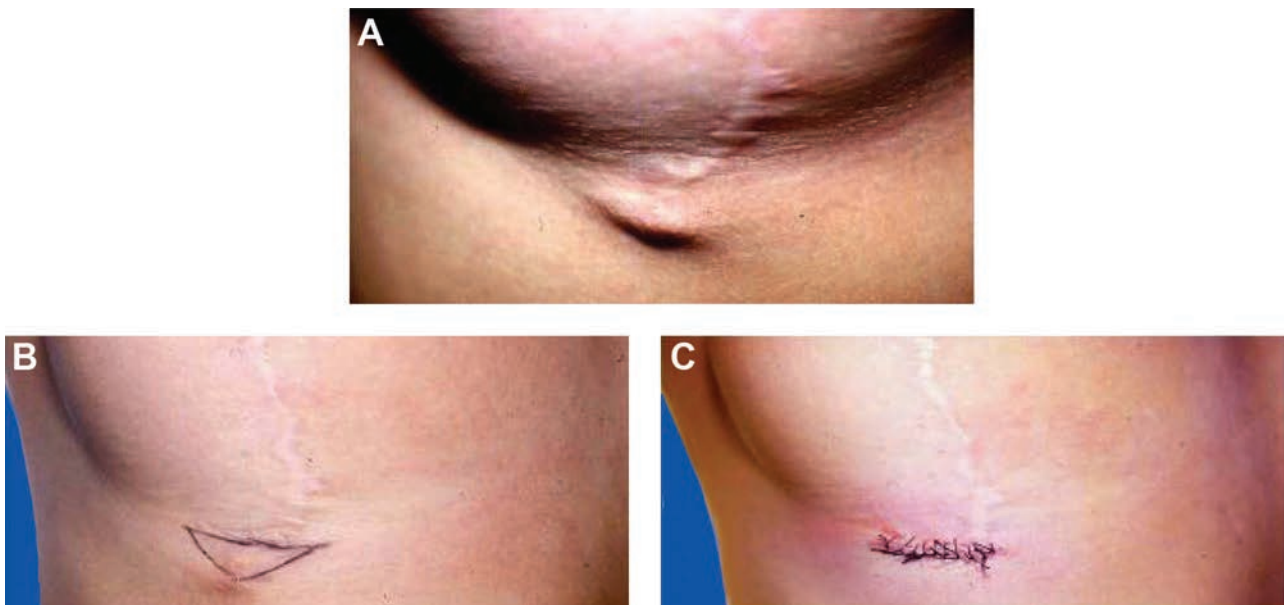


Figure 22. (A) Excessive scarring and persistent postoperative dog ear on the lower end, corrected by skin resection (B) and suturing (C).



Figure 23. Enlarged postoperative vertical scarring.

cases of skin, fat, or gland necrosis. Before 1995, I had two cases of total NAC necrosis and 17 cases of partial necrosis. Until 1995, I always performed the operation with an upper pedicle flap, which resulted in partial or total loss of the NAC in some patients.¹⁹ It took a long time for me to understand that when the NAC was moved upward more than 9 cm, the "kinking" of the pedicle could compromise the venous blood return and, thus, the NAC in some cases. Once I understood this, I decided to perform a lateral or medial pedicle flap when the NAC climbed more than 9 cm. This eliminated the problem, and there were no further cases of NAC necrosis after 1995. I had four severe cases of hypertrophic



Figure 24. Early postoperative vertical mammoplasty results. (A, B) This 23-year-old woman is shown preoperatively and four months postoperatively. (C, D) This 28-year-old woman is shown preoperatively and 18 months postoperatively. (E, F) This 18-year-old woman is shown preoperatively and three years postoperatively.

scarring (Figure 18), three cases of periareolar scar dehiscence caused by excessive tension on the sutures (Figure 19), 17 cases of volume asymmetry (Figure 20), 14 cases

of NAC asymmetry, and 56 cases of inadequate breast shape (Figure 21), which I revised. Before 1975, I had 81 cases of excessive scarring (Figure 22), 21 of which I

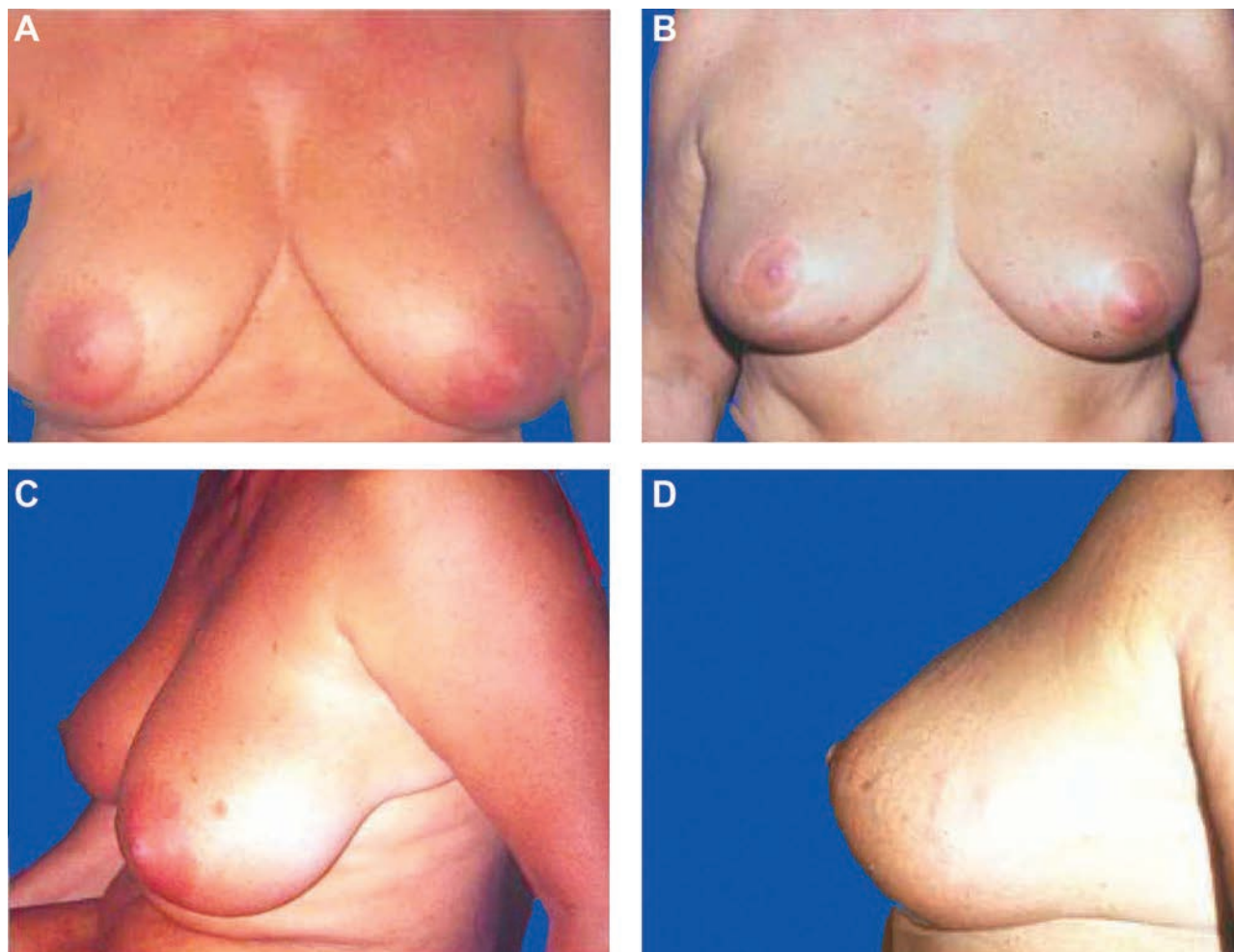


Figure 25. (A, C) This 53-year-old woman presented for correction of breast hypertrophy. (B, D) Nine years after vertical scar mammoplasty with my technique.

revised after 1975. Before 1975, scar length was not considered the major factor in assessing results, although it became so in later years. There were 11 cases of enlarged vertical scars (all revised by me; Figure 23) and two cases of operative enlargement of the breasts.

In Lacotte's series of 1200 breasts,¹⁷ the average per-breast resection was 785 g, and the maximum was 3 kg. His complications included 96 cases of seroma (he occasionally performed liposuction as part of his breast reduction technique), six cases of hematoma, two cases of partial areola necrosis (his technique always includes a superior pedicle flap), and 108 cases of wound dehiscence. Note that Dr. Lacotte's practice involves working with a population group in whom obesity tends to be more prevalent than it is in my patients—this is important because the percentage of complications will be higher in patients who have a body mass index over 30 and/or hypertension.

In 2008, Djemal provided data on a series of 721 patients treated with my technique.¹⁸ His series included seven cases of seroma, five cases of hematoma, eight cases of glandular infection, 15 cases of superficial wound dehiscence, 20 cases of scar revision, eight repeat reductions, four inverted nipples, and eight patients with loss of nipple sensitivity. He reported no cases of fat necrosis or nipple loss.

Clinical results from my patients at different stages of long-term follow up are shown in Figures 24-28.

DISCUSSION

The key to understanding the vertical technique is the realization that it is a concept developed to achieve a safe reduction of breast volume, with aesthetically-pleasing, long-lasting results and a minimal postoperative scar. To

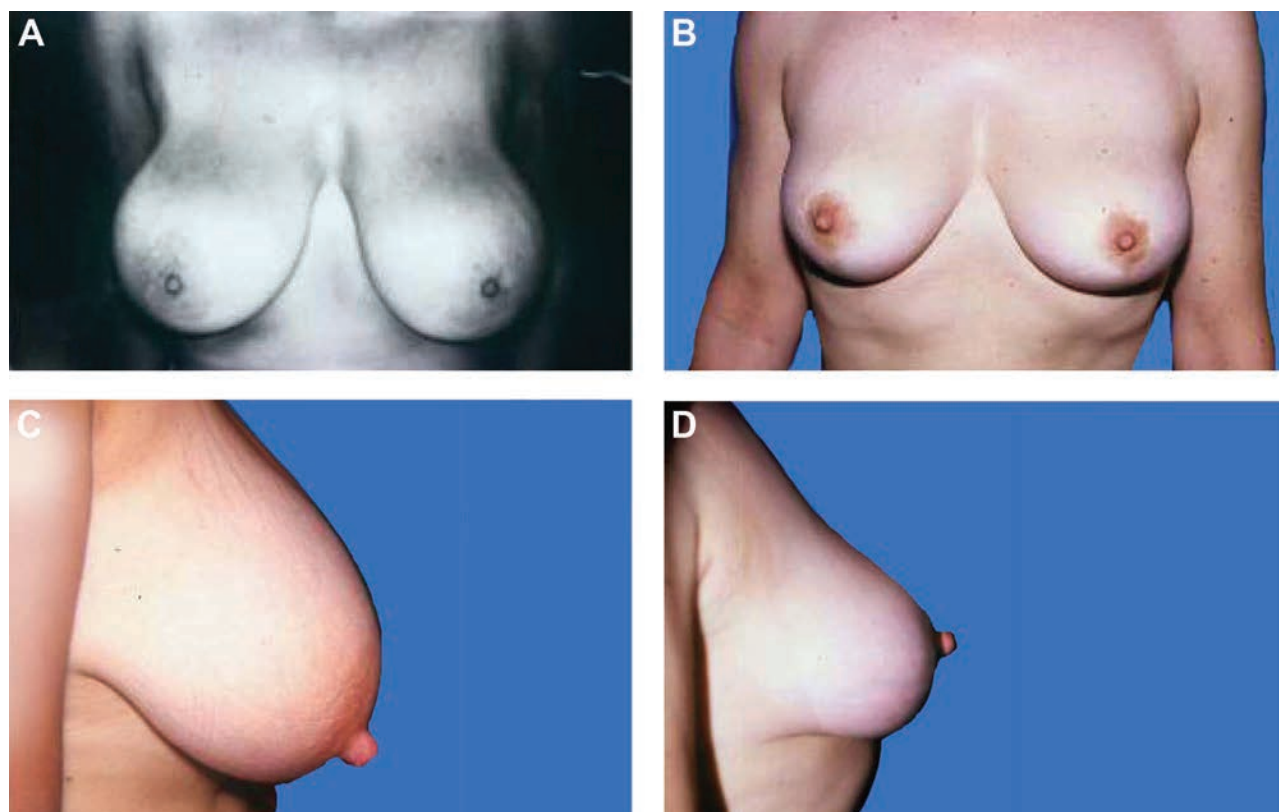


Figure 26. (A, C, E) This 18-year-old woman presented for correction of breast hypertrophy. (B, D, F) Seventeen years after vertical scar mammoplasty with my technique.

achieve these goals, I rejected any skin and gland undermining, instead reducing the size of the breast through a central vertical wedge resection. This type of resection permitted compression of the inferior pole of the breast, which is the key to obtaining conical-projecting breasts with a full upper pole. The vertical scar is the result of the implementation of this concept, rather than the goal of the technique.

The reception given to the vertical mammoplasty technique has evolved over the years. I recall presenting at the Third Annual Plastic Surgery Breast Symposium in Santa Fe in 1988, after which Dr. John McKissock said, "It is magic, but the inverted-T scar is no problem." Dr. Thomas Biggs responded, "We Americans should pay attention to the European vision of Dr. Lassus." It appears to me that the influence of the vertical scar mammoplasty technique increased significantly after Dr. Lejour described and popularized her vertical technique in 1990.²⁰ Since then, many variations of this technique have been published,

including the Hammond technique,²¹ the Hall-Findlay technique,²² the Graf and Biggs technique,²³ and the Mottura technique,²⁴ among others. Although they utilize different principles, all finish with a vertical scar. As this review indicates, my technique has evolved over time, but it is still my belief that the principles embodied in my concept of vertical mammoplasty are key to safely achieving projecting breasts with a full upper pole.

CONCLUSIONS

My vertical scar technique evolved over a series of 2000 patients and 42 years of experience. The technique provides a means for safe reduction of breast volume, with aesthetically-pleasing, long-lasting results and a minimal postoperative scar. It relies on a central vertical wedge resection, rather than skin and gland undermining, to reduce breast size.

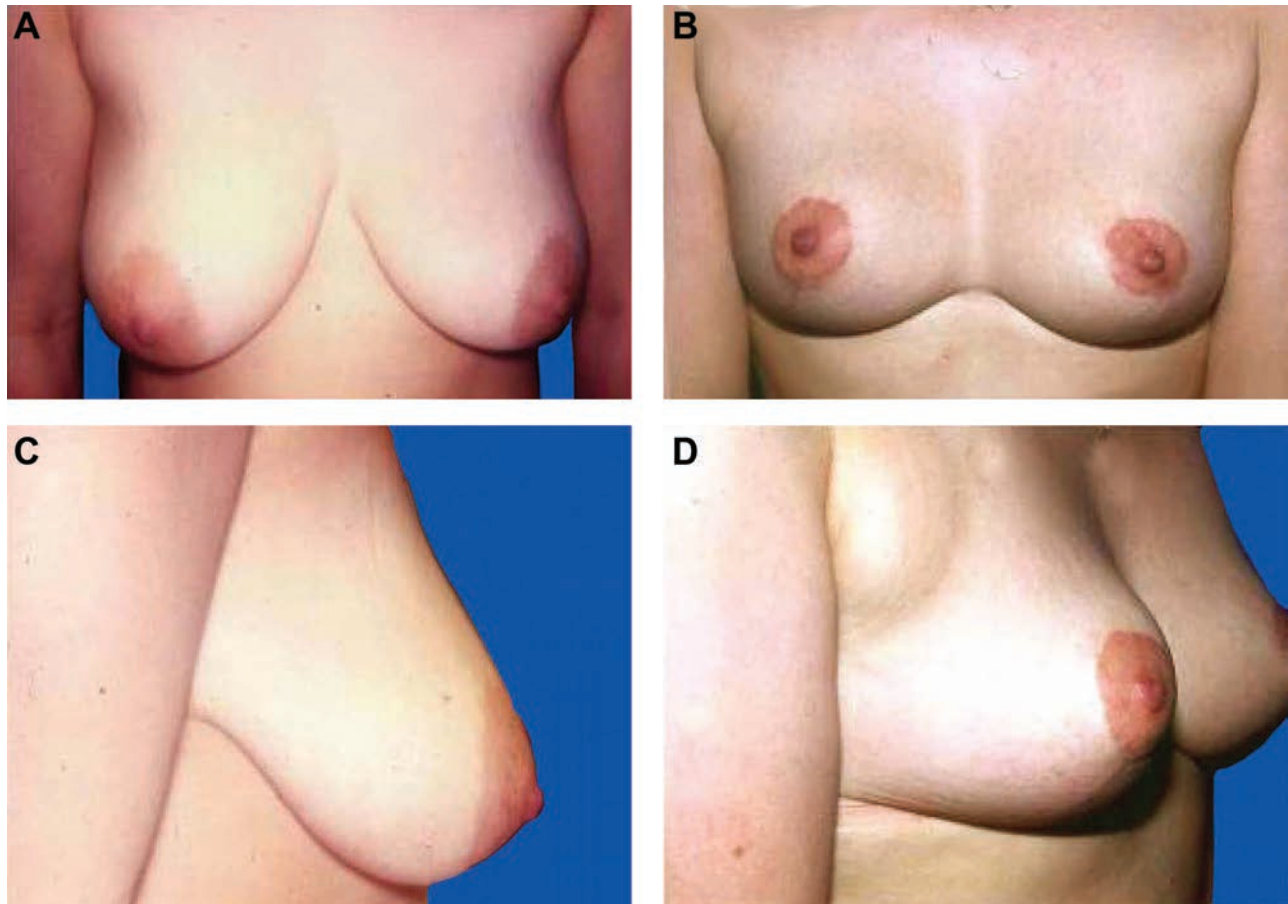


Figure 27. (A, C) This 22-year-old woman presented for correction of breast hypertrophy. (B, D) Twenty years after vertical scar mammoplasty with my technique.

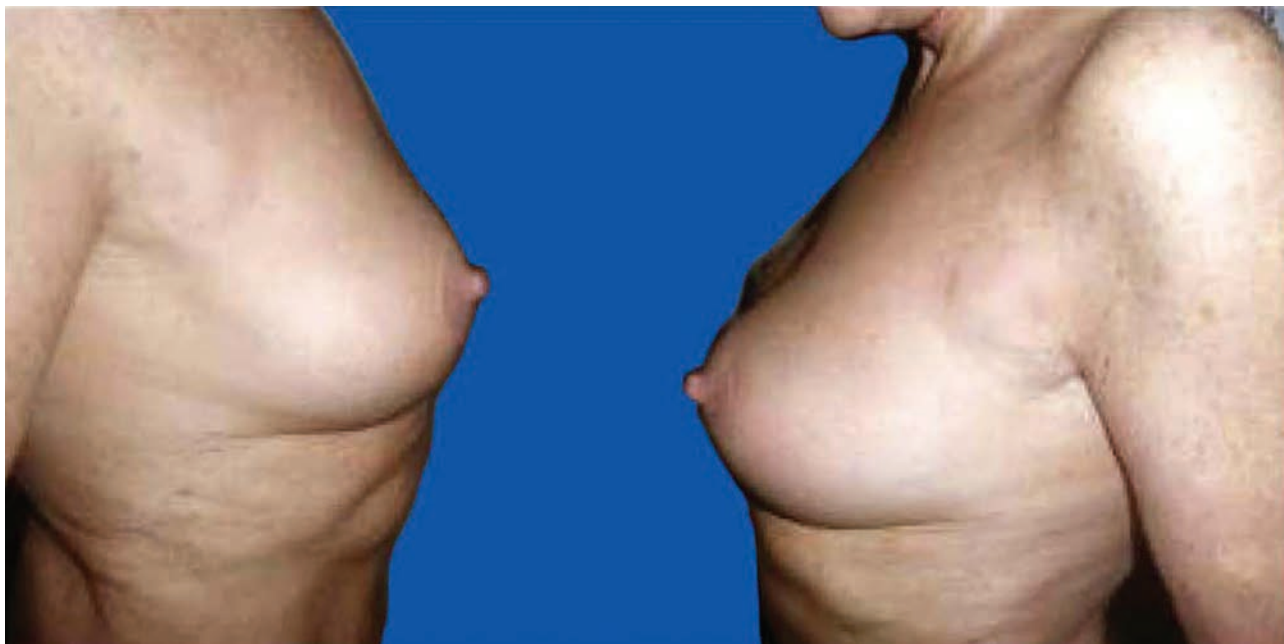


Figure 28. Results are shown 40 years after vertical scar mammoplasty with my technique. No preoperative photographs are available for this patient, but note that the result has maintained conical projection and upper pole fullness over the long term. The patient was 80 years old at the time of these postoperative photos.

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Special Topic

Four-Dimensional Breast Imaging, Part I: Introduction of a Technology- Driven, Evidence-Based Approach to Breast Augmentation Planning

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and G. Patrick Maxwell, MD

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Abstract

Although there are many three-dimensional imaging systems currently available on the market, all of them require a high degree of interaction on the part of the user, making them clinically impractical. Moreover, though claims have been made regarding the validity of these systems for imaging the breast form, there have been no previous reports validating any commercially-available implant simulation models in the plastic surgery literature. In this article, the authors describe the development and evaluate the efficacy of a novel four-dimensional (automated three-dimensional) breast imaging system, validating it as an evidence-based simulation tool for patient consultation, surgical planning, and outcomes analysis in cosmetic breast augmentation. This report, based on a series of longitudinal correlation studies with several patient cohorts, found a highly statistically significant degree of correlation and reliability between the automated measurements obtained with the four-dimensional system and manual measurements.

Keywords

breast surgery, four-dimensional imaging, magnetic resonance imaging

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Following the introduction of the silicone gel prosthesis in 1962, breast augmentation quickly became one of the most frequently performed procedures in cosmetic surgery.^{1,2} It is estimated that more than 3% of the adult female population in the United States (between two million and four million) has undergone breast augmentation.³ Recent data showed that breast augmentation remained the most popular aesthetic surgical procedure in 2010.⁴ Though there has been some debate about the validity of the reoperation rate as a metric of success or failure for this procedure,⁵⁻⁹ it is fair to assume that most plastic surgeons ascribe to the view that this is a salutary metric. Moreover, the US Food and Drug Administration premarket approval data have utilized various rates of and indications for reoperation as a measure of outcomes. Overall reoperation rates run as high as 25% at five years for saline implants and 23.5% for silicone gel implants at three years.¹⁰⁻¹³ It has been observed that reoperations for size change and other device issues, along with incision

choice, asymmetry related issues, and correction of ptosis, form the majority of secondary procedures; all of these post-operative issues may be avoidable with better preoperative surgical planning.¹⁴

To reduce reoperation rates in breast surgery patients, much effort has been made to improve the safety and

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consistency of cosmetic breast procedures. To this end, attempts at objectively measuring a patient's anatomical dimensions have been made with various programs and algorithms, including the Biodimensional System, the TEPID System, the High-Five System, the Body Logic System, and the Akademikliniken System.¹⁵⁻²² Though no single scheme of measurement has predominated, the common paradigm remains true: Quantitative measurements are valuable in improving outcomes in breast augmentation.

A recent study examining the breast augmentation consultation process showed several areas ripe for improvement, including providing a means for patients to visualize potential outcomes, which enhances their trust in the surgeon.²³ With any type of breast surgery—augmentation, reduction, reconstruction, or revision—the goal is to design a symmetrical and aesthetically-pleasing breast form. Clearly, achieving this goal entails developing a breast mound that is proportional to the body, with the nipple located at the most anteriorly-projecting portion of the breast form, which should have minimal ptosis and be teardrop in shape.²⁴⁻²⁶

Existing methods of surgical planning involve different, somewhat primitive techniques to help the patient visualize how her breast form might appear under clothing and then help the surgeon subsequently quantify the necessary volume to achieve the desired goal. Brody had patients choose brassieres with well-formed cups and pad them appropriately until they arrived at a size that suited the image they were trying to obtain; volume was then assessed with water-filled bags.²⁷ This did account for identifying some gross anatomical asymmetries, but subtle asymmetries were more difficult to appreciate with this model. Other plastic surgeons have suggested alternative approaches for determining the implant volume required to achieve aesthetic breasts.²⁸⁻³⁴ Most surgeons rely on their own techniques of assessment for identifying preoperative asymmetries, and it has become clear that selecting appropriate implants can be challenging.^{35,36} Preoperative planning worksheets with questions and measurements can become complicated; they also have their limitations.^{37,38}

In fact, so many approaches to measuring volume in the female breast have been described that a review of the literature might lead one to categorize it as a medical obsession for the last half century.³⁵⁻⁴⁸ Several authors have recently examined the validity of three-dimensional (3D) imaging in measuring breast volume compared to more classical methods as controls.^{49,50} While others have relied on internal controls,⁵¹ magnetic resonance imaging (MRI) has emerged as the accepted standard for noncontact volume measurement^{41,48,50} against which 3D imaging systems are judged. Over the past decade, technological advancements in digital 3D imaging have advanced from a research phase (in which they were bulky, slow tools), to a commercial, albeit rudimentary stage (in which they are widely available throughout the world for a variety of applications). The natural merger of surgical planning systems and digital imaging has stimulated interest from several centers, and verification of the accuracy of some imaging systems has been reported.^{49,51-53} However, all currently-available digital 3D imaging systems involve

manually positioning anatomical markers before determining linear and/or volume measurements; thus, a gap exists between the technology and its ease of use.^{47,51-57}

Breast measurements, whether taken clinically with a tape measure and caliper or recorded digitally by manual placement of landmarks, have suffered from being somewhat subjective. The process is also so time-consuming as to be impractical for day-to-day clinical application. Moreover, the planning, or “morphing,” software systems designed to simulate surgical outcomes have been based not on accumulated patient data but on idealized outcomes.⁵⁵⁻⁵⁷ There is currently a dearth of published data to validate the commercial outcome simulations currently on the market. To make technological progress, improvements are needed in design, image capture and processing speed, and evidence-based simulation algorithms.

To that end, in this report, we introduce a completely automated four-dimensional (4D) image capture and software system with instantaneous anatomical landmark recognition, linear measurement, and volume calculation of the breast; we present results of a study to validate the accuracy of the automated linear measurements compared to manual measurements; we offer data comparing the accuracy of automated volume calculation against the current accepted standard (MRI); and we report our evidence-based approach to developing automated breast augmentation simulation algorithms.

METHODS

Development of Technology

Hardware Image Capture

A structured light-based image capture system was developed specifically for breast imaging. With this system, patients were positioned facing the device with arms akimbo. Structured light was generated from three digital projectors, aligned with mirrors to shorten the focal length to the patient. Both structured light and surface color images were captured by three high-speed CCD digital video cameras (Pike, Allied Vision Technologies GmbH, Taschenweg 2a, Stadtroda, Germany) and then processed with a Dell Precision T3400 desktop computer running Windows 7 Professional 32 Bit O/S, with an Intel Core 2 Duo 3 GHz processor and 4 GB of RAM (Dell Computer, Austin, Texas) using Precision Light Imaging (PLI) software (described in detail later; Precision Light, Inc., Los Gatos, California) (Figure 1). A sequence of 13 progressively-finer parallel line patterns was projected from each of three vectors to triangulate the patient (structured light method). In turn, each projected pattern was captured with the video cameras. By this method, each point in space was assigned a 39-character binary address from which a wire-frame 3D rendering of the form was generated. Finally, three individual color images of the subject were gathered from the same cameras, registered to the 3D form and to one another. Total projection and image capture time was 0.5 seconds. Total processing time to render a displayed image with measurements was 15 seconds.

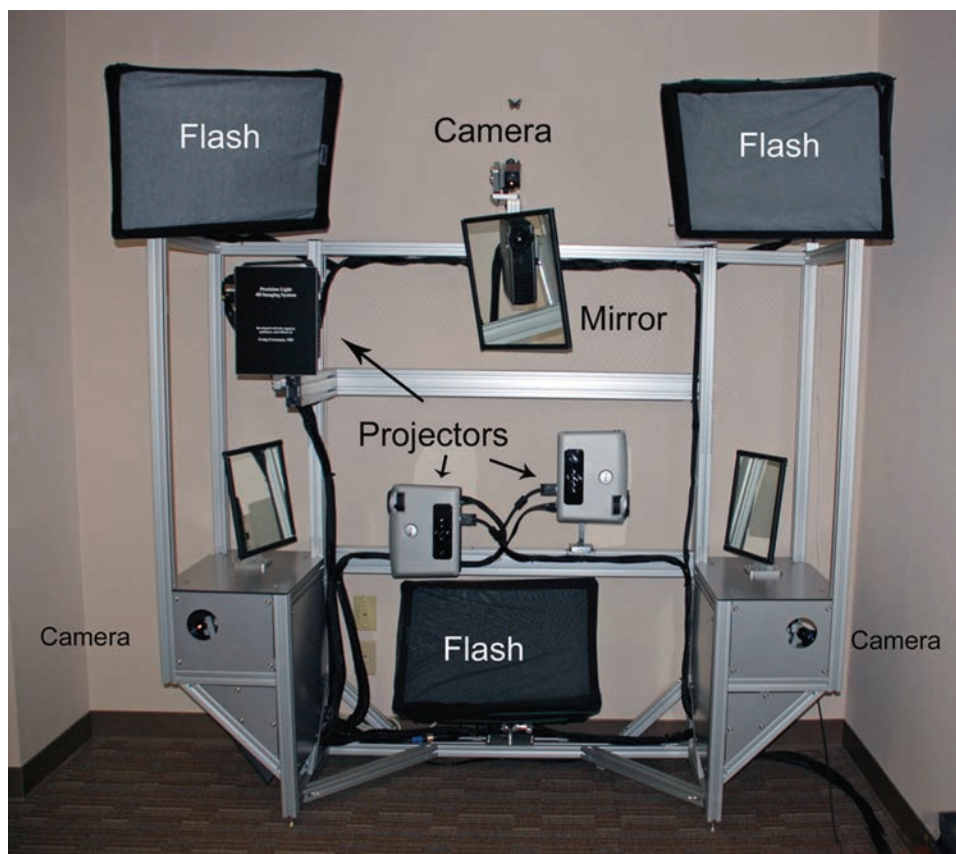


Figure 1. Precision Light Imaging hardware, 78 × 76 × 22 in. (height × width × depth).

Software Image Processing

Automated landmark recognition. Proprietary software was developed specifically for breast imaging (Precision Light, Inc.) to recognize key anatomical landmarks in a completely automated manner from 3D images. Hereafter, *4D imaging* is used to refer to this mechanism of 3D imaging plus automation. This automation was accomplished by the following methodology: A point cloud arising out of the structured light images was converted to a 3D wire-frame reconstruction of the form of the patient. The method of processing the data points has been reported elsewhere⁵⁸⁻⁶⁰ but involves a technique of phase shifting to reduce errors. Onto this wire frame, the individual color images were registered to generate a life-like and recognizable rendering. A separate color contour map was generated from the relationships between adjacent minima and maxima of the wire-frame contour. Key anatomical landmarks—including the inframammary folds (IMF), the axillae, the umbilicus, the sternal notch, the heads of the sternocleidomastoid muscles, the trapezius muscles, the clavicles, the nipples, and the midlines of the IMF—were recognized by virtue of being minima and maxima within this color contour map. These landmark assignments reflected purely mathematical coordinates with a resolution of 0.1 mm (Figures 2 and 3).

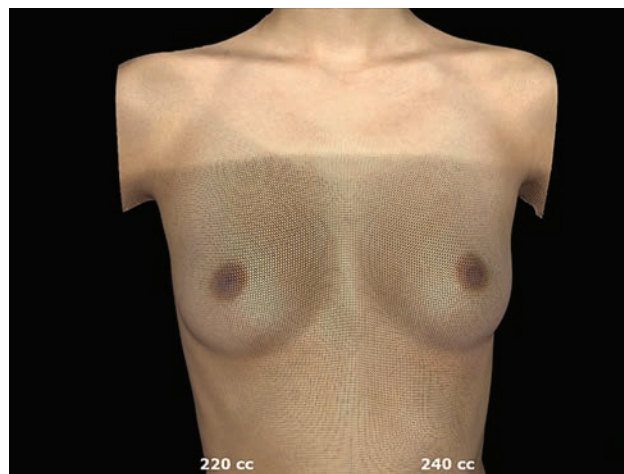


Figure 2. Three-dimensional wire-frame reconstruction

Color value information from the photographic color overlay was the method by which the areolar diameters were recognized. Specifically, the software automatically found the location where the color value of the breast transitioned to the darker value of the areolar tissue (Figure 4).

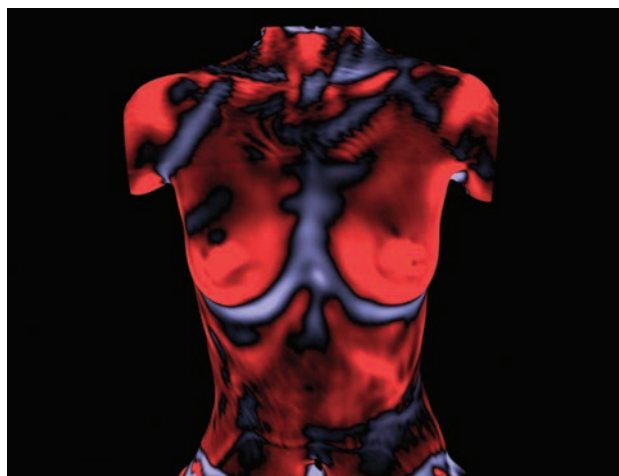


Figure 3. Color contour map.

Point-to-point measurements. Armed with specific contour landmarks, software routines were developed to yield point-to-point measurements automatically. (Some of these were displayed [as in Figure 4] and some were not.)

Midline of torso: The midline of the upper torso was determined by referencing two areas: the midpoint of the area between the sternocleidomastoid muscles and the midpoint between the medial breast folds at the level of the nipples.

Breast base width: To reconcile the frequent issues between horizontal base width and lower pole length, the displayed breast base width corresponded to an average of the base width at the nipple level and twice the inferior breast radius (defined below).

Nipple to midsternal line (not displayed): The linear measurement of the nipple to midsternal line was calculated according to the shortest distance between the 3D coordinates for the nipples and the midsternal line.

Nipple-to-nipple distance (not displayed): The linear measurement between the two nipple positions was calculated as the shortest distance between the 3D coordinates of the left and right nipples.

Intermammary distance: The linear measurement of the intermammary distance was calculated as the shortest distance between the 3D coordinates of the medial boundaries of both breast base fold lines corresponding to the left and right breast.

Inferior breast radius (not displayed): The linear measurement from the IMF to the projected position of the nipple into the chest wall was calculated as the shortest distance between the most inferior point on the IMF to the projection of the nipple onto the virtual chest wall.

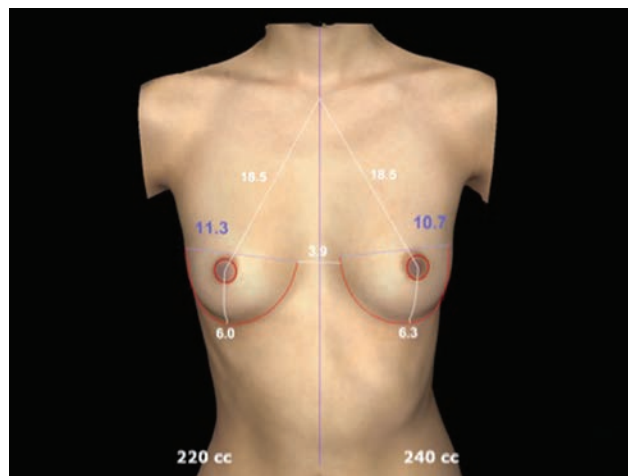


Figure 4. Software rendering of selected automated measurements.

Midclavicle-to-nipple distance (not displayed): The linear measurement of the midclavicle-to-nipple distance was calculated as the shortest distance between the center of the clavicle and the nipple.

Breast height (not displayed): The linear measurement of the upper boundary of the breast mound was calculated as the distance between the horizontal line plotted from a point just beneath the axilla, across the upper chest, to the midsternal line and the most inferior point of the breast fold line, which generally corresponds to the meridian of the breast.

Surface measurements. The 3D system provided consistent and accurate surface measurements because once any two points of interest were identified, the line between those two points over the known surface contour was easily plotted and measured.

Sternal notch-to-nipple distance: The 3D surface measurement from the sternal notch to the nipple was calculated as the 3D line integral over the patient's 3D contour surface along the vector defined between the 3D coordinates for the sternal notch and the nipple.

Nipple-to-IMF distance: The 3D surface measurement between the nipple and the IMF was calculated as the 3D line integral over the patient's 3D contour surface along the vector defined as the 3D coordinates from the nipple to the IMF, with the vector being parallel to the midsagittal plane.

Midclavicle-to-nipple distance (not displayed): The 3D surface measurement from the midclavicle to the nipple was calculated as the 3D line integral over the patient's 3D contour surface along the vector defined between the 3D coordinates for the center point of the clavicle and the nipple.

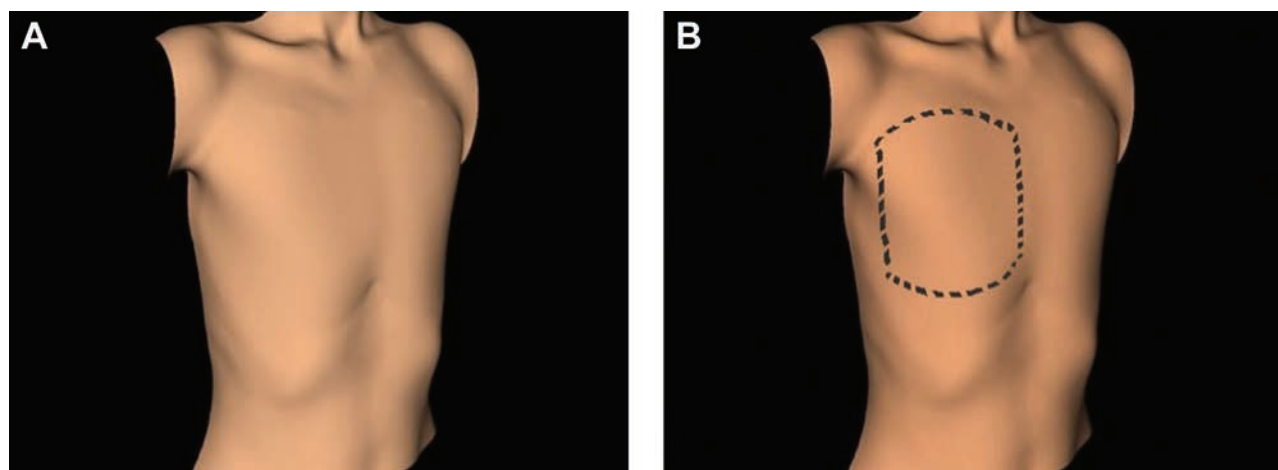


Figure 5. (A) Computer-generated chest wall construction after subtraction of breast and skin tissue.(B) Chest wall rendering showing the outline of breast soft tissue boundaries based on automatic landmark recognition.

Volume measurement. To calculate the volume of the soft tissues of the chest, a construction of the underlying chest wall was rendered on the basis of several previously-described external landmarks, with a spline interpolation method.⁶¹ The boundaries of what constituted the breast were automatically determined by following some key anatomical landmarks and standard rules: The lateral boundary corresponded to a plumb line drawn from the anterior axillary fold and did not include tissue in the lateral tail of Spence. The lower boundary was defined as a line parallel to but 1 cm below the IMF. The medial boundary was defined as the midsternal line, and the upper boundary was an arc plotted from the anterior axillary fold to the upper sternal border, with a peak corresponding to 1/4 the distance from the clavicle to the nipple. (This configuration is based on multiple iterations of data and may appear high on the chest, but it allows capture of excessive superior fullness under various clinical conditions—for example, in the immediate period following implantation.) With the peripheral boundaries of the breast defined with this interpolated chest wall, the overlying soft tissues of breast and skin absent the pectoralis muscle were mapped, and the contained volume became calculable as the 3D integral between the 3D surface contour and the underlying chest wall (Figure 5).

Clinical Validation of Software: Manual vs Automatic Measurement Comparison

Linear measurement comparison. A linear measurement-comparison portion of the study was conducted with 25 randomly selected female volunteers presenting for breast augmentation consultation and 90 healthy volunteers who had undergone primary breast augmentation at least six months prior to data collection, for a total sample size of 115 patients. Manual measurements were made with the standard bidimensional approach (ie, with a measuring tape and calipers) to obtain clinically accessible measurements.

Some automated measurements, such as inferior breast radius, not manually accessible. The specific manual measurements obtained were as follows: base width, nipple-to-IMF distance, sternal notch-to-nipple distance, internipple distance, and nipple-to-midline distance. At the same visit—but immediately after manual measurements, to avoid biasing the manual examiner—4D images were obtained with the PLI system. All manual measurements, 4D image capture measurements, and data processing were completed by one examiner (Ms. Chiu) for consistency. Table 1 summarizes the demographic and implant data for this large cohort. Comparison between manual and PLI measurements was analyzed statistically with the Pearson correlation coefficient for each measurement category.

Repeated automated measurement consistency. Consistency was established among repeated automated measurements by comparing measurement data from two images of the same patient. Twenty-five patients were randomly chosen, and two images were sampled per patient. Data were analyzed with the Pearson correlation method.

Repeated manual measurement consistency. Consistency was established among repeated manual measurements (ie, interrater reliability) by comparing measurement data for the same patient but from two examiners. The same 25 randomly-selected patients who were included in the cohort to ensure automatic measurement consistency were manually measured by two independent examiners and the following distances were compared: sternal notch-to-nipple distance, internipple distance, nipple-to-IMF distance, and base width. The Pearson correlation was used to compare the independent manual measurements between the two examiners. Statistical analysis was carried out with the Pearson method.

Volume measurement comparison. Eleven healthy volunteers were selected semirandomly and included in a separate

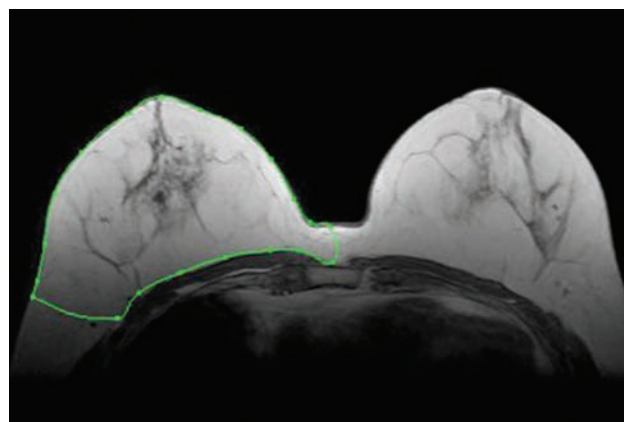
Table 1. Demographic and Implant Data

Variable	Augmented Patients, n = 90	Nonaugmented Patients, n = 25
Age	30.6 ± 12.3	33.3 ± 8.3
Implant type		
Saline	71 (MP = 32, HP = 39)	N/A
Gel	19 (MP = 13, HP = 6)	N/A
Implant size	381.3 ± 53.5	N/A
Incision	AX = 18, IMF = 58, PA = 14	N/A
Implant site	SG = 1, SP = 61, DP = 28	N/A
Average net volume/breast volume		
Right breast	614.5 ± 155.9	249.6 ± 122.0
Left breast	609.2 ± 166.0	298.5 ± 117.7

MP, moderate profile; HP, high profile; AX, axillary; IMF, inframammary fold; PA, periareolar; SG, subglandular; SP, subpectoral; DP, dual plane.

cohort to assess the validity of volume measurement. Semirandomly is meant to indicate that within a group of randomly selected patients, participants were stratified by bra cup size to assess volume measurement across the spectrum of patients presenting clinically for breast augmentation. Three of the 11 patients had previously undergone breast augmentation. MRI scans were obtained with a Siemens Magnetome Symphony 1.5 Tesla MRI scanner (Siemens, Berlin, Germany). All patients were placed in the prone position. Bilateral, noncontrast, T1-weighted, fat-suppressed, and non-fat-suppressed axial and coronal images at 2-mm slice thickness were obtained with a dedicated breast array. These images were processed for 3D volume calculation with the following protocol: On the axial images, control points were placed manually around the entire breast in a manner consistent with the algorithm for the PLI software described previously, avoiding the tail of Spence but delineating the right from left breast by the sternal notch. A line connecting all control points was automatically drawn on all slices, and the volume was calculated with the “fuzzy means” technique, incorporating all tissue types contained within the skin envelope but excluding the chest wall structures, to define a region of interest consistent with the automated software algorithm of PLI. A fuzzy C-means segmentation technique was used to label all magnetic resonance voxels (volumetric pixels) within the tissue contained by the breast skin envelope.⁶²

A graphical user interface was developed to interactively delineate the regions of interest in the non-fat-suppressed slices of interest. Regions of interest were accomplished with a combination of Bezier splines and a Laplacian of Gaussian filter.⁶³⁻⁶⁶ The researcher placed control points of Bezier splines close to the edges of the regions of interest (here, the breast contour). The final contour was displayed after automatic attachment of the Bezier spline control

**Figure 6.** MRI, axial section. Note the outline of the breast delineated for volume measurement.

Photograph courtesy of Catherine Klifa, PhD, University of California, San Francisco, Medical School, Department of Radiology.

points to the closest edges. Points that did not reach the desired final position were manually adjusted by the researcher to yield a final regions of interest, as shown in Figure 6. On the same day, patients were photographed with the PLI system at a separate location, and volume calculations were carried out automatically. Data were compared with the Pearson correlation coefficient.

Development of Breast Augmentation Simulation Algorithms

Forty-seven patients were studied longitudinally prior to and following primary breast augmentation, to gather measurement data to assist software designers in the development of simulation tools. Patients were imaged preoperatively and at one, six, 13, and 26 weeks postoperatively. Based on these measurements, trends of linear and volumetric change were compiled. No unoperated control group was studied. Though it is possible that some measurable changes in breast dimensions (particularly volume) might be found over time in a normal population of women on the basis of weight fluctuations or menstrual cycles, our system is not sensitive enough to detect such minor normal anatomical fluctuations. Proprietary simulation software was initially based on these data, and data were retrospectively obtained in one practice (CNC) and in a prior study by our group.⁶⁷ Subsequently, additional measurement data sets have been obtained from five other clinical sites across all implant types and from the two major US implant manufacturers.

RESULTS

The PLI automated measurement results correlated, with a high degree of statistical significance, to manual measurements in the sternal notch-to-nipple distance (Figure 7), base

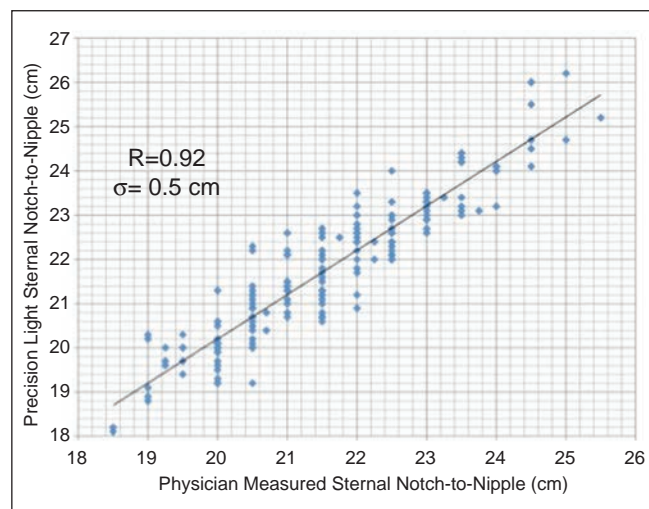


Figure 7. Sternal notch-to-nipple correlation, $R = 0.92$ ($SD = 0.5$ cm).

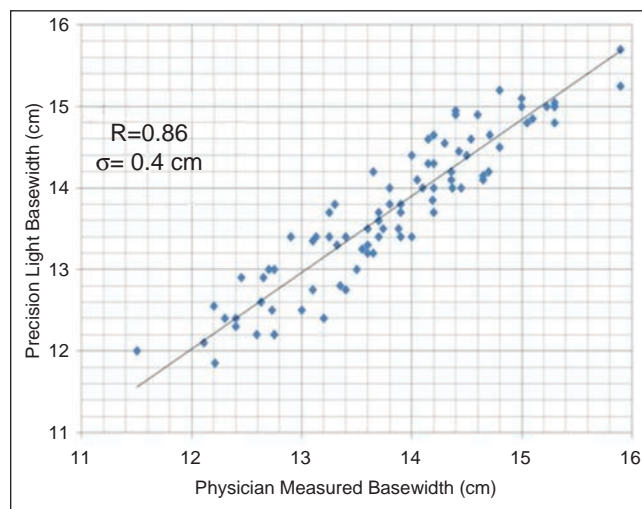


Figure 8. Base width correlation, $R = 0.86$ ($SD = 0.4$ cm).

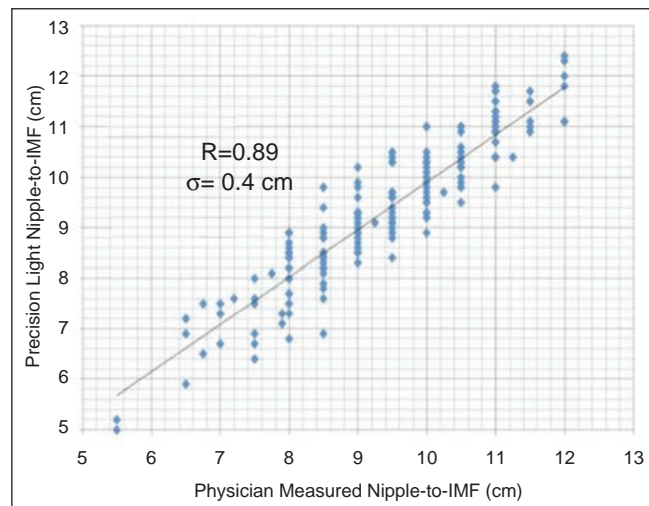


Figure 9. Nipple-to-IMF correlation, $R = 0.89$ ($SD = 0.4$ cm).

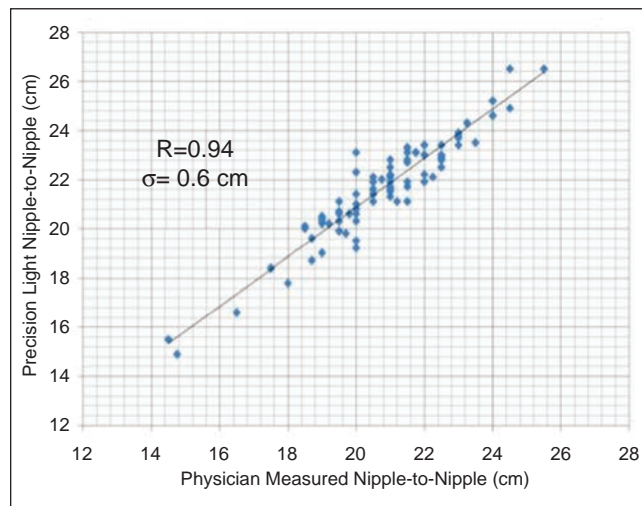


Figure 10. Internipple distance correlation, $R = 0.94$ ($SD = 0.6$).

width (Figure 8), nipple-to-IMF distance (Figure 9), and internipple distance (Figure 10) categories. Volume comparisons to 3D MRI measurements showed a high degree of precision but had less significant accuracy than the linear measurements (Figure 11). Thus, the overall correlation of manual to automated measurements in this series was 91%. The repeatability of the automated measurements ($R = 0.996$) compared favorably to interexaminer variability with manual measurements ($R = 0.993$).

The longitudinal analysis yielded massive quantities of data too extensive and complex to be of practical publication value. General trends in the parameters measured varied by implant type more than by volume but were otherwise consistent with clinical experience. There were

quantitative increases primarily in breast projection (average, 63%) and lower pole lengthening (average, 43%), with very little change after the three-month postoperative period (Figure 12). Volume trends showed an initial expected increase, followed by progressive decline averaging 13% over the first three months, after which they remained stable (Figure 13), consistent with the clinical observation of “implant settling.” The observed trends were included in designing the initial simulation computer algorithms that were subsequently refined by over 1000 additional consultation data sets in a reiterative process. In a companion publication,⁶⁸ a description of the method and validation of simulation software is reported.

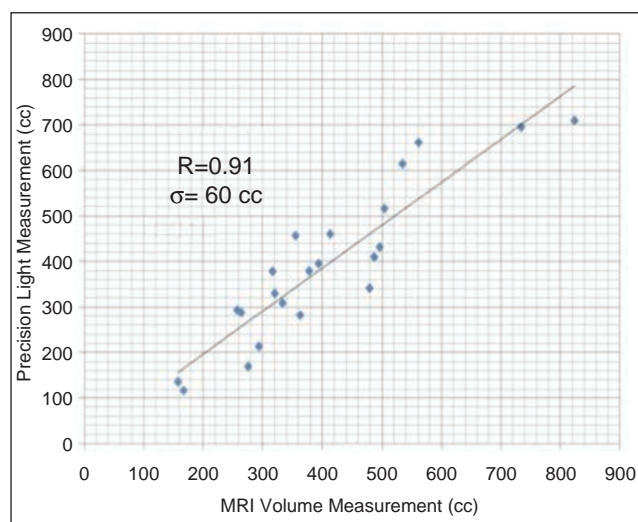


Figure 11. Volume correlation, $R = 0.91$ ($SD = 60$ cc).

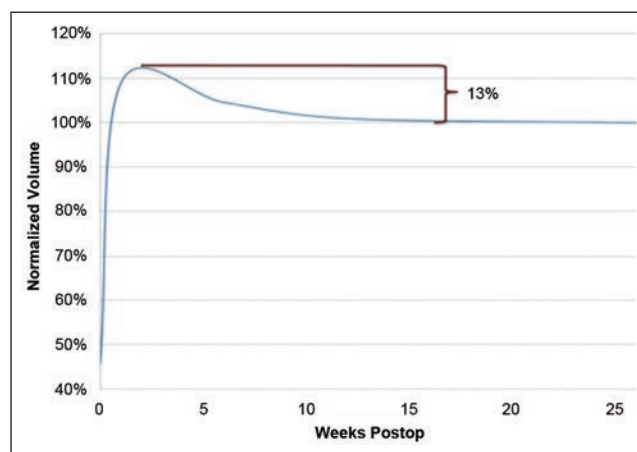


Figure 13. Postoperative volume loss curve. Average loss of volume was 13% over first three months, then remained stable in subsequent months.

DISCUSSION

The promise of a practical 3D imaging tool for everyday application in clinical practice has not been fully realized, because of the need for manual intervention on the part of the clinician. This is time-consuming; it requires a degree of comfort with technology along with some training; and it insinuates the computer between the doctor and the patient. Advancement of the field demands automation. With automation, one realizes much greater ease of use, speed, and consistency of measurement. Absent the distractions of patient-positioning problems, calibration sensitivity, and manual cursor placement, the consultation “flow” is unimpeded and allowed to progress quickly to analysis of anatomical features, asymmetries, and, ultimately, simulation of implantation under various scenarios.

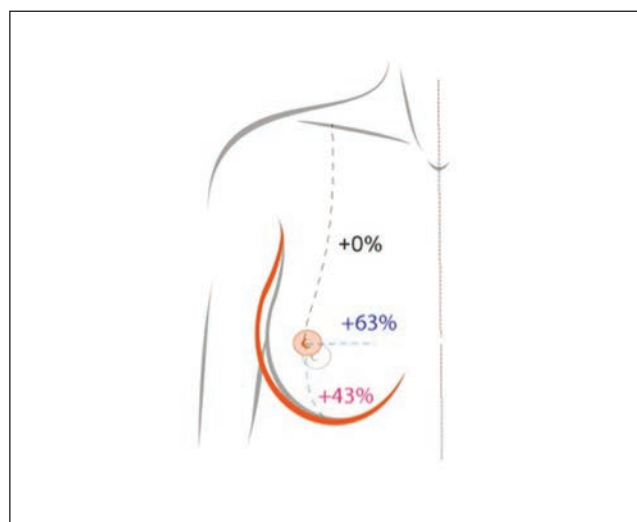


Figure 12. Linear trends in soft tissue stretch, six months after breast augmentation (mean values). Lower pole elongates 43%; projection increases 63%.

While there are a variety of technical means for acquiring an image and rendering the human form in three dimensions, the method of structured light and the utilization of software that automatically recognizes standard anatomical landmarks described here provide a high degree of precision and reproducibility. In other areas, structured light 3D imaging has been used for scanning machine parts with specifications and tolerances far more precise than what is needed in physiological systems. First reported by Boot et al, the Bodymap software was a structured light-based system for studying breast asymmetry.⁶⁹ The last decade has ushered in other pioneering investigations with laser scanning, other forms of structured light, digital photography, and digital photogrammetry.^{47,69-77} While a few manufacturers have entered the commercial marketplace, their systems are too slow and unwieldy for most practitioners, and the machines interfere in, rather than enhance, the consultation process. By dint of first-generation design flaws, they often encumber the physician, who cannot delegate this task to an ancillary provider because of the need to apply clinical judgment at multiple decision points in the manual interfaces of these systems. These first-generation products also require large capital expenditures, and, consequently, such systems have found applicability primarily in a research sphere or in large multiphysician groups or have ultimately fallen into disuse. As a result, there has not been wide adoption of 3D imaging by practicing plastic surgeons as part of their consultation process.

Moreover, though a significant body of literature exists demonstrating the technical aspects of image capture and validation of linear measurements (and in a few instances, volume measurements), no systems to date have been placed on the market with any significant aspects pertaining to

validation of the implant simulation features of the technology. Our data, drawn from several studies presented here, demonstrate the PLI system's ability to rapidly capture and process an image into a clinically useful format in approximately 15 seconds. The validity of the measurements is shown with an overall correlation to manual measurements of 91%. Reproducibility of measurement was also shown, with a reliability of 99.6%.

One important issue for practicing plastic surgeons is the practical consideration of how such systems might be employed clinically. For clinicians to embrace the often-stunning imaging technology now available as a practical clinical tool, the system must not only be user-friendly but also offer some reliability in terms of the image outcomes being presented to each patient and their correlation with actual postoperative results. Only through rigorous validation testing can confidence in such technology develop. In a companion article,⁶⁸ we present more information about the development and testing of our simulation algorithms for breast implant placement, along with personal experience with this imaging system in a clinical practice.

CONCLUSION

Precision Light, a novel 3D digital imaging system, offers software capable of automatically recognizing anatomical landmarks and measuring linear, surface contour, point-to-point, and volume parameters for prospective breast implant patients. Validation testing shows this to be a reliable tool when compared to the controls of manual linear measurement and MRI volume measurement. Repeatability analysis showed a nearly-perfect result when compared to repeatability of manual measurements. Longitudinal studies show a variety of trends over time in the postoperative course of the augmented breast; the large amounts of data acquired were of significant help in the design of computer simulation algorithms. Because of the automated features of this system, the full process (image acquisition, processing, and display of the patient's form with applied measurements) is completed with such rapidity as to make the imaging process practical in a practice setting. While more work is necessary to refine and validate the simulation features of the software, at the present time this system is functional in several private practice settings, and expansion to a larger group of practices is planned.

Acknowledgment

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Disclosures

At the time of acceptance of this research, Dr. Creasman was a principal investigator and a shareholder with stock options at Precision Light, Inc., the manufacturer of the products discussed in this article. Dr. Mordaunt was a founder, CEO, shareholder, and board member at Precision Light. Mr. Liolos

was president, shareholder, and board member at Precision Light. Dr. Gabriel was a shareholder at Precision Light. Dr. Maxwell was also a Founder, shareholder, and Board member at Precision Light. Ms. Chiu has nothing to disclose. Drs. Creasman, Mordaunt, Gabriel, and Maxwell as well as Mr. Liolos, as stockholders in Precision Light, Inc., received financial returns when Precision Light, Inc. was purchased by Allergan Medical after acceptance of this article. Ms. Chiu was paid by Precision Light, Inc. as a summer work-study student.

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Special Topic

Four-Dimensional Breast Imaging, Part II: Clinical Implementation and Validation of a Computer Imaging System for Breast Augmentation Planning

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Catherine Chiu; Allen Gabriel, MD; and G. Patrick Maxwell, MD

Abstract

Background: No publications exist describing the impact of three-dimensional imaging on the consultation process for breast augmentation, nor have existing software products claiming simulation features been validated.

Objectives: The authors describe the application of four-dimensional technology during patient consultation to assist in planning implant size and type.

Methods: Forty-six primary breast augmentation patients underwent preoperative consultation with 4D simulation software; 35 out of 46 also received follow-up imaging. At six months postoperatively, simulated measurements were compared to actual measurements and questionnaires were mailed to patients asking them to assess the imaging experience. A follow-up phone survey 18 months postoperatively examined the persistence of patient attitudes about implant size and imaging. Practice productivity was evaluated by comparing specific parameters (such as scheduling rates) between three separate time periods for the same clinic.

Results: Across all parameters, breast augmentation simulations correlated highly with positive surgical outcomes (R-value = 0.68). The majority (95%) of patients believed the simulations were accurate; 89% also expressed that it enhanced trust in the surgeon and 74% reporting that it helped in choosing an implant size. Despite 48% also indicating that they would select a larger implant if they were to undergo surgery again, no patients have undergone reoperations of any kind. Compared to historical controls, scheduling rates in the practice increased from 40% to 77% after addition of simulation software.

Conclusions: 4D breast imaging appears to be an accurate system for analysis, planning, simulation, and patient education for women considering primary breast augmentation, and application of this technology during the consultation process was correlated with a high degree of patient satisfaction and practice productivity.

Keywords

breast surgery, four-dimensional imaging, magnetic resonance imaging

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In previous reports,¹⁻³ we introduced a system of three-dimensional (3D) breast imaging relying on structured light and automated measurement functions. This 3D rendering system, once automated, is referred to as four-dimensional (4D) imaging. In those previous reports, we described our validation studies to verify the accuracy of this system. While many other 3D imaging technologies exist and limited validation studies have been performed to confirm the accuracy of images,⁴ no extensive validation of clinically relevant, common parameters in various current surgical planning paradigms (including Biodimensional,⁵ BodyLogic,⁶ and Akademikliniken⁷ systems) had been published before our report.² Moreover, the designs of existing, commercially-available 3D imaging systems

require operator placement of cursors, which adds time and a degree of variability to the consultation process.⁸⁻¹⁰

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With automated landmark recognition, 4D imaging has the advantage of instantaneous display of a patient's anatomical measurements, along with analysis of breast and chest wall asymmetries. This automated measurement system also affords the opportunity to serially study changing breast dimensions over time in a standardized way; with this comes the ability to develop simulation tools based on data rather than hypothetical illustrations.

To date, no study has examined the clinical effects of 3D imaging from the patient's perspective. A recent study of the attitudes of European women seeking breast augmentation examined a number of perceived barriers that dissuaded patients from proceeding.¹¹ One important finding was their need to visualize the outcome. Another important factor that discouraged patients was the inability to find a surgeon whom they could trust. To that end, we report the development and refinement of software to simulate breast augmentation and validate accuracy with objective measurements in a prospective group of 46 patients undergoing primary augmentation. Furthermore, we report on the subjective patient response to imaging technology as a means of communicating potential results during the consultation process.

In a separate analysis, the imaging system's effect on practice productivity was evaluated in 100 consecutive breast augmentation consultations over seven months by the tracking the length of consultation times, conversion rates to surgery, the period of time from consultation to scheduling, and the volume of implants ordered year over year, as compared to historical data for the same time interval in the prior two years. Comparison of results in one private plastic surgery practice was corroborated to two other practices that subsequently began utilizing the system. In this way—through objective correlation data, subjective patient reports, and comparative practice statistics—we assessed the efficacy of this 4D imaging software in the clinical setting.

METHODS

Precision Light Imaging Software

The imaging system being investigated in this study is not currently available commercially but has been reported in this journal and presented elsewhere.^{1,2} Precision Light, Inc. (Los Gatos, California) is a proprietary 4D breast-imaging system that incorporates rapid image capture and processing with automated measurement functionality. Data from over 1000 breast augmentation consultations in which this system was incorporated have been accumulated and utilized to refine the image capture, automated measurement, and asymmetry analysis software. Additionally, preoperative and three- to six-month postoperative data have been gathered in a large database from the lead author's (CNC) practice and three other practices.

These software algorithms are patented, but in general terms, the algorithm for simulating the postoperative breast appearance involves taking a captured 3D wire-frame

and photographic skin color images, modifying the breast shape independent of the chest wall, and then reapplying it. With the ability to define the chest wall form through automated landmark recognition, the breast form is removed. After calculating the volume of the breast form's soft tissue, the volume of the breast implant is added and, to a varying degree, a percentage of volume is subtracted, depending on the existing volume of breast and the size of implant chosen. The base width (BW) of the simulated breast is determined by the existing BW or the implant—whichever is greater—plus the upper breast soft tissue thickness entered for a given patient. The height of the resultant breast mound is applied depending on the type of implant specified, with resultant breast heights correlating highly to form-stable implants but to less than the BW of non-form-stable implants. Simulation projections are calculated from the volumes determined in earlier stages. The new breast form is added to the original chest wall but placed 1 cm below the original inframammary fold as a default. The peripheral boundaries of the breast are softened to mimic the contribution of the existing breast and subcutaneous tissue, calibrated from the original upper soft tissue thickness. The nipple-areola complex is separately expanded in diameter, and the subareolar region is copied and pasted from the original breast form back onto the rounded breast form, with positioning determined from accumulated data sets but generally rotating cephalically and laterally. Skin colors are copied from the original and registered to the chest wall and breast form, with data from three cameras registered and dithered along junctions of the three photographic images. Shadows are enhanced by artificially lighting the resultant 3D form to simulate standard medical photography conditions.

Objective Correlation Through Automated Measurements

To validate the simulation algorithms, the Precision Light breast imaging system was introduced in one clinical practice (CNC), and the simulation software tools were implemented during initial breast augmentation consultation beginning in March 2009. The software simulations enabled cooperative discussion between the patient and surgeon to determine implant size and type. Over six months, 46 consecutive primary breast augmentation patients were recruited to participate in a long-term study. Patients with ptosis were excluded, as were patients presenting with secondary issues. The 46 patients who were selected agreed to return for follow-up imaging and complete a questionnaire at six months postoperatively. The simulated measurements of sternal notch to nipple, nipple to inframammary fold, BW, and volume were stored as a reference, to be compared with follow-up measurements. The screen shots shown in Figures 1-11 demonstrate a typical sequence of images presented to patients during

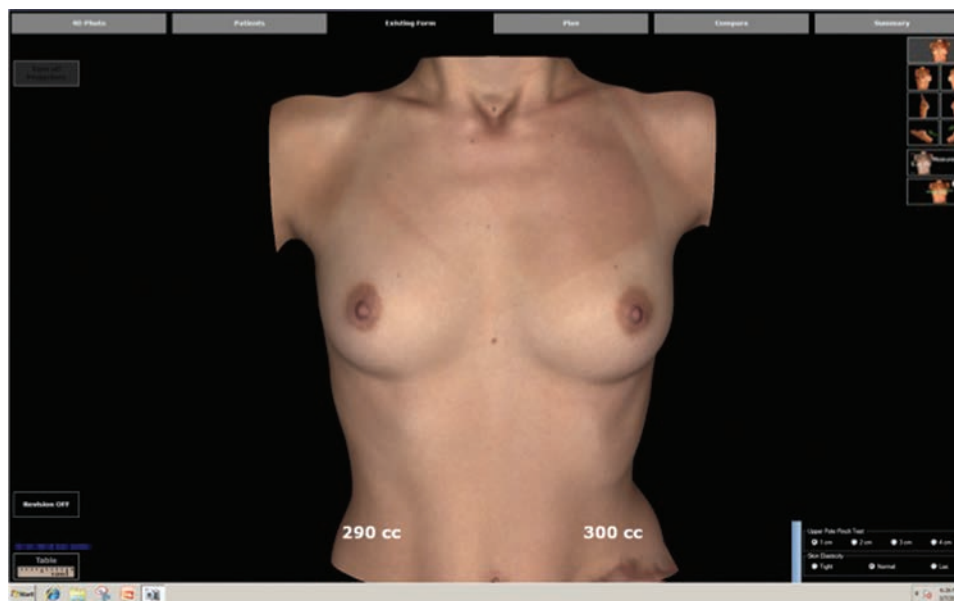


Figure 1. Precision Light 4D imaging display immediately after image capture.

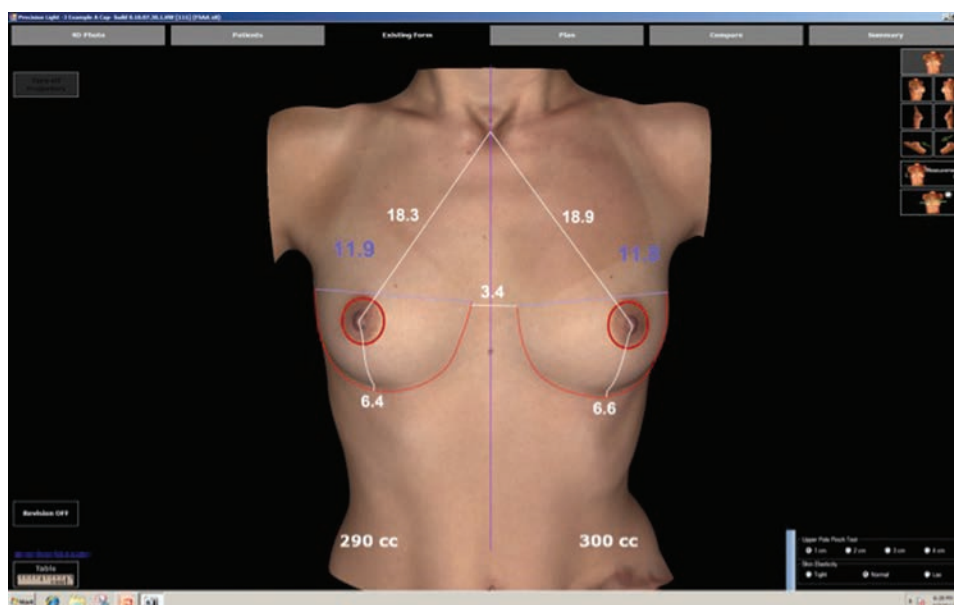


Figure 2. Patient anatomy with automated measurements applied.

the consultation. Along with automated measurements, symmetry analysis was carried out to assess differences in nipple height, inframammary fold position, projection, and shift of the midline. The “worm’s eye” view (Figure 7) shows differences in breast projection compared to the chest wall contour. A simulation of postoperative appearance was shown to each patient, including a clothed version. Finally, an operative plan view was generated for projection in the operating room.

Subjective Comparison Through Patient Feedback

Questionnaires (see appendix, online at www.aesthetic-surgeryjournal.com), along with copies of the individual preoperative photos and simulation images, were mailed to all 46 patients six months postoperatively. Patients were asked to rate the role that 4D imaging played in their decision-making process, the accuracy of the imaging, and

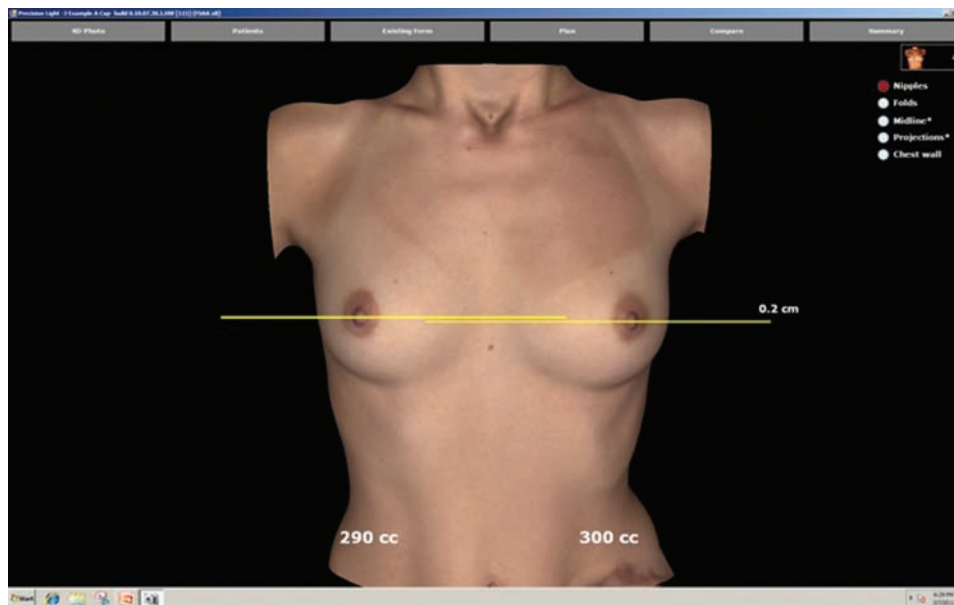


Figure 3. Asymmetry analysis: nipple-level comparison.

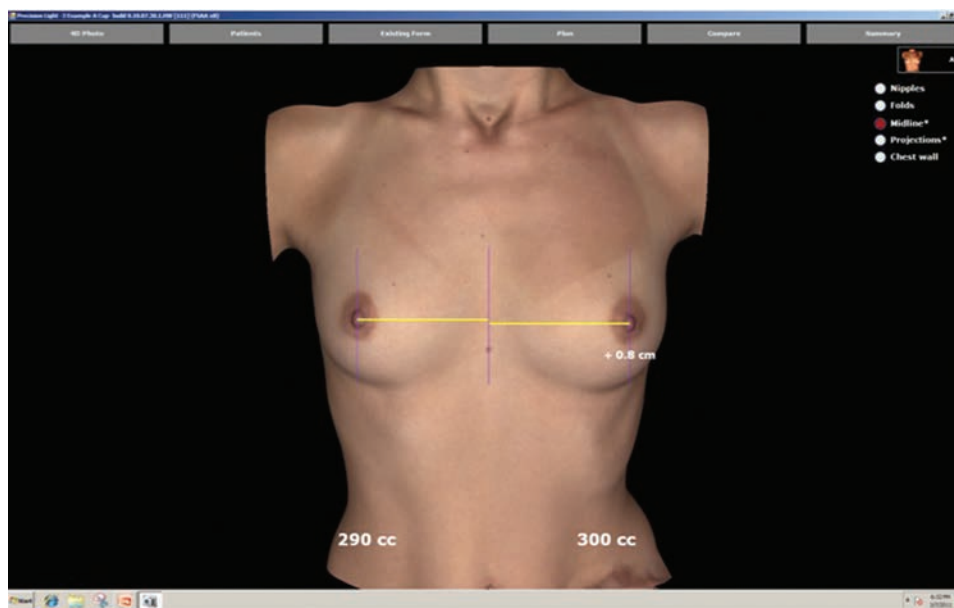


Figure 4. Asymmetry analysis: nipple-to-midline comparison.

other measures of patient satisfaction (including implant size choice). These early postoperative data were compared to longer-term follow-up in the form of phone calls placed by an independent nurse to all questionnaire respondents

at an average of 18 months postoperatively. During that phone call, patients were queried about their overall satisfaction, implant size satisfaction, and the importance of imaging in their initial decision making.

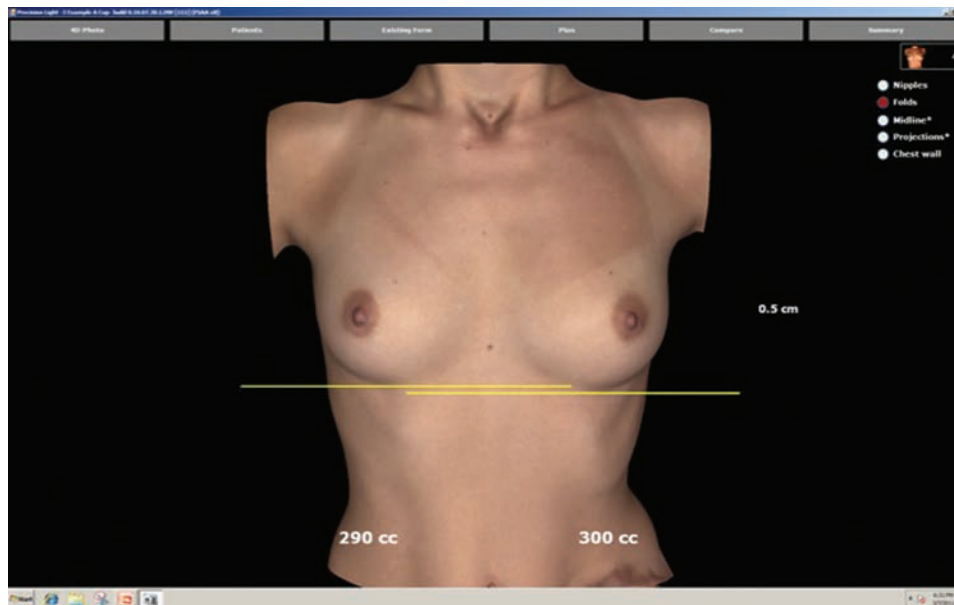


Figure 5. Asymmetry analysis: inframammary fold comparison.

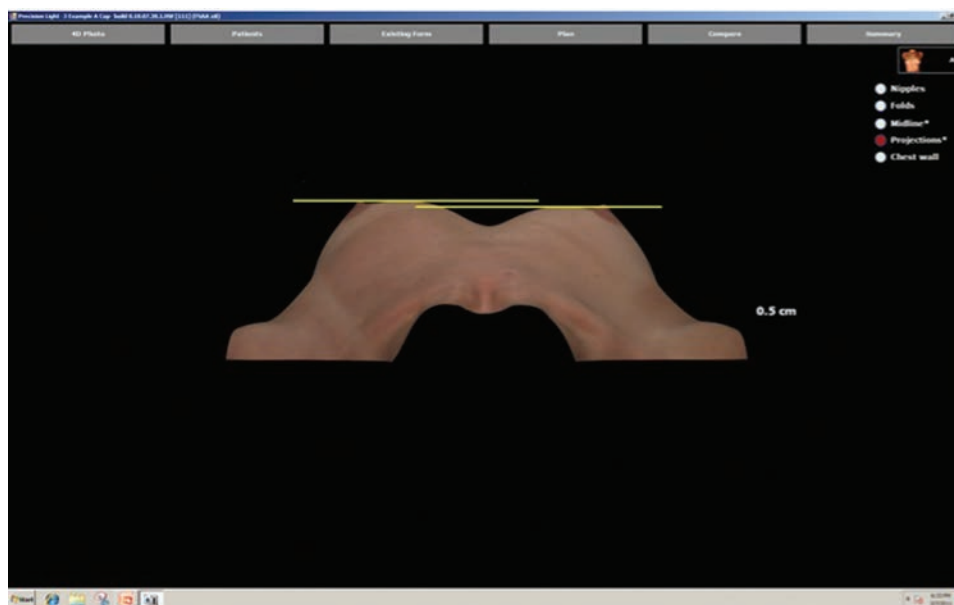


Figure 6. Asymmetry analysis: breast projection comparison.

Effect on Private Practice Productivity

For the seven-month period from March 2009 to September 2009, concurrent with the introduction of this technology into a single practice setting, selected data points (practice management metrics) were calculated and compared to the same seven-month period in the two prior years (2007 and 2008). These data were collected through chart review and practice scheduling software (NexTech, Tampa, Florida)

and included consultation time, conversion (scheduling) rates, and the time interval between consultation and scheduling.

All consultations were performed entirely by the lead surgeon (CNC). After approximately eight months, 100 patients had been deemed appropriate candidates for primary breast augmentation; those patients were included in a cohort for this portion of the analysis. Results were calculated in terms of percentages and compared with the

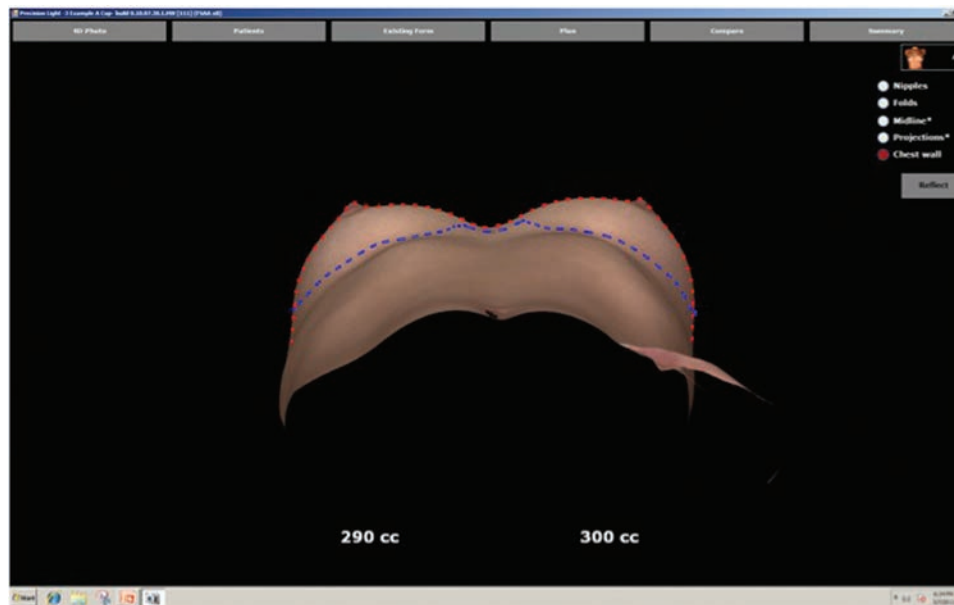


Figure 7. Asymmetry analysis: comparison of chest wall (blue) and breast (red), as seen from below.

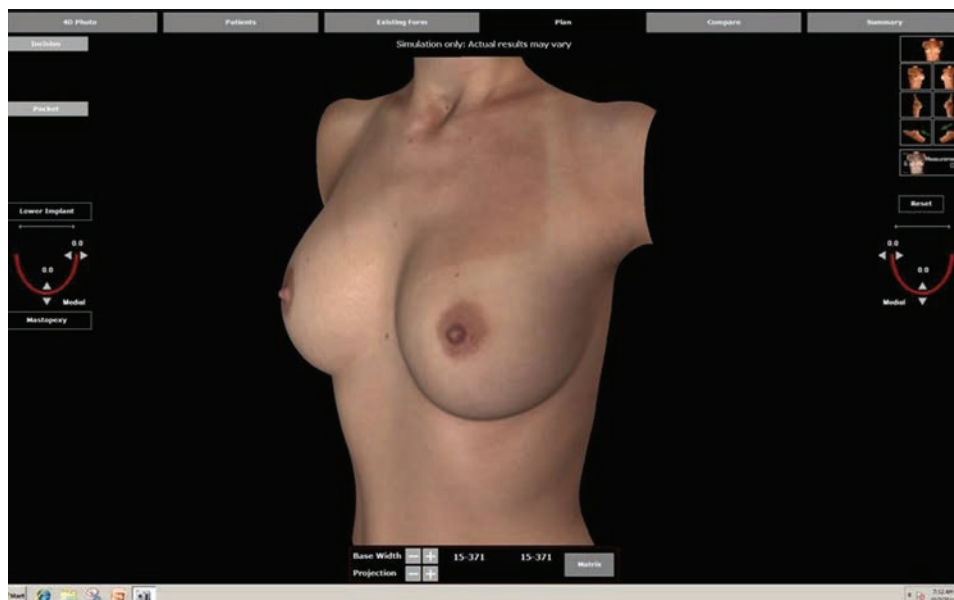


Figure 8. Potential postoperative simulation: oblique view.

Cochran-Mantel-Haenszel test for statistical validation. The results from this practice were subsequently compared to two other clinical practices for corroboration.

RESULTS

4D Measurements

The demographic profile of the 46 patients enrolled in this prospective study is summarized in Table 1. Thirty-five

patients (76%) returned for follow-up imaging at six months. Measurements derived from the simulations at the initial consultation were compared to 4D imaging measurements of actual six-month outcomes with the Pearson correlation coefficient. No manual measurements were compared, since the accuracy of the automated measurement function was already established in a prior study.¹ Representative examples of objective comparison between simulated preoperative and actual postoperative outcomes at six-month follow-up are shown in Figures 12

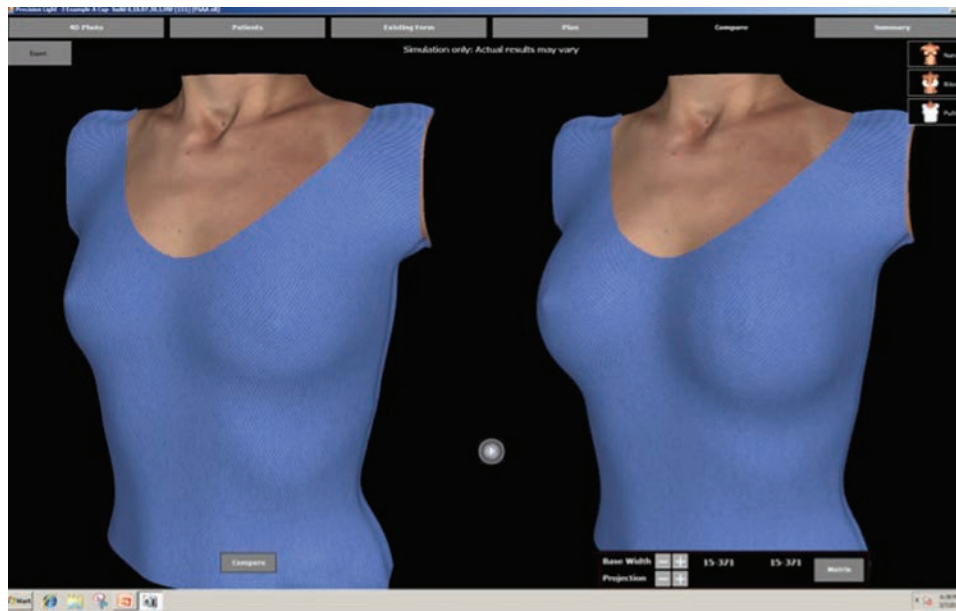


Figure 9. Preoperative simulation (left) and potential postoperative simulation (right): oblique view, clothed.

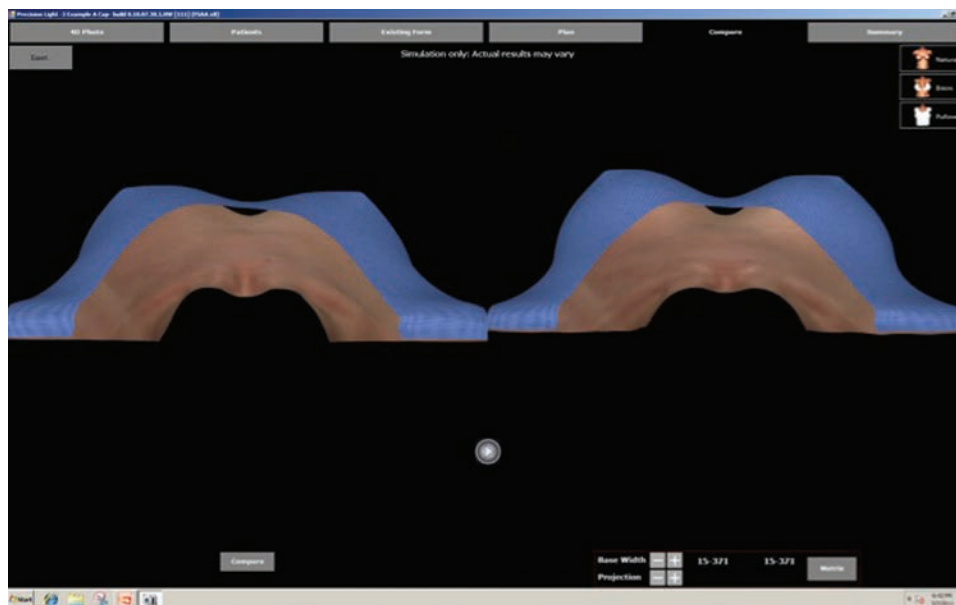


Figure 10. Preoperative simulation (left) and potential postoperative simulation (right): clothed, view from above.

and 13. Statistical comparisons are shown in Figures 14-17 for each parameter measured. Comparison of simulated and actual outcome measurements showed an overall correlation of 68%.

Patient Questionnaires

Of the 45 patients surveyed, 37 responded to the six-month follow-up questionnaire sent by mail (80%).

Questionnaire responses remained anonymous to the reviewers to maintain patient confidentiality and optimize the candor of the responses. (A copy of the questionnaire can be found at <http://aes.sagepub.com/supplemental>). Results of the questionnaire are summarized in Table 2. Most patients (a total of 83%) indicated that the imaging process was either the “main reason” they had chosen their surgeon or was “very important” in helping them choose their surgeon. Fifty-seven percent indicated that the consultation with the surgeon, which included 4D image simulations

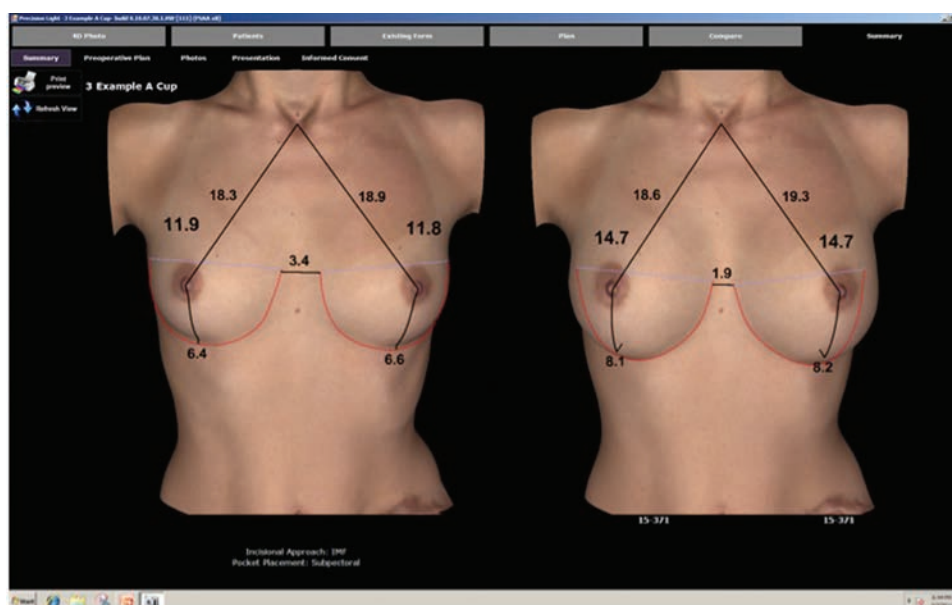


Figure 11. Preoperative simulation (left) and potential postoperative simulation (right): operative plan view.

Table 1. Patient Demographics and Implant Data (N = 46)^a

Category	No.
Nulliparous	24
Parous ^b	22
Silicone gel implant	
Moderate profile	13
High profile	9
Saline implant	
Moderate profile	10
High profile	13
Low profile	1

^aMean age, 32 years. Mean implant size, 348 cc.

^bMean no. of children, 2.

and cooperative implant selection, had resulted in their having “complete trust” in their surgeon. Interestingly, 52% indicated that they were happy with the size of their implants at six months, but 48% indicated that, if they were to undergo the augmentation procedure again, they would select a larger implant. In terms of complications, one patient developed an early capsular contracture six weeks postoperatively, which was treated and remained soft 18 months after capsulectomy. There were no other complications in any of the respondents.

At 18 months postoperatively, 28 of 35 previous questionnaire respondents were available for telephone interview. When asked about satisfaction with implant size

and what they would select if they were to undergo the surgery again, 17 (61%) replied that they would select the same implant (mean implant size in these respondents, 325 cc); 10 (36%) replied that they would prefer a larger implant (mean implant size, 391 cc); and one patient (3.5%) indicated that she would prefer a smaller implant (she initially received a 400 cc low profile gel implant). These responses did not differ significantly from the six-month results, although the percentage of patients who were happy with their current implant size had increased. When asked to rate overall satisfaction with the surgical outcome on a five-point grading scale (1 = low, 5 = high), the patients who indicated size satisfaction reported an average rating of 4.9, while the other groups (combined) rated their satisfaction at 4.4. The overall satisfaction for the cohort was 4.7. No patient contacted in the 18-month survey had undergone reoperation for size change. All 28 patients expressed satisfaction with the value of imaging as a means of visualizing the outcome.

Practice Productivity

Surgical scheduling rates and the time interval from consultation to scheduling were calculated and compared to the similar seven-month periods in the two years prior to implementing the imaging device. Scheduling rates for primary breast augmentation consultations increased from 40% to 73%. The percentage of patients scheduling surgery on the day of the consultation increased from 14% to 46%.

Orders for implants through the manufacturer during the study period were reviewed and compared with the same period in the prior year; the number of implants ordered increased by 29%. There was a coincidental rise in the number of silicone gel implants ordered (70%), which

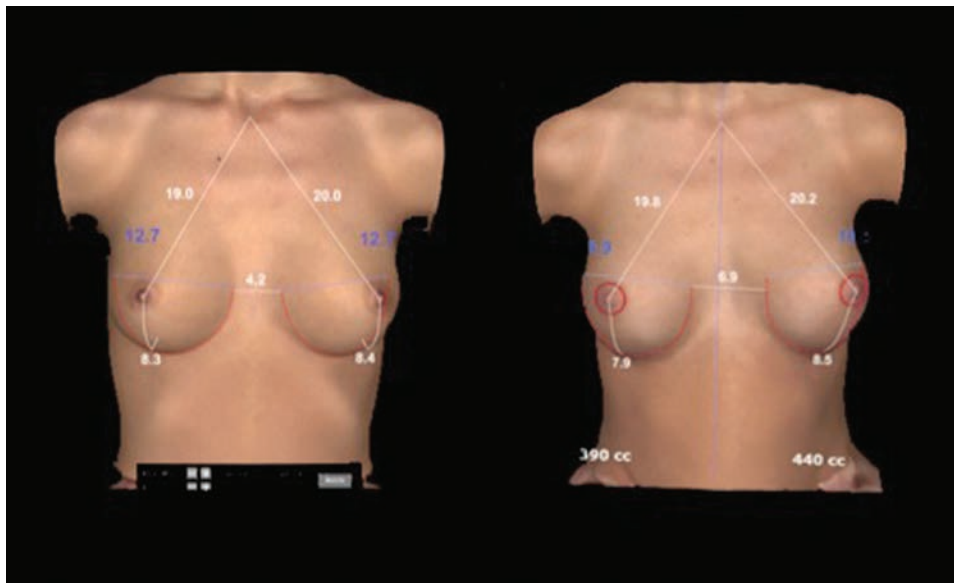


Figure 12. Representative patient example of simulated postoperative image (left) vs actual postoperative image at six-month follow-up (right), with automated measurement data.

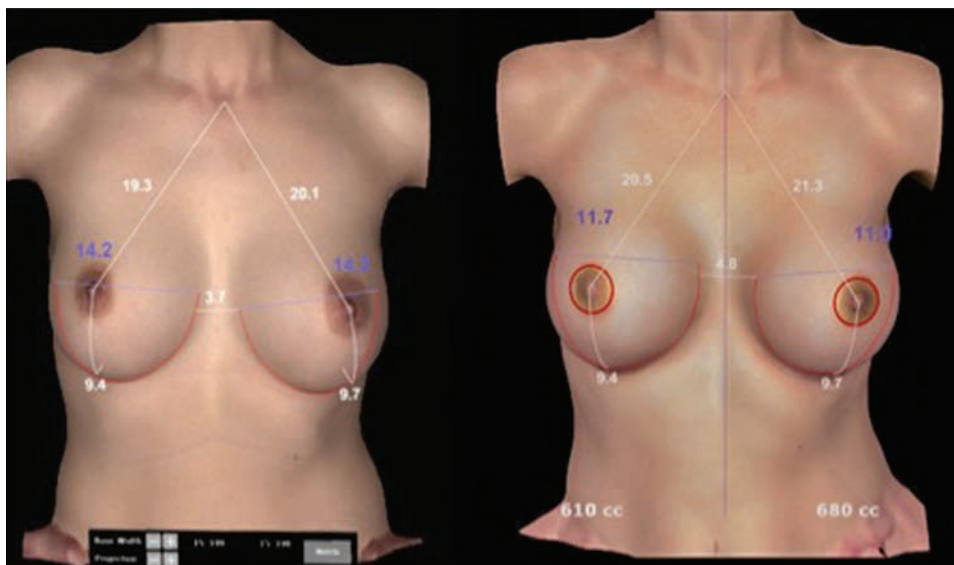


Figure 13. Representative patient example of simulated postoperative image (left) vs actual postoperative image at six-month follow-up (right), with automated measurement data.

contributed to the increase in the overall dollar amount spent on implants (43%). Since choice of implant type (saline vs silicone gel) is primarily based on patient preference, we do not believe that the increased placement of silicone devices is responsible for the increase in scheduling rates.

The duration of consultations initially increased from an average of 45 to 65 minutes in the first month after introduction of imaging. Toward the end of the first month, as familiarity improved with the process of integrating imaging into the consultation, the contact time during consultations quickly decreased from an average of

65 to 30 minutes and has remained stable for over one year. Manual measurements, bra stuffing, and other demonstration techniques to simulate postoperative implant size are no longer utilized in the lead physician's practice. Physical examinations for masses, tissue integrity, and upper pole pinch thickness are still performed manually. Similar statistics were gathered from two other plastic surgery practices in other parts of the country (Nashville, Tennessee, and Louisville, Kentucky) utilizing the same imaging system. Comparable increases in productivity were realized (Table 3).

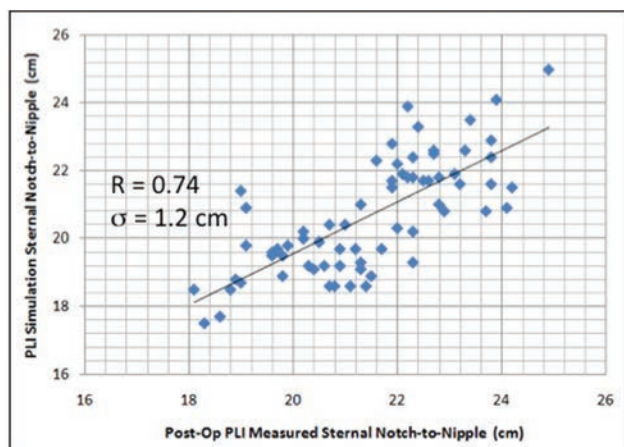


Figure 14. Comparison of simulated postoperative results to actual six-month measurements of distance from sternal notch to nipple. Pearson correlation coefficient = 0.74, SD = 1.2 cm.

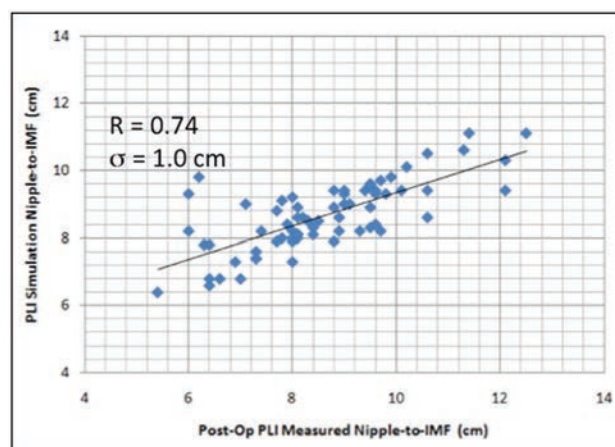


Figure 15. Comparison of simulated postoperative results to actual six-month measurements of distance from nipple to inframammary fold. Pearson correlation coefficient = 0.74, SD = 1.0 cm.

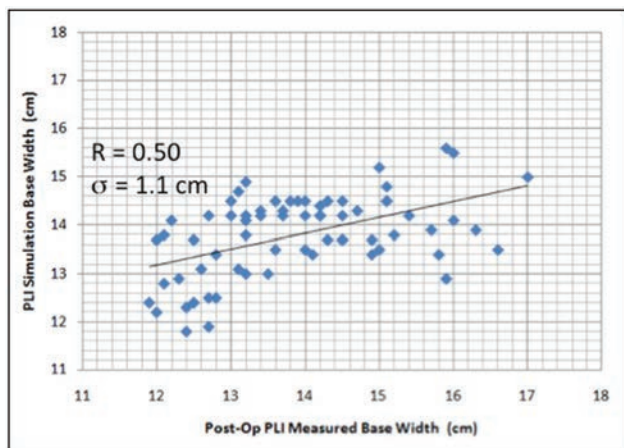


Figure 16. Comparison of simulated postoperative results to actual six-month measurements of base width. Pearson correlation coefficient = 0.50, SD = 1.1 cm.

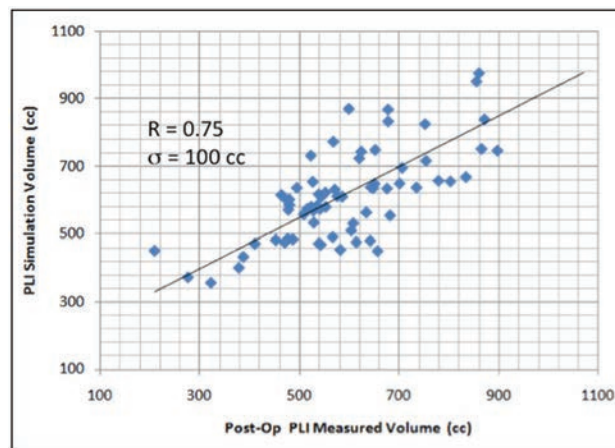


Figure 17. Comparison of simulated postoperative results to actual six-month measurements of volume. Pearson correlation coefficient = 0.75, SD = 100 cc.

DISCUSSION

While a number of authors have published their work validating technology for imaging the breast,^{4,12-15} the implant outcome simulation models have, to date, been placed on the market without much in the way of data-driven support for the morphing component of the technology.⁸⁻¹⁰ In general, a leap of faith is required to correlate the published evidence supporting image accuracy with claims about the validity of simulations generated from those images. The predictive value of a surgical simulation does not necessarily follow the objective accuracy of a preoperative image. Implant simulations involve manipulation of an accurately portrayed and measured preoperative image to display a potential postoperative image under variable implantation circumstances, which is a complex process. We have set out to validate our simulation images

with data-driven algorithms as a first step in what promises to be an ongoing process of refinement of the software.

The data showed an overall correlation of 68% when objective measurements were compared between the simulated images and the final result. Though this correlation may not seem as strong as one might expect, the most poorly correlated parameter was BW. The automated BW displayed by the software is a measure derived from the actual landmarks present horizontally but offset by the measurement of inferior breast radius as rendered by the software, so more variation is to be expected. Another reason for this finding may be that the images are captured with the patient's arms akimbo, a posture that stretches the soft tissue overlying the implant, which accentuates the implant's prominence in the actual postoperative images and, to some extent, minimizes the softening of the surrounding

Table 2. Results of Six-Month Follow-up Questionnaire (n = 37)

Question	Response Rate, %
Would not have undergone surgery without simulation	21
Role of imaging in choosing physician	
Main reason	16
Very	67
Moderate	16
Somewhat	5
Not a factor	3
Discussion with imaging yielded complete trust in physician	47
Accuracy of simulation	95
Implant size satisfaction six months	
Prefer larger	48
Prefer smaller	0
Same	52

soft tissue that is present when the patient's arms are placed at her sides. Simulations are designed to display a breast with a more relaxed posture and do not take this factor into account, so the BW of the actual postoperative image is generally smaller than the BW of the simulation. This finding should improve as more long-term data become available on various tissue types and implant types and sizes, but it may be a limitation of the technology protocol. Given the variability of soft tissue dynamics under conditions unique to a variety of available implants, we feel that the objective measurement correlation between the simulations and actual outcomes is respectable. Moreover, the important correlation in our mind is the perception of the patient. With a photograph of the preoperative breast next to the simulated outcome, 95% of patients believed (according to the six-month questionnaire) that the simulations accurately reflected their outcomes.

When queried about the factors that led to their decision to undergo breast augmentation, 21% of respondents indicated that they would not have elected to have the procedure without the imaging tool allowing them to visualize the outcome, and 83% indicated that the simulation was very helpful or primary in their decision to choose their surgeon. Seventy-four percent of patients thought the imaging was useful in choosing implant size. At eighteen months, all 28 phone questionnaire respondents felt that imaging had been an important factor in their decision to undergo the procedure and in their choice of an implant size. Interestingly, according to the six-month questionnaire, 48% of patients indicated that if they were to undergo the surgery again, they would choose a larger implant, despite being satisfied that the original simulation accurately

Table 3. Surgical Scheduling Rates in Comparative Practices^a

4D Imaging	Practice 1	Practice 2	Practice 3
Before	40	39	59
After	73	93	75

^aIn percentages. Three practices were compared with the Cochran-Mantel-Haenszel test, $P < .0001$: the primary practice described in the article (Practice 1: San Jose, California) and two plastic surgery practices in other parts of the country (Practice 2: Nashville, Tennessee; Practice 3: Louisville, Kentucky).

portrayed their outcome. This can only be interpreted as a subjective change of opinion, not a problem with soft tissue atrophy or failure of the imaging. Follow-up at 18 months showed persistence of this sentiment at almost the same rate, but no patient in the lead author's practice has returned seeking size change during the two years since software implementation, and among the patients from this cohort who responded to the 18-month follow-up, none have undergone reoperation. No control group was followed during the study period or questioned at six months, because the questionnaire centered on the role of imaging in the process of undergoing breast augmentation, which would have been irrelevant in patients who were not imaged. Questions regarding size dissatisfaction could have been compared, but we chose to rely on previously published data on reoperation rates for comparison.¹⁶⁻¹⁸

Once again, our questionnaire data demonstrated that 48% of patients changed their minds about size. We make no claims that we can predict or control long-term satisfaction with breast size, even with preoperative imaging software. Rather, this software can effectively demonstrate for patients what can reasonably be achieved surgically. Because the latter is the aim of the Precision Light software, we designed our questionnaire to draw a distinction between satisfaction with imaging (and the accuracy of imaging in demonstrating the postoperative result) and satisfaction with postoperative breast size. In one sense, this should verify what most plastic surgeons already understand: that satisfaction with any aesthetic operation is a "moving target," as the self-image of the patient evolves (or fails to evolve) postoperatively.

A particularly helpful feature of the 4D imaging simulation is that it enables the patient to collaborate on the decision about implant size during the consultation. (We often review this decision at a separate preoperative visit as well.) The 0% reoperation rate from the time of this study to date suggests that by including patients in the decision-making process with the aid of a visual rendering, they realized (or at least had a good idea) how their chosen implants would appear. The collaborative decision process, in essence, represents a contract with the patient that documents patient responsibility beyond the standard degree of informed consent; this "contract" may affect the patient's tendency to request a size change. Furthermore, 4D imaging is a useful tool for determining implant size because inappropriately small or large implants can immediately be visually compared to the chosen size, thus clearly demonstrating to

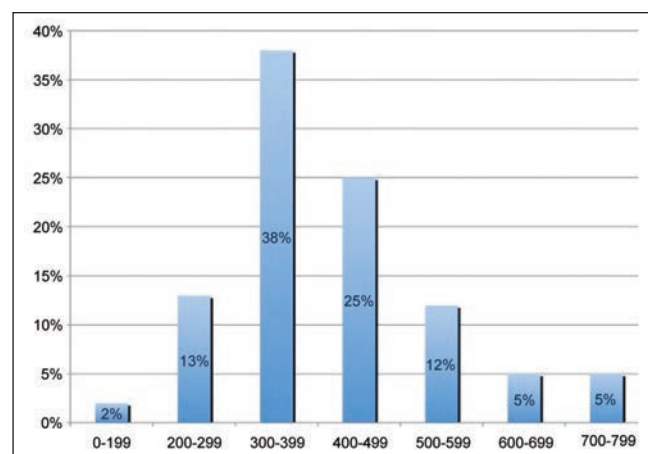


Figure 18. U.S. silicone gel breast implant sales by size. Combined data from Allergan Medical and Mentor Corporation, provided to the author by the manufacturers.

the patient any limitations of her anatomy. This is particularly useful in patients with tight lower poles, widely spaced breasts, narrow BW, and asymmetry.

Some surgeons may not share our conclusions about the importance of imaging and may reasonably wonder why it is helpful or necessary. This can best be answered by reviewing the humbling literature on reoperation rates in breast augmentation,^{16,17} which approximate 20% in the first three years, with upward of 30% to 40% of those reoperations being for size change.¹⁸ Hedén et al¹¹ described a confidence gap with breast augmentation procedures—or, perhaps more precisely put, a lack of confidence in the surgeons who perform it. In the primary augmentation setting, 50% of women reported difficulty finding a surgeon they could trust, and 24% thought that the surgeon did not really listen to what they wanted. Nearly 80% of women who sought consultation did not proceed further, representing at best a significant waste of consultation time and cost and at worst a failure to address the needs of women. The central conclusion of this important study was that more effective communication tools are needed to identify and agree on the anticipated outcome of breast augmentation.

How consultations are conducted is a personal decision and speaks to the style of each surgeon; this report is not intended to persuade others to adopt a specific bedside approach or an algorithmic, “one style fits all” formula. Instead, we are reporting on the clinical application of a novel device, demonstrating the validity of the technology underpinning it, and presenting data regarding the unintended but positive consequences of this technology on our practice productivity and our collaborative approach to patient management. While some have taken a somewhat authoritarian, not to mention complex and time-consuming, approach of educating patients on their augmentation philosophies, including absolute limits drawn on implant volumes,^{19,20} and while others have applied time-honored “bra stuffing” techniques for estimating size,^{21,22} implant sales data available from manufacturers, such as Allergan Medical and Mentor

Corporation, in personal communication reveal that the sizes of implants sold in the United States are far greater than what either of these planning methods would predict (Figure 18). This begs the question of whether these extensively published breast augmentation planning methods are actually being adopted or if they actually conflict with the day-to-day experience of plastic surgeons trying to counsel patients. This discrepancy does not necessarily indicate a lack of merit for traditional methods but may indicate a need for more appropriate visualization tools to simplify decision making.

As this study shows, available technology can be refined to assist not just the patient in visualizing her result but also the surgeon in diagnosing asymmetry, educating the patient, and fostering a bond of trust prior to the surgical event. Implementing 4D imaging in breast surgery consultations eliminates the subjective factor of evaluating chest wall asymmetry and identifying the existing volume of each breast.³ By explaining that breast asymmetries are the rule rather than the exception and that subtle preoperative differences may be more obvious after breast augmentation, patients will have a more realistic expectation for their final results, which will minimize postoperative complaints. We have found that patients are very open to learning about their anatomical measurements, limitations, and the impact of placing anatomically inappropriate prostheses when they understand how appropriate preoperative decision making will improve their eventual results. It may be that body analysis is perceived more positively by patients because the process is more objective; the receptiveness may also be due to something as simple as the patients being more at ease, since they can be clothed rather than exposed in front of a mirror. More extensive questioning in future studies could identify the reasons for patients’ openness to this type of consultation, but regardless of the cause, the response of patients is overwhelmingly positive.

As stated, practice productivity was dramatically improved with this imaging system after a brief learning curve. This finding may help mitigate physician concerns about the initial costs incurred in setting up such a system, although that factor is beyond the scope of this report. One intangible, unanticipated consequence of this technology has been a much more sophisticated quality to the consultation process. In our practices, the technology has helped change our approach from authoritative to collaborative. Bringing a patient-empowered, self-educated, collaborative spirit into the consultation process acknowledges the modern state of affairs. Web-based access to information has dramatically increased the level of patient access to information, and information about breast augmentation is no exception. In fact, the Internet is now the primary way in which women in the breast augmentation demographic acquire information about this procedure.^{23,24} While plastic surgeons may remain the “authority” in terms of required technical skills, general patient management skills, and breadth of experience, they cannot maintain their status as the sole arbiters of procedural knowledge, as in the past. It has been shown that patients are increasingly demanding

collaboration with their physicians, and technology is at the heart of this transformation.^{25,26}

For plastic surgeons to embrace imaging technology, they must feel confident not only that the system is user-friendly but also that the result displayed by the software is one they can deliver in the operating room. We recognize that only through rigorous testing and refinement can this confidence be solidified, but Parts I and II of this study are aimed at satisfying an evidence-based standard for claiming accuracy in the prediction models. This potential commercial value of a technology must remain the purview of the developers, but scientific studies conducted by clinicians must be published for any technology to provide validation of the manufacturers' product or process claims, which was our intent with this report. It would be a conceit to claim that perfect predictive ability—or “the end of the road” in terms of perfecting this technology—is even in sight. As has been discussed elsewhere,²⁷ “both intense misgivings and supreme overconfidence characterize the attitude of surgeons toward computer imaging. Both opinions are at once justified and highly irrational. . . . On the other hand, apprehensive surgeons should know that with a few precautions, careful and conservative computer imaging greatly enhances surgical practice.” We appreciate that our data do not highlight a perfected system, but this system does offer an advantage in that it moves beyond the subjective realm of current illustration software into one based on evidence.

As such, 4D technology will continue to evolve as more accumulated data sets yield more refined simulation algorithms and more accurate images. The process of developing simulation algorithms is reiterative. It involves dependable image capture and reliable, standardized measurements. It then requires large amounts of data collected under many anatomical and clinical situations. As this process moves forward, the predictive value and legitimacy of the simulations will improve. As surgeons, though, we must keep in mind that the anatomy of the female breast is infinitely variable; surrounding soft tissue thickness, varying degrees of ptosis, and areolar pigmentation all conspire to challenge clinicians as well as software engineers. Just as there will likely never be a perfect breast implant, it would be unrealistic to assume that there will ever be a perfect imaging system. However, automation promises to standardize the necessary measurements and transform 3D imaging into a practical and effective clinical tool.

CONCLUSIONS

Though still nascent, 4D imaging technology holds promise as a practical tool for patient education and preoperative planning in breast augmentation. As patients' access to web-based procedural information increases and the availability of new implants with different soft tissue effects adds to the already vast options for implant choice, the demands on surgeons' time in the preoperative phase of breast augmentation will likely increase. Our experience shows that this clinically-validated simulation tool for consultation

appears to improve communication between patient and surgeon, increase surgeon productivity, and may even assist in lowering reoperation rates. In short, 4D breast imaging appears to be an accurate system for analysis, planning, simulation, and patient education for women considering primary breast augmentation, and application of this technology during the consultation process correlates with a high degree of patient satisfaction.

Disclosures

At the time of acceptance of this research, Dr. Creasman was a principal investigator and a shareholder with stock options at Precision Light, Inc., the manufacturer of the products discussed in this article. Dr. Mordaunt was a founder, CEO, shareholder, and board member at Precision Light. Mr. Liolos was president, shareholder, and board member at Precision Light. Dr. Gabriel was shareholder at Precision Light. Dr. Maxwell was also Founder, shareholder, and Board member at Precision Light. Drs. Creasman, Mordaunt, Gabriel, and Maxwell as well as Mr. Liolos, as stockholders in Precision Light, Inc., received financial returns when Precision Light, Inc. was purchased by Allergan Medical after acceptance of this article. Ms. Chiu was paid by Precision Light, Inc. as a work-study student.

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Commentary on: Four-Dimensional Breast Imaging, Parts I and II

Albert Losken, MD

Objectively measuring and accurately counseling patients on breast size and shape is a challenge for aesthetic and reconstructive breast surgeons alike but is particularly important when discussing potential outcomes in patients who wish to undergo cosmetic breast augmentation. For years, surgeons have relied on existing two-dimensional photographs of pre- and postoperative cases, with the hope that information could be extrapolated by the current patient from cases of women with similar breast or body habitus who underwent a similar procedure. Other crude measures include having the patient place different implants in her bra or test specially-designed bras with built-in sizers. While these methods have been considered sufficient in the past, we now live in a technology-savvy, data-driven, information-heavy society. Patients seeking breast surgery are accustomed to having easy access to a virtually unlimited amount of information at any time. There are even smart phone applications that model how a woman would look with a particular size of breast implant (Perfect, SPATAPS, LLC, Birmingham, Alabama; iAugment, Touch Studios, New Orleans, Louisiana). However crude it may be, the fact that these applications exist (and that there is more than one) further highlights the obvious demand and importance of simulated modeling of potential surgical results. Being able to provide legitimate information of this sort during the consultation—in an accurate, controlled, and more scientific fashion—is therefore a welcome addition to our consultation options.

In two articles describing the development of a four-dimensional (4D) imaging tool, Creasman et al have nicely presented the science behind, as well as the application of, a novel system for preoperatively assessing and measuring potential patients. The technology involves a three-dimensional (3D) structured light system with an automated measurement function (which provides the fourth dimension), along with a proprietary computer simulation algorithm that helps increase the accuracy and realism of the simulated result for individual patients. In Part I, the authors introduce the technology in a scientific manner and document the accuracy of its automated measurement features (linear and volumetric). In Part II, they discuss

how they have been able to integrate 4D imaging into the lead author's private practice. A specific cohort of 46 patients was assessed. The measurement correlations at six months were 68% (meaning that the postoperative measurements matched the preoperative predictive measurements 68% of the time), and 95% of patients felt that the simulation accurately reflected their outcomes. Although breast augmentation can be a relatively standardized procedure, actual outcomes vary significantly, depending on surgical technique, implant placement, quality of tissue planes, skin envelope, and postoperative complications. Therefore, such simulations, no matter how exact the software, are only as accurate as the surgeon's ability to precisely deliver the results. Anatomical contingencies and morbidities being favorably represented in objective simulation algorithms can increase the correlation between expected and actual results. While refinements in software are continually being made to improve the accuracy (and, therefore, the correlative value), the authors found this technology to be very helpful to their patients and the overall practice.

Three-dimensional imaging of the breast is not necessarily new. There have been numerous publications validating different systems (as the authors mention in Part I), but the availability of this technology has not translated into widespread clinical application. Not only did Dr. Creasman et al demonstrate a system that is technologically superior to the existing products, but they also tried to measure the impact of this system from a patient's perspective, which is unique in the literature. Their patients reported being generally satisfied with the value of imaging as a means of visualizing outcomes. However, despite the

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ability to view the potential outcomes, there were still 36% of patients who wished that they had chosen larger implants, according to an 18-month follow-up survey. It would have been interesting to know whether this number was higher in a control cohort of similar patients who did not receive 4D imaging simulation preoperatively. It would also be interesting to look at longer-term revision rates for size change to see whether they are lower in this group than in the authors' historical controls or in premarket approval data, which estimated 4% to 10% at six-year follow-up.^{1,2} If having the patient participate in the decision and assume responsibility for size choices truly does translate into a lower revision rate for the surgeon, that alone would be a major advantage of this system. However, again, I would like to point out that outcomes ultimately depend on the surgeon's technical ability to deliver the simulated results. While the decision process might be made easier with 4D imaging, this technology will likely not eliminate the need for size change.

Although 3D imaging of the breast was introduced over a decade ago, it is unclear exactly why it has not become more common in clinical practice. Cost is likely a major factor. While there has been significant improvement in the image quality and technology over the years, the convenience, reliability, portability, ease of use, and cost-effectiveness of digital cameras remain difficult to match. The cost of 3D technology is often a major deterrent from mainstream application, so this aspect of the 4D program described by Creasman and his coauthors will need to be closely scrutinized. Those concerns aside, the authors did demonstrate many reasons why this system would be beneficial to the modern surgeon, patient, and practice.

The true benefit of this system to the surgeon seemed to be in enhanced preoperative planning, improved patient counseling, increased understanding of the patient's desires, and a more cooperative decision process. Benefit to the patient was in being able to visually anticipate what her individual result might be with a particular volume; in turn, she felt more comfortable with the consultation, the level of surgeon-patient communication, and the operative

plan. The benefit to the practice was that this technology seemed to take on the role of a marketing tool, which was interesting. In a field where getting patients through the door is a major first step, the novelty of the patient being able to visualize her breasts in three dimensions is unique enough for word to spread rapidly through the community, which will likely draw some interest. As proof, the authors cited a significantly increased rate of patient booking, including scheduling surgery on the day of consultation. The ability to improve scheduling rates from 40% to 73% and day-of-consult scheduling from 14% to 46% is impressive, although the comparison is based on two different periods. While it likely provides a certain degree of confidence on behalf of the patient, it really does not demonstrate the surgeon's actual work. Pre- and postoperative results will still speak for themselves both with individual patients and with the community at large.

We live in exciting time; keeping pace with the ever-changing digital and information age is a challenge in society at large, as well as in the plastic surgeon's clinical practice. Although this system is not yet commercially available, the 4D technology described by Creasman et al is a welcome and timely addition, and the authors are to be congratulated on providing us with early evidence about its potential utility.

Disclosures

The author declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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The Influence of Career Stage, Practice Type and Location, and Physician's Sex on Surgical Practices Among Board-Certified Plastic Surgeons Performing Breast Augmentation

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Abstract

Background: Breast augmentation is the most commonly performed cosmetic surgical procedure in the United States, but surgeon preferences in terms of technique and postoperative care regimen vary widely.

Objectives: The authors investigated the influence of career stage, practice type and location, and physician's sex on surgical technique preferences among board-certified plastic surgeons performing breast augmentation.

Methods: In October 2009, an online survey was e-mailed to all active members of the American Society of Plastic Surgeons practicing within the United States. Response frequencies were calculated and correlated with surgeon demographics.

Results: From the pool of 4737 respondents, 898 responses were received (18.9%). Surgeons performing breast augmentation were more frequently male, between 46 and 65 years old, and had practiced for at least 20 years in solo private practice in a suburban setting. Surgical volume most frequently consisted of 10% to 25% cosmetic surgery, with 10 to 50 breast augmentations performed per year. Surgeons in practice for five years or less were more likely to use smooth, round silicone gel-filled implants, to select implants smaller than 300 cc, to use the dual-plane pocket, and to recommend yearly follow-up. Surgeons in practice for more than 20 years were more likely to select saline implants, utilize the subglandular plane, perform closed capsulotomy, and place drains. Surgeons at academic centers performed fewer breast augmentation surgeries and placed smaller implants than those in private practice, while surgeons in suburban locations performed more breast augmentations than those in urban or rural locations. Surgeons in the West performed the greatest number of augmentations, although the largest-sized implants were placed in the Southwest. Compared with men, women surgeons appeared significantly less likely to use saline implants, were less likely to perform more than 100 breast augmentations per year, and were significantly more likely to place implants less than 300 cc.

Conclusions: Surgical preferences were associated with years in practice and included differences in technique and postoperative care. Practice location was associated with differences in procedural volume, implant size, incision location, and recommended follow-up time, while practice type was related to surgical volume, implant size, implant location, and percentage of cosmetic surgery performed.

Keywords

breast enhancement, breast enlargement, capsular contracture, dual plane, primary or secondary or revision breast augmentation, subglandular, subpectoral, implants, saline, silicone gel

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Breast augmentation remains the most popular surgical cosmetic procedure in the United States.¹ Surgeon preferences vary widely with respect to preoperative planning, surgical technique, and postoperative care. While general assumptions exist regarding the correlation of implant size and surgical volume with geographic location and practice type, a systematic review and statistical analysis of such differences has not been performed. Variations in surgical preferences

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based on career stage and physician's sex are also believed to exist, although the degree of and reason for such differences have not been examined. The aim of this study was therefore to investigate the prevalent practices of surgeons performing breast augmentation, to correlate surgeon preferences with career stage and practice location and type, and to examine any differences related to physician's sex. Possible explanations for significant differences are also discussed.

METHODS

Study Design

In October 2009, a link to an online multiple-choice questionnaire (via SurveyMonkey) was e-mailed to 4737 active members of the American Society of Plastic Surgeons (ASPS) practicing in the United States. The survey was available for a three-month period, with one e-mail reminder sent in November 2009. There was no financial or other incentive for participation. Respondents included in the analysis were limited to those who indicated that they performed breast augmentation in their practices.

Survey Instrument

The multiple-choice survey was designed by the primary investigator (NSN) and reviewed for its comprehensive nature by a convenience sample of plastic surgeons, which consisted of colleagues. The survey included questions on respondent demographics and practice description, surgical techniques, observed complications, and methods of surveillance and treatment (see online appendix, available at www.aestheticsurgeryjournal.com).

Statistical Analysis

Response frequencies were calculated for surgeon demographics, practice description, and surgical preferences. The chi-square (for independence and for trend), analysis of variance, and nonparametric analysis of variance tests (Kruskal-Wallis) were utilized to correlate the results.² Surgical preferences by sex were evaluated with logistic regression analyses to control for years in practice. Each practice/preference served as a dichotomous outcome variable, while sex served as the primary exposure variable. Years in practice, a polychotomous variable, was kept intact in each model using design variables.²

RESULTS

A total of 898 complete responses were received, for a response rate of 18.9%. The 870 respondents who indicated that they performed breast augmentation in their practices served as the study sample. Characteristics of the sample population are shown in Table 1.

Surgeon Demographics and Practice Description

Respondents were predominantly male (87.1%) and between the ages of 46 and 65 years (67.6%). Most had been in practice for 11 to 20 years (36.9%) or greater than 20 years (43.8%), practiced in suburban (52.3%) or urban (40.8%) settings, and were in private solo practice (67.4%). Many (42.4%) reported that cosmetic surgery composed 10% to 25% of their practice; 22.1% had practices consisting of 51% to 75% cosmetic surgery; and 19.3% of practices were at least 75% cosmetic. The largest percentage of respondents (43%) performed 10 to 50 breast augmentation surgeries per year, while 22.6% performed 51 to 100 procedures per year and 21.2% performed more than 100 procedures per year (Table 1).

Patient Characteristics

Respondents indicated that most of their patients were between the ages of 30 and 49 years (93.2%) and Caucasian (81.0%). Patients were predominantly of medium build (70.8%) with a self-reported preoperative breast size of an A cup (29.1%) or a B cup (61%). The most frequently requested postoperative breast size was a C cup (78.3%) or a D cup (16.4%).

Surgical Preferences

Implant size. The average implant placed by the respondents was between 300 and 400 cc, with 37.9% of surgeons reporting an average size of 301 to 350 cc and 32.85% reporting an average size of 351 to 400 cc. A small percentage (13.6%) reported primarily using implants sized 251 to 300 cc. When selecting a size, surgeons tended to rely on the patient's choice (42.8%) or their own aesthetic judgment (32.8%). A few (9.3%) indicated that they relied on Tebbetts's TEPID system (tissue characteristics of the envelope, parenchyma, and implant and the dimensions and fill distribution dynamics of the implant) as the determining factor.³ Surgeons were divided almost equally on the intraoperative use of sizers: 35.3% never placed sizers, 28.7% sometimes placed sizers, and 31.5% always placed sizers. Surgeons who relied on the patient's choice as the determining factor in selecting implant size were significantly more likely to place implants larger than 350 cc, as compared to those who relied on their own judgment for selection ($P < .05$). Surgeons who relied on their own judgment were also more likely to use intraoperative sizers ($P < .01$).

Implant location. The majority of respondents (50.5%) preferred the subpectoral plane; 22.4% preferred the dual-plane approach; and 6.1% primarily used the subglandular location. Some respondents (17%) indicated that they

Table 1. Clinical and Practice Characteristics of Respondents (n = 870)

	Years in Practice							
	≤ 5 (n = 35)		6–10 (n = 133)		11–20 (n = 321)		> 20 (n = 381)	
	No.	%	No.	%	No.	%	No.	%
Practice location								
Southeast ^a	4	11.4	35	26.3	95	29.6	114	29.9
Northeast ^b	15	42.9	27	20.3	62	19.3	78	20.5
Midwest ^c	8	22.9	19	14.3	73	22.7	56	14.7
West ^d	5	14.3	31	23.3	56	17.5	90	23.6
Southwest ^e	3	8.6	21	15.8	35	10.9	43	11.3
Practice setting								
Suburban	21	60.0	52	39.1	112	34.9	170	44.6
Urban	12	34.3	75	56.4	188	58.6	180	47.2
Rural	2	5.7	5	3.8	21	6.5	30	7.9
Practice type								
Private, solo	23	65.7	85	63.9	201	62.6	277	72.7
Private, single specialty	7	20.0	26	19.5	80	24.9	65	17.1
Private, multispecialty	1	2.9	6	4.5	20	6.2	20	5.2
Academic/university center	4	11.4	16	12.0	16	5.0	18	4.7
Cosmetic patients								
< 10%	5	14.3	8	6.0	14	4.4	16	4.2
10%–25%	6	17.1	22	16.5	35	10.9	35	9.2
26%–50%	7	20.0	42	31.6	68	21.2	75	19.7
51%–75%	7	20.0	24	18.0	64	19.9	73	19.2
> 75%	10	28.6	37	27.8	140	43.6	182	47.8

^aMaryland, Washington, DC, Virginia, West Virginia, Kentucky, North Carolina, South Carolina, Georgia, Florida, Tennessee, Mississippi, Alabama, Arkansas, Louisiana.

^bMaine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, New Jersey, Delaware.

^cOhio, Indiana, Michigan, Illinois, Wisconsin, Missouri, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Kansas.

^dAlaska, Hawaii, Washington, Oregon, California, Idaho, Nevada, Montana, Wyoming, Utah, Colorado.

^eTexas, Arizona, New Mexico, Oklahoma.

did not have a clear preference; their choice for implant location was dictated by the patient’s anatomy.

Incision location. The inframammary incision was the preferred approach for 66.1% of respondents, while 22.8% preferred a periareolar incision, 7.3% favored the transaxillary approach, and 0.2% most frequently utilized a transumbilical incision.

Implant type. The largest percentage of respondents (43.7%) preferred silicone gel-filled implants, while 27.9% preferred saline and 24.5% used both in even proportions. The majority of surgeons (86.7%) placed smooth, round implants, with those manufactured by Mentor (Santa Bar-

bara, California; 50.8%) favored over those manufactured by Allergan (Irvine, California; 32.8%).

Postoperative care. Postoperatively, respondents tended to fit their patients with surgical bras only (46.9%) as opposed to compression dressings alone (18.2%) or breast straps alone (4.8%). A small percentage used surgical bras and breast straps together (7.0%) or surgical bras and a compression dressing together (4.6%), while 11.6% used no dressing. The majority of respondents (91.6%) did not use drains routinely. After the first postoperative year, 57.4% of surgeons requested yearly follow-up, 8% requested biennial follow-up, and 26.6% required no further visits.

Complications. Surgeons reported that the most frequently observed complication in their practice was capsular contracture (CC; 82.3% of respondents). Many (59.4%) indicated that less than 5% of their patients had experienced a Baker Grade II or higher CC, while 25.6% reported a rate between 5% and 10%. Most surgeons (64.5%) did not observe a difference in the contracture rate based on the placement of silicone versus saline implants. Among those who performed both subglandular and subpectoral augmentations, 49.9% reported a higher incidence of contracture following subglandular augmentation.

Following the first CC of Baker Grade II or higher, 52.2% of respondents performed open capsulotomy or capsulectomy and implant exchange within the same pocket; 21.3% performed open capsulotomy or capsulectomy and implant exchange to a new pocket; 32.1% prescribed Accolate (Astra-Zeneca Pharmaceuticals LP, Wilmington, Delaware), Singulair (Merck and Co., Inc., Whitehouse Station, New Jersey), or other medications; 26% observed the patient; 6.3% performed closed capsulotomy; and 2.2% recommended implant removal.

Following the second contracture, 34.7% performed open capsulotomy or capsulectomy and implant exchange within the same pocket; 47.9% performed open capsulotomy or capsulectomy with implant exchange to a new pocket; 13.4% prescribed Accolate, Singulair, or other medications; 15.3% recommended implant removal; and 3.1% performed closed capsulotomy.

Preferred methods for preventing CC included prophylactic antibiotics (71.3%), implant massage (66.3%), cleaning powder from gloves prior to handling the implant (51.3%), vitamin E administration (18.0%), Accolate (14.3%) or Singulair (13.1%) treatment, and external ultrasound (5.2%).

Other complications included implant rippling (observed by 76.4% of respondents), implant deflation or rupture (76.2%), hematoma (74.0%), sensory changes of the nipple-areolar complex (60.8%), implant displacement or rotation (53.6%), the “double bubble” deformity (45.4%), and infection (42.8%). Methods of infection prevention included administering intravenous antibiotics preoperatively (86.7%), irrigating the pocket (78.5%), prescribing oral antibiotics pre- or postoperatively (51.0%), and changing gloves prior to implant insertion (41.7%). Surgeons irrigated pockets with triple antibiotic solution (33.9%), bacitracin solution (29.1%), saline (23.6%), and/or Betadine solution (Purdue Pharma LP, Stamford, Connecticut; 20.8%).

Years in Practice as a Factor in Surgical Preferences

The correlations between years in practice and respondents' surgical preferences, divided into four categories, are shown in Table 2. Group comparisons revealed the following.

Surgeons in practice for five years or less were significantly more likely than all other respondents to place silicone gel-filled implants (50.6% vs 42.0% for those in practice more than five years; $P < .05$), to report an average

implant size less than 300 cc (34.3% vs 14.9%; $P < .01$), to select a dual-plane pocket (40.0% vs 21.7%; $P < .05$), and to recommend yearly follow-up (80.0% vs 56.4%; $P < .01$). Surgeons in practice for six to 10 years were more likely than surgeons in practice for 11 to 20 years to place implants less than 300 cc (21.1% vs 10.9%; $P < .01$). When compared to surgeons in practice for more than 20 years, surgeons in practice for six to 10 years were more likely to place silicone gel-filled implants (51.9% vs 39.9%; $P < .05$) and to use the dual-plane approach (28.6% vs 18.6%; $P < .05$).

Surgeons in practice for 11 to 20 years were more likely than surgeons in practice for five years or less to place implants in the subpectoral plane (48.3% vs 34.3%, $P < .05$). When compared to surgeons in practice for six to 10 years, they were more likely to place larger implants, specifically those sized between 351 and 400 cc (30.4% vs 26.3%; $P < .05$). When compared to surgeons in practice for more than 20 years, there were multiple significant differences. In particular, surgeons in practice for 11 to 20 years were more likely to place larger implants, sized between 351 and 400 cc (38.6% vs 30.4%; $P < .05$), to use smooth round implants (91.6% vs 81.4%; $P < .01$), to report a contracture rate of less than 5% (62.6% vs 50.7%; $P < .01$), to use a surgical bra (65.1% vs 53.5%; $P < .01$), and to follow patients after the first postoperative year (55.5% vs 58.3%; $P < .01$). Surgeons in practice for more than 20 years were more likely than all other respondents to use saline implants (33.3% vs 23.7%; $P < .01$), to place anatomic implants (2.6% vs 0.4%; $P < .05$), to use the subglandular plane (9.7% vs 3.3%; $P < .01$), and to place surgical drains (5.8% vs 2.0%; $P < .01$).

In analyzing data from questions that had non-mutually-exclusive response categories, certain trends were discovered (Table 2). Specifically, the following increased alongside years in practice: the use of no form of pocket irrigation ($P < .01$), the use of closed capsulotomy after the first and second instances of CC ($P < .01$), and the use of a “sleeve” for infection prevention ($P < .05$). On the other hand, the following decreased with years in practice: the use of triple antibiotic solution for pocket irrigation ($P < .01$), the use of breast implant massage to prevent CC ($P < .05$), the use of open capsulotomy/capsulectomy with implant exchange to the same pocket after both the first and second CC ($P < .05$), the use of open capsulotomy/capsulectomy with implant exchange to a different pocket after the first CC ($P < .05$), the use of oral antibiotics for infection prevention ($P < .05$), the practice of changing gloves prior to implant insertion ($P < .01$), the “no touch” technique ($P < .01$), and pocket irrigation for infection prevention ($P < .05$).

Practice Type as a Factor in Surgical Preferences

There was no difference in the number of breast augmentation surgeries performed on the basis of the type of

Table 2. Self-reported Surgical Preferences by Years in Practice (n = 870)

	Years in Practice								P ^a
	≤ 5 (n = 35)		6–10 (n = 133)		11–20 (n = 321)		> 20 (n = 381)		
	No.	%	No.	%	No.	%	No.	%	
Implant size, cc									
≤ 300	12	34.3	28	21.1	35	10.9	61	16.0	< .05
301–350	12	34.3	43	32.3	121	37.7	154	40.4	.11
351–400	10	28.6	35	26.3	124	38.6	116	30.4	.82
> 400	1	2.9	16	12.0	33	10.3	35	9.2	.96
Implant material									
Saline	9	25.7	24	18.0	83	25.9	127	33.3	< .01
Silicone gel	16	45.7	69	51.9	143	44.5	152	39.9	< .05
Both	10	28.6	29	21.8	87	27.1	87	22.8	.55
Implant type									
Smooth, round	34	97.1	116	87.2	294	91.6	310	81.4	< .01
Textured, round	1	2.9	3	2.3	13	4.0	24	6.3	< .05
Anatomic	0	—	0	—	2	0.6	10	2.6	< .05
Varies	0	—	3	2.3	4	1.2	22	5.8	< .01
Incision location									
Inframammary	25	71.4	92	69.2	215	67.0	243	63.8	.16
Periareolar	10	28.6	25	18.8	77	24.0	86	22.6	.96
Transaxillary	0	—	5	3.8	20	6.2	36	9.4	< .05
Transumbilical	0	—	0	—	1	0.3	1	0.3	.90
Pocket irrigation									
Saline	12	34.3	24	18.0	66	20.6	103	27.0	.22
Water	0	—	0	—	2	0.6	1	0.3	.47
Bacitracin solution	15	42.9	37	27.8	95	29.6	106	27.8	.26
Triple antibiotic solution	16	45.7	61	45.9	112	34.9	106	27.8	< .01
Betadine solution	4	11.4	24	18.0	72	22.4	81	21.3	.24
None of the above	1	2.9	3	2.3	17	5.3	31	8.1	< .01
Implant placement									
Subpectoral	12	34.3	63	47.4	180	56.1	184	48.3	.57
Subglandular	2	5.7	7	5.3	7	2.2	37	9.7	< .05
Dual plane	14	4.0	38	28.6	72	22.4	71	18.6	< .01
No preference (varies with patient)	7	2.0	14	10.5	54	16.8	74	19.4	.10

(continued)

Table 2. (continued)

	Years in Practice								P ^a
	≤ 5 (n = 35)		6–10 (n = 133)		11–20 (n = 321)		> 20 (n = 381)		
	No.	%	No.	%	No.	%	No.	%	
Capsular contracture preventive medications/techniques									
Zafirlukast (Accolate)	7	2.0	20	15.0	47	14.6	50	13.1	.76
Montelukast (Singulair)	4	11.4	21	15.8	37	11.5	52	13.6	.28
Vitamin E	2	5.7	21	15.8	54	16.8	80	21.0	.97
Breast massage	27	77.1	95	71.4	220	68.5	235	61.7	< .05
External ultrasound	2	5.7	4	3.0	20	6.2	19	5.0	.56
Prophylactic antibiotics	27	77.1	98	73.7	221	68.8	274	71.9	.74
Cleaning powder	21	6.0	64	48.1	160	49.8	201	52.8	.67
None	2	5.7	6	4.5	26	8.1	29	7.6	.34
Capsular contracture (Baker Grade II or higher)									
< 5%	28	8.0	95	71.4	201	62.6	193	50.7	< .01
5%–10%	5	14.3	23	17.3	78	24.3	117	30.7	< .01
10%–15%	1	2.9	3	2.3	15	4.7	37	9.7	< .01
> 15%	0	—	0	—	6	1.9	14	3.7	.15
First capsular contracture									
Observation	12	34.3	40	30.1	79	24.6	95	24.9	.16
Medications	9	25.7	41	30.8	104	32.4	125	32.8	.44
Closed capsulotomy	0	—	1	0.8	12	3.7	42	11.0	< .01
Open capsulotomy/capsulectomy (same pocket)	17	48.6	79	59.4	180	56.1	178	46.7	< .05
Open capsulotomy/capsulectomy (different pocket)	13	37.1	27	20.3	70	21.8	75	19.7	< .05
Implant removal	1	2.9	1	0.8	6	1.9	11	2.9	.26
Second capsular contracture									
Observation	3	8.6	12	9.0	25	7.8	41	10.8	.37
Medications	1	2.9	22	16.5	41	12.8	53	13.9	.55
Closed capsulotomy	0	—	0	—	5	1.6	22	5.8	< .01
Open capsulotomy/capsulectomy (same pocket)	18	51.4	43	32.3	108	33.6	133	34.9	< .05
Open capsulotomy/capsulectomy (different pocket)	14	4.0	66	49.6	160	49.8	177	46.5	.85
Implant removal	7	2.0	22	16.5	52	16.2	52	13.6	.21
Postoperative dressing									
Surgical bra	27	77.1	79	59.4	209	65.1	204	53.5	< .01
Breast straps	4	11.4	23	17.3	50	15.6	46	12.1	.24
Compression dressing	8	22.9	28	21.1	74	23.1	103	27.0	.15
None	2	5.7	16	12.0	35	10.9	58	15.2	.07

(continued)

Table 2. (continued)

	Years in Practice								P ^a
	≤ 5 (n = 35)		6–10 (n = 133)		11–20 (n = 321)		> 20 (n = 381)		
	No.	%	No.	%	No.	%	No.	%	
Drain use									
Yes	2	5.7	1	0.8	7	2.2	22	5.8	< .05
Infection prevention									
Oral antibiotics	20	57.1	76	57.1	173	53.9	175	45.9	< .05
Intravenous antibiotics	33	94.3	115	86.5	286	89.1	320	84.0	.07
Change of gloves	20	57.1	76	57.1	138	43.0	129	33.9	< .01
Use of “sleeve”	0	—	6	4.5	16	5.0	24	6.3	< .05
“No touch” technique	17	48.6	56	42.1	98	30.5	119	31.2	< .01
Pocket irrigation	32	91.4	108	81.2	253	78.8	290	76.1	< .05
None of the above	0	—	0	—	3	0.9	6	1.6	.45
Post Initial year follow-up									
Yearly	28	8.0	71	53.4	178	55.5	222	58.3	< .01
Every two years	0	—	14	10.5	17	5.3	38	10.0	.54
Every five years	0	—	4	3.0	4	1.2	9	2.4	.99
Never	6	17.1	31	23.3	104	32.4	90	23.6	.98

^aFor trend over years of practice.

private practice—solo, single specialty, or multispecialty. However, surgeons in solo private practice were more likely to report a higher percentage of cosmetic surgery in their clinics, with 67.9% reporting a cosmetic case load greater than 50%, compared to 61.2% of single-specialty groups and 46.8% of multispecialty groups ($P < .01$). Respondents from academic centers performed significantly fewer breast augmentations compared to those in private practice according to the following trends: less than 10 cases per year (29.6% vs 7.8%), 10 to 50 cases per year (61.1% vs 41.8%), 50 to 100 (5.6% vs 23.9%), and more than 100 (1.9% vs 22.6%) ($P < .01$). Private practice physicians also performed more cosmetic surgery than those at academic centers, with 65% vs 37% reporting that more than 50% of their practice was cosmetic ($P < .01$). Practice setting evaluations showed that 50% of suburban surgeons performed more than 50 breast augmentations per year, compared to 38% of urban practitioners ($P < .01$). More urban practices (43%) reported a case volume of more than 75% cosmetic surgery, compared to 16% of rural practices ($P < .01$).

There was no correlation between implant size and practice setting ($P = .35$), nor was there any correlation between the type of private practice and implant size. Surgeons in private practice, however, were more than twice as likely as academic surgeons to place implants

larger than 350 cc (44.4% vs 18.5%; $P < .01$). Surgeons in rural, suburban, and urban practices had similar requested postoperative sizes. Surgeons in rural locations were significantly more likely to use the subglandular plane (12.1% vs 4.2% vs 7.6%, respectively; $P < .05$; Figure 1).

Practice Location as a Factor in Surgical Preferences

Surgeons in the West performed significantly more breast augmentation procedures and cosmetic surgery than surgeons in the Northeast, with 29.1% vs 9.9% reporting more than 100 breast augmentation cases per year ($P < .01$) and 56.0% vs 28.6% reporting that more than 75% of their caseload was cosmetic ($P < .01$; Figure 2). The patient age range and race among all five locations were similar, but Northeast surgeons reported a greater proportion of patients with a “small frame” body type (37.0% vs 23.1%; $P < .05$). Surgeons in the Midwest and Northeast reported an average preoperative size of an A cup for 36.2% and 38.6% of their patients, respectively, compared with approximately 26.1% for the other three regions ($P = .06$). The requested postoperative size was largest in the Southwest, with 30.4% of practices reporting that a D cup or larger was the most frequently requested size, com-

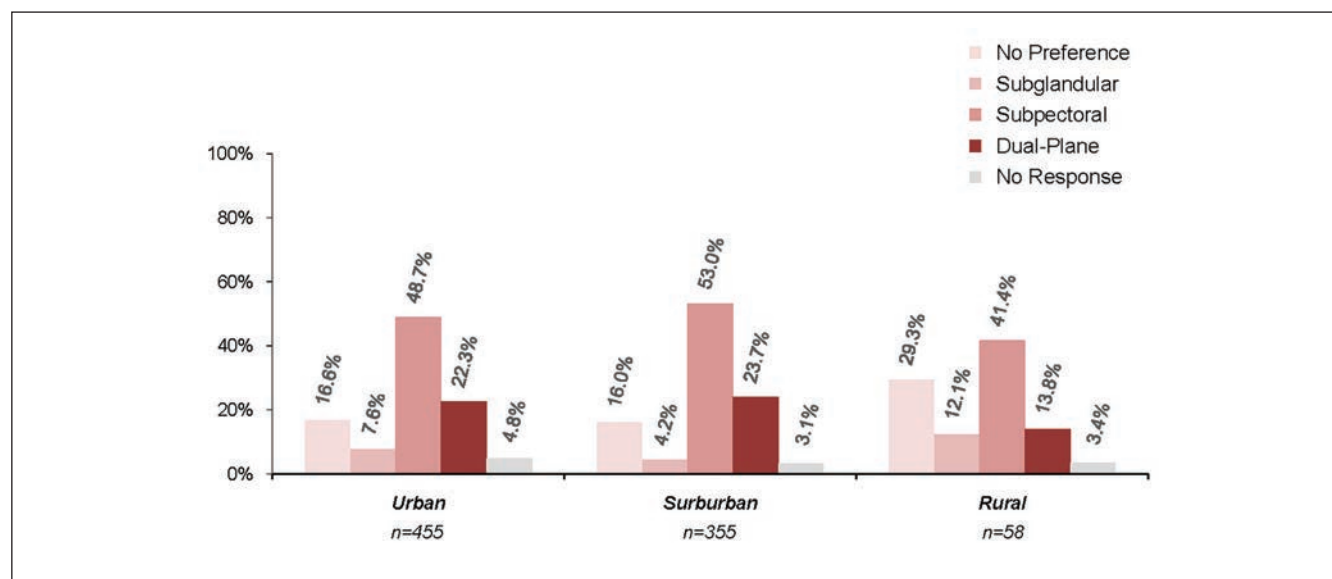


Figure 1. Preferred implant placement by practice setting.

pared to 24.7% in the West, 15.7% in the Southeast, 13.5% in the Midwest, and 4.9% in the Northeast ($P < .01$). Average implant size was also largest in the Southwest, with 57.8% placing an average implant size greater than 350 cc, compared to 47.3% in the West, 46.4% in the Southeast, 45.5% in the Midwest, and 21.4% in the Northeast ($P < .01$; Figure 2). Surgeons in the West utilize the periareolar incision significantly more often (37.8% vs 26.6% in the Southeast, 19.7% in the Northeast, 14.6% in the Midwest, and 13.1% in the Southwest; $P < .01$). The type of implant placed, pocket selected, irrigation solution, use of drains, dressing choices, and infection prevention measures did not vary with practice location. There were, however, differences in recommended patient follow-up, with significantly more practices in the Midwest (38.5%) and Southeast (32.5%) reporting that they do not require any follow-up after the first postoperative year when compared to practices in the Northeast (23.5%), West (22.2%), and Southwest (21.4%) ($P < .01$).

Sex as a Factor in Surgical Preferences

After controlling for years in practice, women surgeons were found to be significantly more likely than men to place implants sized less than 300 cc (23.2% vs 14.1%, $P < .05$). There was no significant difference between surgeon's sex and patient-requested postoperative size (17.3% of men surgeons reported a request for a D cup compared to 11.6% of women surgeons; $P = .24$). Men surgeons were significantly more likely to place saline implants (29.4% vs 17.9%, $P < .05$). Women surgeons used silicone gel-filled implants more frequently, although this number did not reach statistical significance (52.7% vs 42.3%; $P = .10$). Compared to women surgeons, men were more likely to perform more than 100 breast augmen-

tations per year (22.8% vs 9.8%; $P < .01$). There was no association between the sex of the surgeon and the preferred location for implant placement, the method used to determine implant size, or the recommended patient follow-up time (Table 3).

DISCUSSION

The current study is the largest survey of board-certified plastic surgeon breast augmentation practice patterns to date. Notable findings from the survey include the fact that respondents who performed breast augmentation were most frequently middle-to-late career, were in solo practice, and performed breast augmentation as a relative minority of their total surgical volume. They tended to have specific preferences or practice patterns that appeared to be related to years in practice, practice location and type, and physician's sex.

Surgical decisions and techniques change as the surgeon matures, reflecting not only the surgeon's training and experience but also the current literature. Training in plastic surgery has evolved, and later-career surgeons may continue practice patterns that are no longer in line with current treatment standards. The degree to which these sometimes-competing influences manifest in practice patterns has thus far remained unclear.

In our study, surgeons in practice for five years or less showed a tendency to be both conservative and cautious, as demonstrated by their tendency to place smaller implants, change the implant pocket for the first instance of CC, and recommend yearly follow-up. Their preference for silicone gel-filled implants (which reentered the market in 2006⁴), the dual-plane technique (which was initially described in 2001⁵), and triple-antibiotic irrigation (which was detailed in 2006⁶) reflects their comfort level with

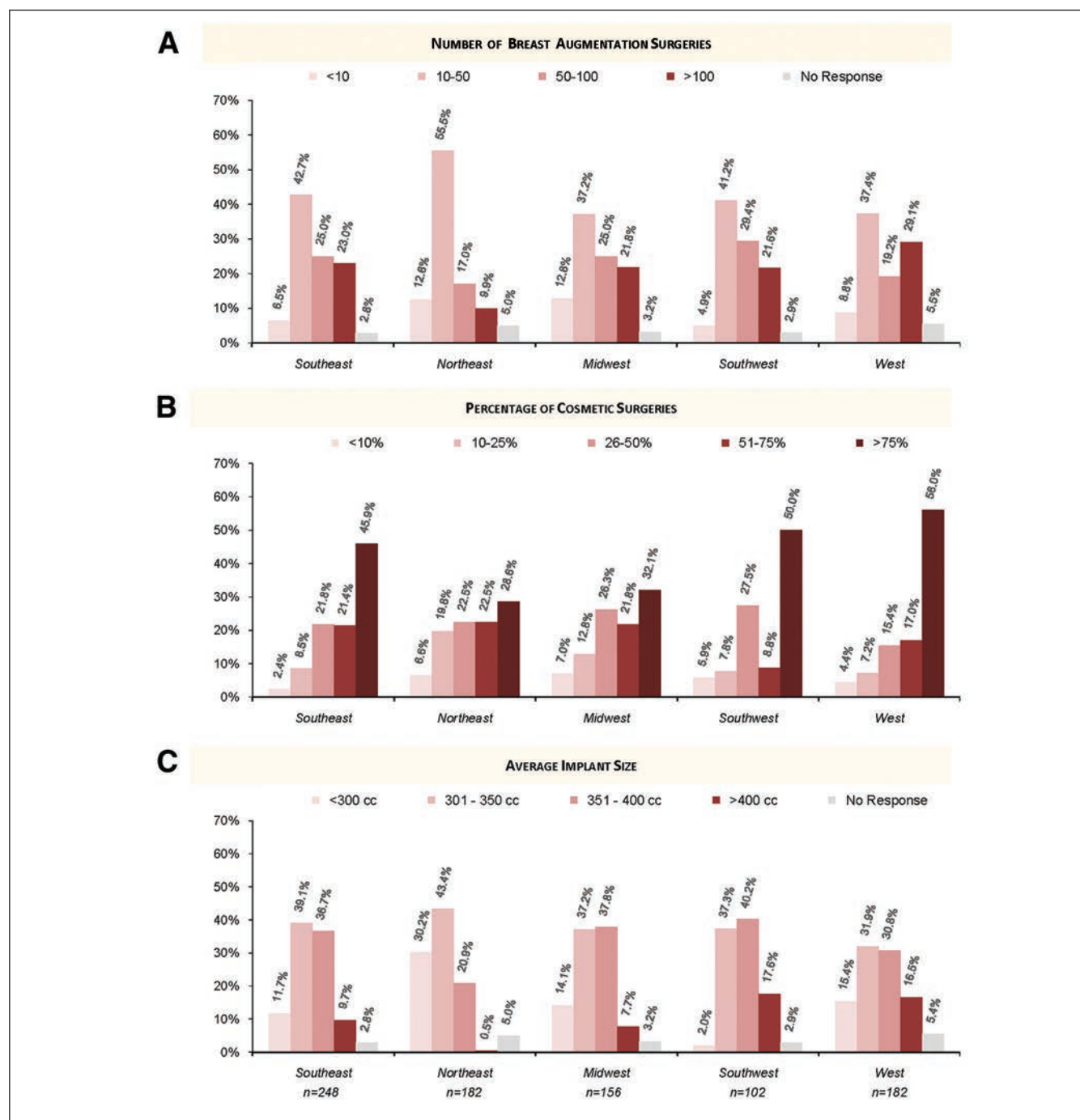


Figure 2. Number of breast augmentation procedures (A), percentage of cosmetic surgeries as a function of total surgeries performed (B), and average implant size (C) by practice location.

devices and techniques that were available and promoted during their training and the early stages of their careers.

Surgeons in practice for six to 10 years were similar to their younger colleagues in their preference for silicone implants, smaller implant sizes, and triple-antibiotic irrigation. However, this group also showed a beginning of the

tendency of more senior surgeons in the survey to recommend medication in addition to or instead of surgery for CC. This could indicate either greater experience with the challenges of treating CC or greater confidence in exploring new treatment options. The use of nonsurgical modalities, specifically ultrasound and leukotriene inhibitors, was most fre-

Table 3. Differences in Clinical Practice by Sex (n = 870)^a

	Men (n = 758)		Women (n = 112)		P ^b
	No.	%	No.	%	
Implant material					
Silicone gel	321	42.3	59	52.7	.10
Saline	223	29.4	20	17.9	< .05
Implant size, cc					
< 300	107	14.1	26	23.2	< .05
300–400	535	70.6	80	71.4	.57
> 400	88	11.6	0	—	.97
Postoperative size requested					
C cup	599	79.0	93	83.0	.47
D cup	131	17.3	13	11.6	.24
Breast augmentations per year					
< 10	67	8.8	13	11.6	.43
10–50	314	41.4	61	54.5	< .01
51–100	176	23.2	21	18.8	.35
> 100	173	22.8	11	9.8	< .01
Implant placement					
Subglandular	46	6.1	7	6.3	.50
Subpectoral	388	51.2	51	45.5	.25
Dual plane	166	21.9	29	25.9	.69
No preference	130	17.2	19	17.0	.71
Method for determining size					
Patient's choice	321	42.3	51	45.5	.36
Surgeon's judgment	248	32.7	37	33.0	.87
TEPID system ³	74	9.8	7	6.3	.24
Other method	87	11.5	11	9.8	.64
Follow-up					
Yearly	442	58.3	57	50.9	.15
Every two years	59	7.8	10	8.9	.53
Every five years	15	2.0	2	1.8	.91
Never	198	26.1	33	29.5	.50

^aPercentages do not add up to 100% due to nonresponse.

^bAdjusted for years in practice.

quently described after 2000, which would correlate with an exposure of this group of surgeons to these techniques in their training and early careers.⁷⁻¹⁴ Similarly, this group also

showed the beginnings of the trend of later-career surgeons to request less frequent follow-up, although the reason for this is unclear and may be related to personal experience.

The greatest number of differences was seen between surgeons in practice for 11 to 20 years and those in practice for more than 20 years, suggesting that significant changes in surgical practices may occur during this middle stage of the breast augmentation surgeon's career or, alternatively, that a dramatic change in training standards and curriculum occurred during the years between these two groups. Compared to their senior colleagues, surgeons in practice for 11 to 20 years were more aggressive in their selection of larger implant sizes and their tendency to perform an open procedure for the first instance of CC. However, they were also more likely to use a number of adjunct measures during and after surgery, including the triple-antibiotic irrigation, oral and intravenous antibiotics, glove change prior to implant placement, surgical bras, and more frequent follow-up.

It was notable that surgeons in practice for more than 20 years were more likely to prefer saline implants, which would likely reflect the wide availability of these devices and the surgeons' extensive experience with them during the majority of their careers. In addition, these surgeons were in practice during the Food and Drug Administration's moratorium on silicone gel-filled breast implants in 1992, which could have adversely affected their opinion of silicone gel implants. The higher preference for anatomic implants by surgeons in practice for more than 20 years might also be explained by device availability, as trials for anatomic, highly-cohesive silicone gel implants began in 2001.¹⁵ However, this group was also more likely to report that their implant choice depended on the patient's anatomy; therefore, the preference for anatomic implants may simply reflect the surgeons' significant experience with matching patients to devices. Although only a small number of surgeons reported performing closed capsulotomy, utilizing the subglandular plane, and placing drains routinely, the association of these techniques with having been in practice for more than 20 years most likely reflects techniques that were more widely used during training and in the early part of their careers.¹⁶⁻¹⁸ Perhaps the most remarkable finding regarding surgeons in practice for more than 20 years was their general tendency to perform fewer numbers of adjunct procedures and fewer open procedures for CC. This streamlined approach is difficult to interpret, as it could indicate either that later-career surgeons do not adopt new techniques as readily or that their experience has shown them that many adjunct procedures are simply unnecessary.

Differences between practice types were generally as expected, with surgeons in solo private practice performing more cosmetic surgery than their academic or multi-specialty colleagues. It is unclear, however, why surgeons in private practice would place larger implants than those in an academic setting, since, presumably, patients with similar body types would be equally distributed between both settings. However, because academic surgeons generally perform fewer breast augmentation procedures, this may simply reflect a conservative approach on their part. Although the survey results indicated that surgeons in rural locations were more likely to place implants in the

subglandular plane, this group included a large number of surgeons in practice for more than 20 years.

Findings regarding regional differences also generally confirmed prior assumptions. Survey respondents from the West performed significantly more cosmetic surgery in general and breast augmentation in particular, a finding that correlates with statistics in which breast augmentation makes up 37% of all cosmetic surgical procedures in the Mountain-Pacific region.¹⁹ This is notably higher than all other regions, in which breast augmentation makes up 14% to 16% of the total cosmetic volume.¹⁹ Although surgeons from the Southwest did indeed place significantly larger implants, the average size requested was larger in the Southwest. Therefore, this difference cannot be attributed to surgeon preference alone. Surgeons in the West were more likely to favor the periareolar incision, but our survey did not evaluate whether this was secondary to surgeon or patient preference. Midwest and Southeastern practitioners were more likely to discharge patients from care following their first postoperative year, but the reason for this was also unclear.

Examining surgical practices and preferences by surgeon's sex revealed unexpected results. Specifically, these results suggested a tendency among women surgeons to place smaller implants or prefer smaller breasts in their patients. The reasons behind the preference of men surgeons for saline implants are unclear. While we hypothesized that women surgeons would be more likely to perform larger numbers of breast augmentations, our data showed that men surgeons were twice as likely to perform more than 100 breast augmentations per year. Of note, in communication with the ASPS office (November 2010), the percentage of women surgeons responding to this survey (12.9%) did not differ significantly from the percentage of women surgeons who are active members of ASPS (12.3%) ($P = .68$).

Limitations of this study included a relatively low response rate of 18.9%. In particular, the response rates from surgeons who had been in practice five years or less and six to 10 years were very low as compared to the other two groups. However, each of these groups included only five years of duration, as compared to at least ten years for the other two groups. In addition, because only active members of ASPS were surveyed, the number of eligible surgeons in practice for less than five years was likely small. It is also likely that nonresponders in the same years-of-practice categories underwent comparable training to their responding colleagues and thus would have reported similar practices. Nevertheless, results for surgeons in practice for five years or less and for six to 10 years should be interpreted with caution given the possibility of nonresponder bias.

Also, several questions in the survey listed responses that may not have been clear to some responders, which could have been a limitation. For example, the question regarding preferred implant location did not specify "subpectoral" as complete subpectoral placement, as opposed to the dual-plane I position, in which the implant is placed in a partial subpectoral position. In addition, "subfascial placement"

was not offered as a choice in this category. The questions regarding CC were specifically limited to allow the survey to be completed in a short period, but many additional questions could have been asked about items such as the placement of acellular dermal matrices and whether implant exchange was always performed at the time of surgery. Certainly, the lack of clear guidelines on the treatment of CC limits the interpretations of results from any survey on this topic. Finally, the ranges that we selected for years in practice were based on a general impression of pivotal time points in a surgeon's career, although there are no data in the surgical literature that clearly define such points. Indeed, the number of changes in the practice of breast augmentation in the United States over the past 20 years renders interpretation of some of these differences difficult.

CONCLUSIONS

A number of factors influence the breast augmentation surgeon's choices for preoperative, intraoperative, and postoperative care. In the results from our survey, geographic location was associated with differences in procedural volume, implant size, incision location, and recommended follow-up time. Practice type was related to not only the volume of surgery performed but also the implant size, implant location, and percentage of cosmetic surgery as part of the surgeon's practice. Career stage also had a significant influence on the surgeon's choices. Surgeons in this survey were more likely to retain the techniques learned during their training or early in their careers, suggesting that they rely more on their personal experience than the current literature as their careers advance. Finally, sex-based differences existed with regard to not only implant size and type but also procedural volume.

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Minimal-Scar Handlift: A New Surgical Approach

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Abstract

Background: Removal of excess skin from the aging hand can cause scarring in one of the body's most visible areas, which is highly undesirable for patients. A minimal-scar approach to tightening this skin, in conjunction with the rejuvenating effects of minimally-invasive procedures, is therefore needed.

Objectives: The authors describe a new technique for limiting scar size and visibility by locating the incision in a unique position on the ulnar side of the dorsum of the hand.

Methods: Eleven patients were treated with the authors' method between March and September 2009. Both hands were treated for each patient, but these procedures occurred separately, at an interval of two to four months. The surgical approach included skin flap advancement and rotation, and the procedure took place under local anesthesia and sedation. The resultant scar was S-shaped. Changes in postoperative stress ratio were visualized.

Results: Patients reported being highly satisfied with this procedure with regard to scar size, quality, and location. No major complications were observed, such as infection, flap necrosis, and nerve damage. All minor complications were treated conservatively. Patients with Fitzpatrick skin types I-III profited from less scar visibility in their outcomes. All patients experienced quick recovery with minimal downtime, independent of skin type.

Conclusions: The minimal-scar handlift technique is an effective surgical approach to rejuvenating the hand and can be implemented concurrently with minimally-invasive techniques for volume restoration. The complication rate is low, and patient/surgeon satisfaction with outcomes is high.

Keywords

handlift, minimal scar, rejuvenation, dorsum

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In addition to its great functional importance, the hand has become aesthetically significant. Volume in the hand, similar to volume in the face, is a sign of youth; therefore, more patients are presenting for hand rejuvenation. Prevailing skepticism about the surgical approaches associated with handlifting is fueled by the visibility of scars on the surface of the hand with existing techniques.^{1,2} For this reason, minimally-invasive techniques addressing skin texture, age marks, prominent veins, and tissue loss dominate the current cosmetic market.³⁻¹⁴ However, none of these techniques offer fully-satisfying results, since they do not treat excess skin on the aged hand.

A youthful hand is characterized by its smooth surface, its skin texture and elasticity, and its subcutaneous soft tissue content. These features combine with a slender appearance, more defined interdigital creases, a strong bony skeleton, and defined muscle elements to lend it a "sportive" appearance.¹⁵⁻¹⁷ Any procedure aimed at restoring

these elements in an aged hand must address excess skin; rebuilding a truly-tight dorsum in the hand cannot be achieved with minimally-invasive methods.

Major limitations with existing surgical techniques for treating the hand include the high degree of necessary exposure and the functional importance of the appendage. Because of the hand's prominence, any aesthetic or functional changes are immediately perceptible. To address these concerns, we developed a minimal-scar handlift, which yields a scar of more limited size located in a

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unique position distal to the bony prominence of the caput ulnae, where it is nearly invisible in the regular ulnar-tilted hand-arm position.

METHODS

Patients

This pilot study was conducted between March 2009 and September 2009 with patients who presented to the Department of Plastic and Reconstructive Surgery, Santa Casa de Misericórdia General Hospital, Rio de Janeiro and were treated by two of the authors (MH, LMB-R). The study was approved by the local ethics committee, and informed consent was obtained from all patients.

The cohort included 11 women (22 hands) with an average age of 57.8 years (range, 44-69 years). The degree of excess skin was assessed preoperatively through a pinch test; patients deemed to have remarkable skin excess of at least 1.5 cm in the dorsum of the hand were selected for further examination. Only patients who had undergone no previous treatments to the hand and who had neither scars nor limitations in range of motion were then enrolled in the study. Preoperatively, all patients underwent physical examination and blood testing to exclude chronic and systemic diseases, deformations of the hand, skin diseases, or circulatory problems (such as Raynaud phenomenon or other vaso-occlusive diseases).

Technique

Four patients were smokers. They were asked to suspend nicotine for a minimum of four weeks before the surgery, but only two of the four, followed these instructions. Each patient's hands were treated in two separate procedures; the nondominant hand was treated first to facilitate postoperative mobility and scar treatment. The dominant hand followed at an interval of two to four months. All patients underwent the same standardized protocol, including the surgical sequence described later, 10 days of wrist immobilization, and then postoperative follow-up at four days, 10 days, three weeks, and every three months, to a maximum of 20 months. Scar treatment included a compression garment that patients were instructed to wear for two months. They were also instructed to apply ultraviolet protection until scar maturation was completed.

This outpatient procedure was performed under intravenous sedation and local anesthesia. The dorsal branches of the ulna and radial nerve were numbed, and the incision line was infiltrated with lidocaine 1% and epinephrine diluted to 1:400,000. The area of the flap was not infiltrated, to preserve objective assessment of all anatomical structures and superficial wrinkles during surgery. To avoid overcorrection, which could lead to tension on the suture line and subsequent limitations in the patient's range of motion, the wrist was placed into functional position. Another pinch test was then administered, which rendered an artificial wrinkle without pulling force. The



Figure 1. A manual pinch test is administered in the dorsal carpal region, with the wrist in functional position, to evaluate skin excess.

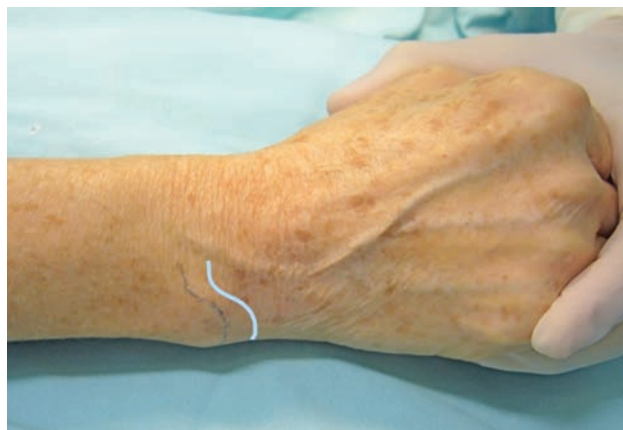


Figure 2. The S-shaped incision line curves around the distal border of the caput ulnae, ending in a horizontal direction in the relaxed skin tension lines in the ulnar as well as radial direction. Distal drift of forearm skin is compensated by about 5 mm in a proximal direction. The original incision line is shown light blue.

excess skin was marked in the dorsal carpal region, at the most proximal point on a line between the second metacarpophalangeal joint and the caput ulnae (Figure 1). This line also defined the primary vector of the flap. The distal base of the pinch wrinkle was marked with blue dye (Point A). The proximal base was brought together with the S-shaped incision line, which was a distally-curved bow at the inferior border of the caput ulnae, extending in a radial and ulnar direction. The entire incision line was positioned in relaxed skin tension lines (Figure 2).

The distal drift of the relatively-mobile forearm skin over the bony prominence of the ulna was compensated by elevating the incision by about 5 mm. The changes in skin tension between these two areas were measured and optically viewed with a special marking technique (Figure 3). Undermining—one of the key steps to addressing wrinkles up to the interdigital creases—was performed under direct vision in the subcutaneous plane between the superficial and intermediate fatty lamina, corresponding to



Figure 3. Distal distraction of the horizontal lines occurs on the forearm mostly in the ulnar segment (marked with blue dye), demonstrating the change in tension after suturing. The original position is marked in light blue.

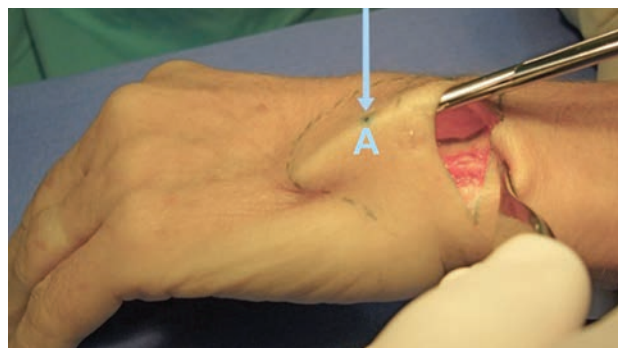


Figure 4. The subcutaneous plane between the superficial and intermediate fatty layer is shown, with undermining guided by fascia structure. The limits and Point A are marked with blue ink on the dorsal skin surface.



Figure 5. The dorsal venous plexus is preserved completely. This is primarily to avoid bleeding and preserve the accompanying microvascular and lymphatic vessels, thereby preventing complications.



Figure 6. Movement of the advancement rotation flap is shown, with its main vector (blue arrow) from the center of the second metacarpophalangeal joint to the center of the caput ulnae.

anatomical studies by Bidic et al.¹⁸ The extent of undermining was restricted to the ulnar and middle third of the dorsum (Figure 4), but its importance in decreasing tension on the suture line and simplifying rotation movements during the different vector settings is obvious. Simple excision would increase shear forces on the suture line and limit the rejuvenated area. More extensive undermining causes “dog-ears,” which are difficult to compensate for and would necessitate a longer incision line, which we wanted to avoid. Great importance was placed on preserving the dorsal venous plexus to limit bleeding-related complications (Figure 5). When necessary, the scar was extended but only in an ulnar direction to maintain its low visibility.

Hemostasis was avoided whenever possible to prevent damage to the delicate microvascular and lymphatic systems of the hand. Following flap mobilization, a typical

advancing and rotating movement was performed in the main vector direction (Figure 6). The skin was incised to Point A (described earlier), advanced by $2.8 \text{ cm} \pm 0.9 \text{ cm}$, and stitched to the base of the caput ulnae with a 6-0 non-absorbable sutures (Figure 7). The two resultant skin flaps were rotated in several more vertical vectors to limit incision length, thus compensating for discrepancies along the cut edge. The wrist was maintained in functional position during the entire surgical procedure, and the relaxed skin tension lines were strictly respected when the sutures were positioned. These maneuvers guaranteed a tension-free fixation of the skin. The closure line was placed in one plane, including both 6-0 single and horizontal mattress sutures (Figure 8). No drains were placed. The entire procedure lasted between 25 and 30 minutes.

A dry dressing was applied with a palmar splint, with the hand in neutral position. Splinting was a preventive



Figure 7. After making the key stitch, the skin in the radial and ulnar extensions is compensated with new vector setting and positioning of the suture line in the relaxed skin tension lines.

measure to avoid any tension that might be placed on the wound during the critical wound-healing period (since the hand is such a high-movement area), thus promoting better scar quality. Patients were instructed immediately after surgery to perform active finger movements and keep the hand and arm elevated to limit swelling. No antibiotics or antiphlogistics were prescribed. Patients were instructed to keep their wrist immobilized for ten days. To enhance lymphatic drainage, patients were also instructed to perform a light massage over the entire dorsum of the hand, starting after splint removal, which occurred 10 days postoperatively, and continuing for a period of four weeks. Subsequently, patients were given a compression dressing (Micropore, 3M, St Paul, Minnesota) and asked to maintain strict ultraviolet protection for two months.

RESULTS

Follow-up ranged from 14 to 20 months. During postoperative visits, we administered the same pinch test applied during presurgical selection, to measure changes in skin laxity once the wound-healing process was completed and the scar was mature (generally after six months). A significant decrease in excess skin was found, at a reduction of 60% to 75% (verified with calipers). The advancement and rotation movement of the flap during the surgical procedures altered the orientation of patients' hand wrinkles up to the metacarpophalangeal joints (II to V), in the direction of the caput ulnae and more vertically. None of the patients commented on or complained about this effect. The distance between wrinkles was increased by the stretching effect of the procedure. In eight hands, the interdigital folds appeared more slender. In all four hands of two patients, the tightened skin also reduced vein prominence. However, this effect was limited to the proxi-



Figure 8. The final suture line is shown. Note the vasoconstrictive side effect of epinephrine (white discoloration).

mal third of the dorsum and depended on the amount of preexisting subcutaneous tissue.

The postoperative phase was nearly painless for most patients. Only two patients utilized analgesics, for up to four days. No patients experienced limitations in range of motion after the wound-healing process was complete. Transient edema occurred in all patients to different but minor degrees, and was observed as a transient puffy appearance of the dorsum of the hand; it resolved between two and three weeks postoperatively. Recovery was quick; patients were able to begin weightbearing activities beginning at two weeks postoperatively. Limitations were noted for up to six weeks in the dominant hand, depending on the type of work being performed.

Complications were remarkably minor: No instances of flap necrosis, infection, or nerve damage were observed. One small hematoma (< 1 cm) did occur but was reabsorbed after two weeks without treatment. One seroma occurred after three weeks but also resolved without treatment. Partial suture dehiscence occurred in two noncompliant patients, who had undergone premature splint removal without consultation or permission. Secondary suturing in one of these patients prevented further complications. The second patient was treated conservatively



Figure 9. (A, C) This 53-year-old woman with Fitzpatrick type III skin presented for hand rejuvenation. (B, D) 17 months after minimal-scar handlift procedure, the overall hand appearance is more elegant. There is improved definition in several of the interdigital folds; the hand appearance is more slender; scar visibility is low. Note that the patient had significant sun exposure in Figure 9C and 9D. This patient experienced partial suture dehiscence on the right wrist due to noncompliance and premature splint removal. She was treated conservatively with compression dressing for two months. Her outcome was good, and she requested no revisionary or supplemental treatments.

with compression dressing (Micropore) for two months. She requested no revisionary or supplemental treatments, and her results were positive (Figure 9). Delayed wound healing, characterized by a slowed bleaching effect, was observed in both hands of one patient, who was a smoker (Figure 10). (Four patients in this study were smokers.) Other clinical results are shown in Figures 11-13, including demonstrations of scar visibility. Dyspigmentations were more likely to be seen in patients with darker skin, thus increasing scar visibility.

An independent jury of plastic surgeons analyzed the results at one year postoperatively and noted significant satisfaction with scar quality (diameter, texture, color), position, visibility, and left-to-right-side comparison. Patients were also asked to complete a questionnaire on their satisfaction with the procedure in terms of rejuvenation effect, scar quality, location, and visibility, as well as overall satisfaction. All 11 patients completed the questionnaire that was handed out at the last follow-up visit and all reported being highly satisfied with the surgical results; no revisions have been



Figure 10. (A, C) This 62-year-old woman presented with skin excess, advanced decline of skin tonicity, preexisting age marks, prominent veins, and visible subcutaneous tissue loss. (B, D) 20 months after minimal-scar handlift, this patient's results demonstrate scar quality and its near invisibility in the hand's regular position. She experienced delayed wound healing, characterized by a slowed bleaching effect, likely because she was a smoker without consequences on the final results. The patient also demonstrates postoperative wrinkle reduction over the proximal two-thirds of the dorsum with tightening of the skin; the wrinkles in the forehand have also changed to a more vertical direction. The caput ulnae is more prominent and the anatomical structures are more visible. (E, F) Close-up demonstration of the patient's left and right hands at 20 months postoperatively.



Figure 11. (A, C) This 69-year-old woman presented with very thin hands with prominent veins, age marks, and a significant loss of subcutaneous soft tissue, which had resulted in prominent extensor tendons and intermetacarpal hollowing. The patient's skin excess was very significant; tonicity was minimal; and deep horizontal wrinkles predominated on the wrist and proximal dorsum of her hand. (B, D) 19 months after minimal-scar handlift, in which the skin flap was advanced by 3.3 cm. This patient's postoperative course was unremarkable and her satisfaction high. She would benefit from supplementary treatments, such as a combination of autologous fat tissue transfer to correct tissue loss and trichloroacetic peeling or laser rejuvenation. (E) Close-up at 19 months postoperatively shows good scar quality with good positioning distal to the caput ulnae.

requested to date. However, five of 11 requested further non-surgical treatments for various additional age signs. This rate is similar to the phenomenon seen with facelift patients, who often request further nonsurgical treatments after surgical skin tightening.¹⁹

DISCUSSION

This new surgical approach permits the dorsum of the hand to be tightened by removing excess skin. Superficial wrinkles are reduced, and the hand's appearance is younger with better definition of anatomical landmarks.

The aging process of the hand is characterized by changes in superficial and deep anatomic features.¹⁵⁻¹⁷ It can be compared with the aging process of the face,

although gravity plays a less important role, and wrinkles are primarily the result of structural changes and tissue loss rather than one of function and movement.

One challenge presented by handlift surgeries involves a mismatch between the overlying skin envelope and the amount of underlying soft tissue. Patient tolerance for scars and complications is extremely poor in those who seek hand rejuvenation as a purely-aesthetic treatment; function must also be strictly maintained.¹⁵⁻¹⁷ These concerns explain practitioners' persistent resistance to surgical approaches for treating the hand and patients' and surgeons' preference for minimally-invasive techniques,³⁻¹⁴ even if these nonsurgical approaches fail to address skin excess. However, as mentioned in several studies,^{3,15,16} overall patient satisfaction cannot be sufficiently achieved by treating only extrinsic or intrinsic aging changes. To fully address the problem,



Figure 12. (A, C) This 44-year-old woman presented with advanced loss of skin tensile force comparable with what is seen in aged women as a result of massive weight loss. (B, D) 15 months after minimal-scar handlift, in which the skin flap was advanced by 3.4 cm. Even in this relatively-young patient, the rejuvenating effect was visible, and the patient was satisfied. As a positive side effect, tissue tightening compressed the veins and reduced their appearance. The postoperative appearance of the dorsum of the hand was tighter with fewer wrinkles.

patients seem willing to undergo surgical procedures for hand rejuvenation, as long as the scars have a low degree of visibility (similar to patient attitudes about facelifting procedures). Our development of this minimal-scar handlift for treating skin excess was based on this experience. The limited scar visibility and low complication rate opens the door for broader indications.

As in the face, the complexity of aging requires an interdisciplinary approach. Different techniques are available for the treatment of volumetric tissue loss, dominant veins, or skin changes.³⁻¹⁴ The technique presented here

is clearly intended to be complemented by additional nonsurgical treatments. For longevity reasons, we favor autologous material (fat) transfer to restore soft tissue loss, in combination with trichloroacetic peeling or laser rejuvenation treatments to improve skin texture and reduce age marks.^{3,13} However, concurrent treatment is avoided, to avoid even temporarily compromising to the skin's delicate circulation.³ Furthermore, to limit stress in the postoperative period, we recommend treating each hand in a separate procedure and treating the nondominant hand first (which, in the case of all our patients, was the left hand).

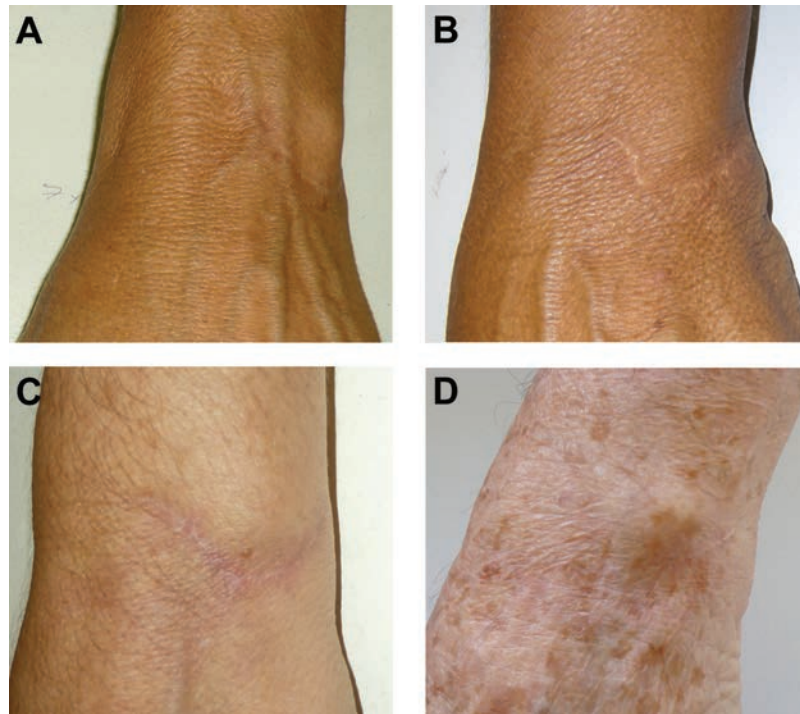


Figure 13. (A) This 53-year-old patient presented with Fitzpatrick Type 3 skin and is shown at 17 months follow up. (B) This 62-year-old patient presented with Fitzpatrick Type 4 skin and is shown at 11 months follow up. (C) This 44-year-old patient presented with Fitzpatrick Type 2-3 skin nine months follow up. (D) This 69-year-old patient presented with Fitzpatrick Type 2 skin and is shown at 19 months follow up. Various scar maturation states demonstrating differences in visibility depending on the advanced bleaching effect and among between scar, skin type, and color. Scar maturation of more than six months must be taken into consideration before making a decision on supplementary treatment. Dyspigmentations were more likely to be seen in darker skin, thus increasing scar visibility even more. Palpably thinner scar tissue is formed in Fitzpatrick Type 2 and 3 skin.

This handlift is the first of its kind to surgically meet the requirements for a truly-aesthetic outcome. Other procedures developed to date have not achieved a comparable satisfaction rate, nor have they sufficiently met the demands of aesthetic treatment.^{1,2} In comparison to previously-published techniques, such as one described by Wendt et al,^{1,2} our resulting scar is limited in size and well placed in a unique position to limit visibility. The S-shape of the incision and the changing of the traction vectors after fixing the primary inseting point enabled us to smooth the skin without extending the incision or adding excisions in a transverse direction (which might be required for patients with large skin excesses that require a resection in a not only longitudinal but also transverse direction).

The use of a bone structure, the caput ulnae, as a pivot point also makes this technique unique and shows its similarity to a classic facelift procedure. Placing the suture in relaxed skin tension lines in the ulnar area, together with radial extension, makes the scar nearly imperceptible. The idea of placing the scar in a protected and less visible position, limiting tensile forces with the developed flap advancement and rotating technique, worked well and was reflected in high scar quality and significant patient satisfaction. A scar across the entire wrist would have been more visible, longer, and a greater risk to vessels and nerves. Specifically, a long scar would have produced more scar tissue and might have subsequently

conflicted with wrist movement and lymphatic drainage. Even more important, scars in that area carry the stigma of suicide attempt, which is obviously undesirable to patients.

With this technique, we achieved a necessary compromise among undermining, scar length, and rejuvenation effect. The established incision size limited our ability to compensate with the skin flap compensation abilities, but increasing the undermining would have inevitably complicated flap fixation in a short incision technique, thereby increasing the possibility of dog-ears or extended incisions. Low tension on the final suture line and wrist immobilization for ten days prevented the development of hypertrophic scars, keloids, and wound dehiscence, minimizing postoperative complications.

Note that lighter skin ages faster and shows not only textural changes but also greater loss of subcutaneous soft tissue.^{15,16} One consequence of a tighter skin envelope is that (1) less volume is needed for subcutaneous tissue enhancement and (2) accompanying complications (ie, irregularity) are more limited.³ Ultimately, the hand will not appear “puffy” and will retain its slender, tightened appearance with better definition of the anatomical structures. The color mismatch between scar and skin observed in patients with darker skin did not seem to affect overall satisfaction, but it did prompt us to make surgical recommendations accordingly and to treat patients with lighter skin more frequently.

We disagree with Coleman that tightening the skin increases vein and tendon visibility.³ Our results showed vein visibility to be stable and even improved in a few cases where the slight compressive effect reduced vein visibility. We do, of course, agree that this effect would be more impressive with a combined volume substitution. In fact, each of our patients would have benefited from additional nonsurgical volume enhancement. Stated simply, our technique is one where the aging hand can be surgically treated in a manner similar to that of the aging face, with a combination of treatments.

CONCLUSIONS

Our minimal-scar handlift technique is a moderately-invasive, cost-effective procedure for rejuvenating the aging hand. We specifically recommend this surgical approach for Caucasian patients older than 50 years who present with significant skin excess and no nutritional tissue deficits. In patients with darker skin, this technique should be utilized only if the patient is informed of and accepts the likelihood of greater scar visibility. In patients with subcutaneous tissue loss, age marks, or dominant veins, accompanying treatments can (and should) follow the procedure.

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Disclosures

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Commentary on: Minimal-Scar Handlift: A New Surgical Approach

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We enjoyed reading the article by Handle et al entitled “Minimal-Scar Handlift: A New Surgical Approach.” Their technique is certainly a worthwhile addition to the plastic surgery literature and a procedure that we may elect to utilize in select patients. The basic idea behind their approach—namely, excising skin and leaving the scar hidden—is an essential tenet of plastic surgery. It is what many of us aim for in our aesthetic surgery practices on a daily basis for many anatomical areas. However, as the authors note, excisional procedures solve only some of the problems of the aging body, leaving unaddressed losses of skin elasticity, bone, muscle, and fat, as well as changes in position of these structures.

Plastic surgeons have made great strides in the last 10 years in terms of nonsurgical rejuvenation with lasers and other energy devices, as well as fillers and toxins. The ultimate goal of any rejuvenation procedure is to restore elasticity and multiple-level volume loss with no scars—we think of this as the “holy grail” of cosmetic surgery. However, we are currently unable to currently achieve complete rejuvenation with nonsurgical procedures alone, regardless of anatomical area. Studying the “state of the science” in terms of a nonsurgical approach to the aging hand is indicative of where technology is today in regard to aesthetic restoration, and it gives us a good idea of where we might go in the future.

Features of the aging hand include color changes (uneven pigment deposition or age spots), changes in skin thickness and elasticity, loss of volume/fat, increased visibility of veins, loss of muscle, and bony prominences. We will address possible approaches to each of these issues, beginning with the deepest anatomical structures. Changes in the bony composition can include arthritic changes, traumatic changes, and aging loss. From an aesthetic perspective, few techniques address these changes, but if a functional need arises and is corrected, there may be an aesthetic component to such a procedure (ie, to minimize scarring). Otherwise, bony prominences are addressed with volume restoration to camouflage the bone. Loss of muscle is both an aesthetic issue and a functional issue. It can occur through the natural aging process or because of injury, denervation, or other wasting conditions. Correction

is achieved through a functional approach, with diet and exercise rehabilitation to restore musculature, or through volumizing with fat or synthetic fillers to hide the defect. These procedures can be offered in combination or alone. Changes in dorsal hand veins can occur as a result of alterations in the veins themselves or from overlying skin/fat changes. To the average rejuvenative patient, an increase in vein visibility is not attractive. Treatment involves vein eradication through sclerotherapy, endovenous ablation, or stripping/increasing the volume around the veins to camouflage them with fat or synthetic fillers.

Treating loss of volume is the mainstay of hand rejuvenation in an aesthetic practice. Structural fat grafting, as outlined by Coleman¹ and referenced by Handle et al, remains the most durable and natural approach to hand volume restoration. The fat hides the underlying bony prominences, visible tendons, muscle loss, and veins. There is anecdotal evidence of skin improvement from the fat transfer as well—currently thought to be a result of the effects of adipose-derived regenerative cells present in the fat (Figure 1). In our practices, we perform far more synthetic filler injections to the hands than we do fat grafts, primarily because most of our patients want a quick and easy procedure with minimal downtime. Currently-available fillers that are appropriate for the hand include calcium hydroxyapatite, poly-L-lactic acid, and hyaluronic acid. Everyone has preferences, and we know of no comparative study of the hands with these fillers. Our preference is calcium hydroxylapatite diluted with 0.2 to 0.5 mL

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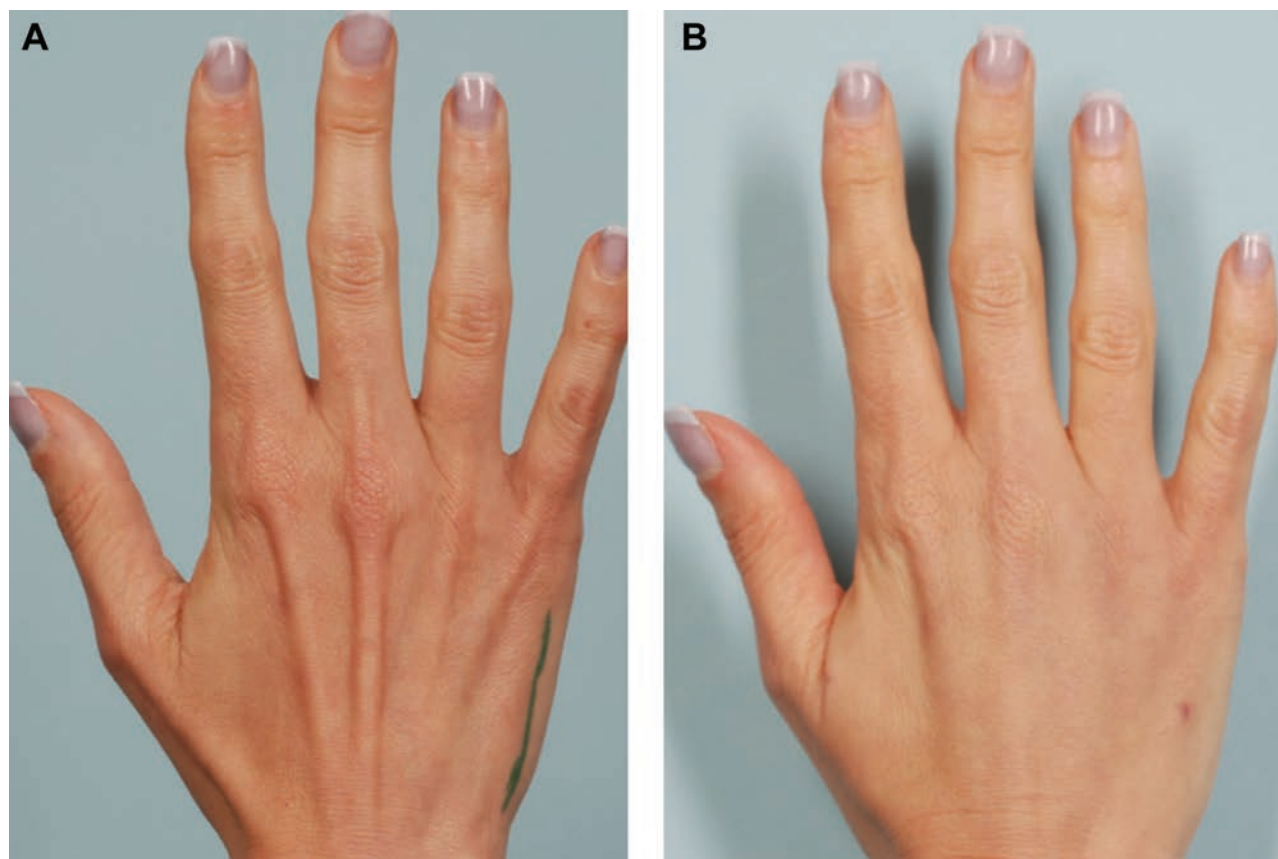


Figure 1. This 51-year-old woman is shown three months after fat grafting to her hands.

of 1% lidocaine for every 1.5 mL of filler, then injected with a blunt 22-gauge needle (Softfil, Soft Medical Aesthetics, Paris, France). This blunt cannula specifically designed for fillers avoids bruising by rolling over the veins. There is typically a single entry point for the filler, and the length of the cannula (50-70 mm) allows even filler placement.

In terms of skin thickness and elasticity, the concept of improving elasticity, restoring collagen, and thickening the skin is something that we are currently achieving through a variety of techniques. The simplest approach is through retinoid skin care products. There are clear data that long-term application of these products will improve skin quality. Other minimally-invasive techniques, such as microdermabrasion, may also help, albeit in a minor way. Laser resurfacing with full-field or fractional carbon dioxide, erbium, or YSGG lasers can tighten skin as well as remove unsightly pigmentations. However, due to the lack of sebaceous glands in the hand dorsum (true for all nonfacial areas), settings must be kept superficial to avoid scarring. Multiple, lighter treatments are preferred to one deeper treatment for similar reasons (Figure 2). Most devices currently utilized for tightening skin work through a heat-related mechanism. Heating the skin causes release of heat shock proteins, which are thought to improve skin elasticity. These devices are categorized into light devices (such

as long-pulse-width intense pulsed light machines) lasers that deliver through noncontact mechanisms (1064 nm), or blended (1064/1319 nm) or radiofrequency devices. As the mechanism of correction appears to be heat related, at this time it is unknown whether there are any advantages of lasers over radiofrequency devices.

Uneven pigmentation and solar elastosis of the hand are tell-tale signs of aging. Restoration of even pigmentation can be achieved through skin care, chemical peels, laser resurfacing, or pigment lasers or devices. Skin care with bleaching creams such as hydroquinone (with or without retinoids) can improve skin pigmentation and, as described above, increase elasticity. Laser resurfacing can also improve color, but removing hand pigment in one session (as done in the face) is unadvisable due to scarring risks. Chemical peels are an excellent way of correcting pigment; blended light peels are recommended. Typically, we apply pulsed light devices and Q-switched lasers to correct pigment. Pulsed light devices require multiple sessions but have little or no downtime. Q-switched lasers usually remove unwanted pigment in one treatment but have longer downtime.

Our conclusion—and the conclusion of the authors—is self-explanatory: Hand rejuvenation requires multimodality treatment, and there is no one device or

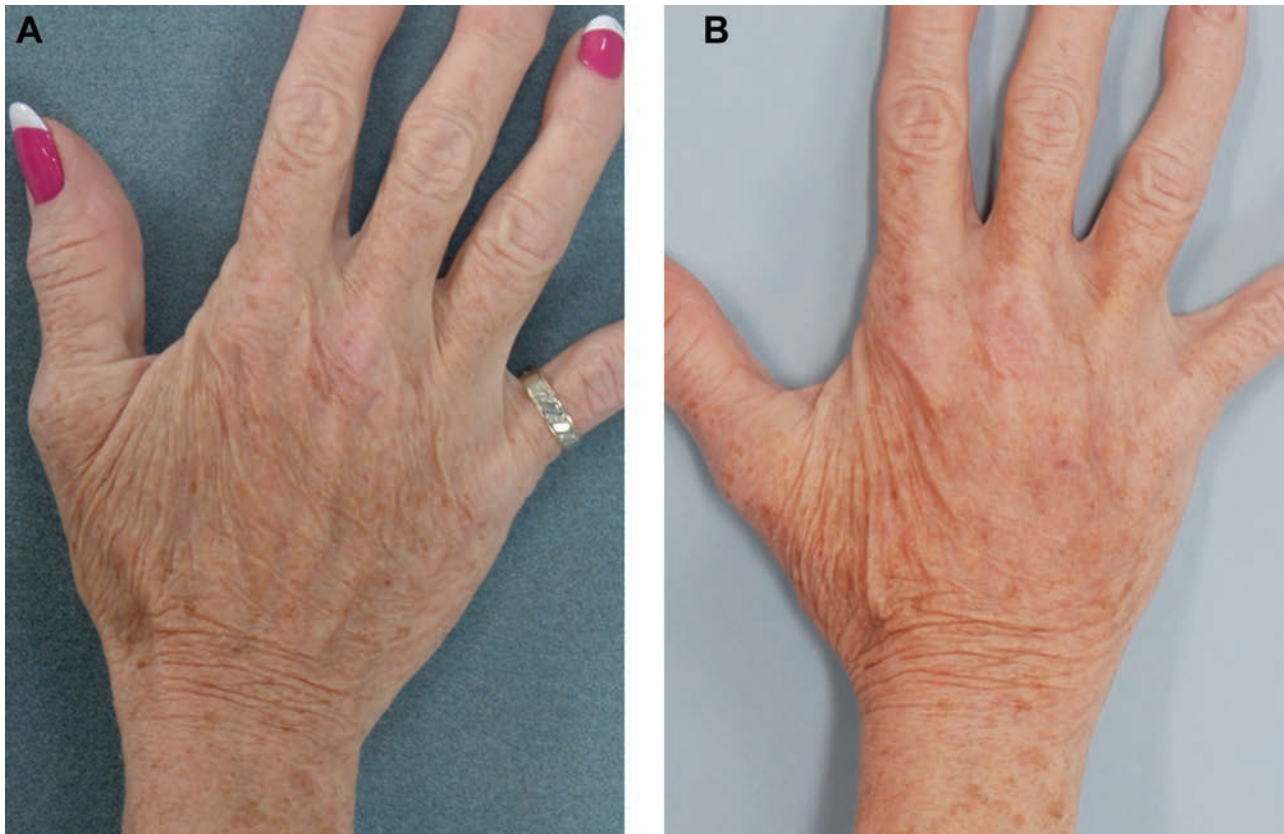


Figure 2. This 72-year-old woman is shown after a single superficial pass with a YSGG 3.5J device (20% overlap).

technique that works for every patient. The excisional procedure described by the authors is therefore a nice addition to current techniques. We note, though, that most plastic surgeons would choose a nonsurgical technique for hand rejuvenation, foregoing excisional techniques until elasticity is too poor for noninvasive approaches. Although recommending nonsurgical treatments over surgical treatments may be counterintuitive to surgeons, if we look over the last 15 years, we see that this concept is not limited to hand rejuvenation—that is, nonsurgical options have been embraced in increasing numbers by plastic surgeons and patients alike. Our belief is that this trend will continue and that

better nonsurgical techniques will be developed to provide alternatives to surgical options.

Disclosures

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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Investigating the Efficacy of Vibration Anesthesia to Reduce Pain From Cosmetic Botulinum Toxin Injections

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Abstract

Background: Many analgesic modalities have been employed with limited success to alleviate the pain associated with botulinum toxin type A (BTX-A) injections. Vibration is an effective method of reducing pain during facial cosmetic injections, but it has not been previously studied in the context of clinical cosmetic procedures.

Objectives: The authors evaluate the safety and efficacy of vibration-assisted anesthesia for reducing pain associated with BTX-A injections.

Methods: In this prospective study, 50 patients received BTX-A injections for cosmetic rhytid reduction. Injections were given in a split-face design that was randomly assigned. A vibration stimulus was coadministered with BTX-A injections on one side, while the other side of each patient's face received BTX-A injections alone. Patients completed a questionnaire immediately posttreatment and were contacted for follow-up three to four weeks later.

Results: Patients reported less injection pain on the vibration-treated half of the face as compared to the control side (an average of 1.3 vs 2.4 on a five-point scale; $P = .000$). Overall, 86% of patients preferred to receive vibration with their next BTX-A treatment. There was no significant difference between first-time and repeat BTX-A patients in terms of preference for vibration. Five of 50 patients experienced transient side effects perceived to be associated with vibration, including tingling teeth, increased bruising, and headaches. Of the patients who did not request vibration with subsequent BTX-A injections, none cited decreased BTX-A efficacy as the reason for their preference.

Conclusions: Vibration is a safe and effective means of reducing patient discomfort during BTX-A injections for cosmetic rhytid reduction and may have applications in other cosmetic procedures.

Keywords

Botox, cosmetic injectables, rhytids, vibration anesthesia, analgesia, botulinum toxin

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Cosmetic injectables are rapidly increasing in popularity. Amelioration of rhytids with botulinum toxin type A (BTX-A) is currently the most commonly-performed nonsurgical cosmetic procedure in the United States.¹ The needle puncture necessary to this procedure may cause a certain degree of pain and can be associated with varying levels of patient discomfort and anxiety.^{2,3} Techniques such as verbal reassurance and hand-holding are helpful to calm and distract the patient but may not reduce the perceived injection pain.⁴ The application of topical analgesics (eg, ice packs, anesthetic ointments, and/or vapocoolant sprays) has been attempted as a means to reduce patient discomfort. These modalities have been employed with limited success due to cumbersome application,⁵ increased treatment time, and associated risks, including contact dermatitis^{6,7} and hyperpigmentation or hypopigmentation.^{3,6}

Vibration anesthesia has repeatedly been shown to effectively and safely alleviate pain sensation,⁸⁻¹⁰ most

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likely by reducing pain transmission from peripheral receptors to the brain.¹¹ The mechanism of action for vibration anesthesia is explained in part by the “gate control” theory,¹² which posits that pain sensation can be dampened by costimulation of nerve fibers transmitting nonnoxious stimuli such as vibration. Much empirical evidence exists to support the use of vibration-assisted anesthesia, but there is a paucity of prospective controlled trials^{8,10,13} in the literature. Additionally, none of the previous studies pertain to clinical cosmetic procedures. Therefore, the aim of this study was to evaluate the efficacy, safety, and patient satisfaction associated with topical vibration anesthesia for reducing pain from cosmetic BTX-A injections.

METHODS

An independent institutional review board (Abington Memorial Hospital, Abington, Pennsylvania) prospectively reviewed and approved the study protocol before patient enrollment and monitored the clinical investigation. Informed consent was obtained for each patient according to institutional review board protocol.

Patient Selection

This prospective randomized study enrolled 50 patients seeking temporary minimization of their glabellar folds with BTX-A. All were above 18 years of age. Naïve patients (ie, not previously treated with BTX-A) and repeat patients (ie, previously treated with BTX-A at the same anatomic site) were eligible to participate. Exclusion criteria included previous allergic reaction to BTX-A, preexisting disorders affecting neuromuscular junction function (eg, myasthenia gravis and motor neuron disease), presence of infection or inflammation at injection sites, and pregnancy or lactation.

Study Design

Injections were given in a split-face design (right vs left) that was randomly assigned. A vibration stimulus was coadministered with BTX-A injections on one side (treatment), while the other side of each patient’s face received BTX-A injections alone (control). There was no placebo. Vibration was administered with a small handheld battery-operated device (Pin Point Personal Massager, Brookstone, Inc., Merrimack, New Hampshire; Figure 1). The BTX-A injections were administered with a 32-gauge needle on a 1-mL syringe. To begin the procedure, a trained assistant gently placed the tip of the vibrator on the patient’s skin a few centimeters away from the treatment site (Figure 2). The vibration stimulus was initiated two to three seconds before the BTX-A injection to ensure adequate anesthesia, and it was continued until the needle was withdrawn from the skin. The vibrating device was repositioned in tandem with the needle, approximately 1 to 2 cm from the site of



Figure 1. Vibration anesthesia was administered with this small handheld battery-operated device (Pin Point Personal Massager, Brookstone, Inc., Merrimack, New Hampshire).



Figure 2. During treatment, the vibrating device was positioned on the patient’s skin, approximately 1 to 2 cm from the injection site.

injection. Treatment to one side of the face (with or without vibration) was completed before proceeding to the other side. Symmetric locations in the glabella and forehead

were treated. The same physician (AEW) administered all injections. After all injections were completed, the vibrating device was sanitized with sterilization wipes (Sanicloth Plus Germicidal Disposable Cloth, PDI, Orangeburg, New York).

After the procedure, the physician (AEW) left the room as the patient completed an anonymous questionnaire regarding the treatment. This survey was collected and stored by the assistant. Patients were contacted by telephone approximately three to four weeks after the procedure to inquire about any potential side effects they had experienced.

Patient Questionnaires

Participants were informed before the procedure that they would be asked to make posttreatment comparisons between the pain associated with injections administered on each side of the face. The potential effects of the vibration stimulus were not discussed.

Patients were provided with a five-point Likert-type scale on which to rate the injection pain for each side, with zero representing *no pain*, one representing *mild pain*, two representing *moderate pain*, three representing *severe pain*, and four representing *the worst pain I have ever felt*. Patients were also given the opportunity to report any posttreatment pain, bruising, or adverse effects. Finally, they were asked whether they would prefer vibration with their next BTX-A treatment, with potential response choices being *yes*, *no*, or *unsure*.

Statistical Analysis

Analysis was conducted with SPSS 19 (IBM Corporation, Somers, New York). Appropriate nonparametric analysis methods were applied to the ordinal (Mann-Whitney) and categorical data (Fisher exact test) to determine the statistical significance of differences between the two sides. Each patient served as his or her own control for pain analyses.

RESULTS

Patient Demographics

Three men and 47 women participated in the trial. The average patient age was 52 years \pm 10.5 (range, 28-82). Six patients were receiving their initial treatment during the trial, whereas 44 had previously undergone BTX-A injections at the same anatomic sites.

Pain Reduction

The mean patient-reported pain scores were 1.3 \pm 0.6 for the vibration-treated side and 2.4 \pm 0.8 for the control side, a difference that was highly statistically significant (Mann-Whitney test, $P = .000$). On the vibration-treated

Table 1. Patient-Reported Injection Pain With and Without Vibration Anesthesia

	With Vibration, No. (%)	Without Vibration, No. (%)
No pain	2 (4%)	0 (0%)
Mild pain	35 (70%)	6 (12%)
Moderate pain	11 (22%)	22 (44%)
Severe pain	2 (4%)	17 (35%)
Worst pain ever	0 (0%)	5 (10%)

side, 4% of patients (two of 50) reported no pain; 70% ($n = 35$), mild pain; 22% ($n = 11$), moderate pain; 4% ($n = 2$), severe pain; and none reported “the worst pain I’ve ever felt.” On the control side, zero patients reported no pain; 12% ($n = 6$), mild pain; 44% ($n = 22$), moderate pain; 35% ($n = 17$), severe pain; and 10% ($n = 5$) reported feeling “the worst pain I’ve ever felt” (Table 1).

Overall, 41 of 50 patients rated the injections they received on the vibrated side as less painful than the non-vibrated side. Nine patients rated the pain as being equal on both sides of the face; the mean pain score for these patients was 1.4 \pm 0.7. In comparing these patients with the 41 who did notice a difference in pain (mean pain score = 2.6 \pm 0.7) we found a statistically significant difference (Mann-Whitney test, $P = .000$). No patients reported greater injection pain on the vibration-treated side.

Adverse Effects

Five patients experienced transient side effects perceived to be associated with vibration. Two patients described a “tingling sensation” in their teeth as the vibration was being administered, and one patient noted that her skin felt “tingly” immediately posttreatment. One experienced increased bruising on the vibration-treated half of her face, and another developed a headache the day after injections were administered. All these adverse effects resolved by the three- to four-week follow-up visit. Of the patients who reported adverse effects, only two (one with tingling teeth and another with bruising) declined vibration concurrent with subsequent BTX-A injections.

There was no statistically-significant difference in post-procedure pain (Fisher exact test, $P = 1.0$) or bruising (Fisher exact test, $P = 1.0$) between the vibrated and nonvibrated sides of the face.

Preference for Vibration

Forty-three of 50 patients (86%) stated that they would prefer to receive vibration with their next BTX-A treatment. A small percentage (8%, $n = 4$) were uncertain

whether they would request vibration with subsequent BTX-A treatments; all these patients had rated the injection pain as being equal on both sides of the face during this trial. A few patients (6%, $n =$ three) declined vibration with subsequent BTX-A injections; as noted, two of these patients reported adverse effects. One found the injection pain to be equal with or without vibration. Of the patients who did not prefer vibration with subsequent BTX-A treatments, none cited decreased BTX-A efficacy as the reason for their preference during the follow-up telephone survey. Of the six naïve patients, four reported that they would prefer to receive vibration with their next BTX-A treatment, and 39 of the 44 of repeat patients preferred vibration. There was no statistically significant difference between first-time and repeat patients in terms of preference for vibration (Fisher exact test, $P = 1.0$). Anecdotally, of the nine patients in our study who rated BTX-A injection pain as being unchanged by vibration, five nonetheless reported that they would request vibration with subsequent BTX-A injections.

DISCUSSION

Maximizing patient comfort is an important consideration for all procedures, especially elective aesthetic procedures. Anticipated injection pain has been shown to be a factor in delaying BTX-A treatments for naïve and repeat patients.³ A survey of cosmetic patients revealed that concerns about procedure discomfort rated third in importance to surgical result and physician communication.¹⁴

The few studies on vibration anesthesia stem mostly from dental and dermatology literature, but these studies have demonstrated that it is an effective means of minimizing injection pain.^{8-10,13} The mechanism of vibration anesthesia depends largely on a theory published in 1965 by Melzack and Wall, who termed it the “gate control theory,” and postulated that pain sensation was subject to modulation by intrinsic neurons and controls descending from the brain. The authors hypothesized that a gate synapse ultimately controls the amount of pain signal that ascends to the brain.¹² According to the gate control theory, activation of A-B fibers (“vibration” fibers) stimulates inhibitory interneurons in the spinal cord, which in turn act to decrease the amount of pain signal transmitted by A-D and C fibers (“pain” fibers).¹² It has since been recognized that pain transmission is likely more complex, since the gate control theory is insufficient to explain all types of pain (ie, phantom limb syndrome).¹⁵

In 2004, Melzack advanced a novel neuromatrix theory of pain, proposing that pain is a multidimensional experience produced by a widely distributed neural network (the “body-self neuromatrix”) that generates characteristic patterns of neural impulses.¹⁶ These neural impulses, or neurosignatures, can be generated by sensory stimuli but also independently of them.¹⁶ Thus, counterstimulation by vibration can minimize the sensation of pain at the brainstem/spinal cord level, but other central and peripheral mechanisms likely contribute to the analgesic effect of

vibration.¹⁷ Additional hypotheses to explain the anesthetic properties of vibration include distraction, self-hypnosis, and even the power of suggestion in susceptible patients.^{9,18} Of note, five patients in our study who did not feel that vibration reduced injection pain still preferred vibration with subsequent BTX-A treatments, suggesting that their preference was influenced by a factor other than pain reduction.

Vibration also appears to be a safe method of achieving local anesthesia. Occupational studies indicate that chronic exposure to high-intensity whole-body vibration may be associated with increased risk of spinal degeneration^{19,20} and that long-term hand-transmitted vibration may cause vascular or neural changes in the upper limbs.²⁰ However, to the best of our knowledge, exposure to brief periods of topical vibration is not associated with any significant temporary or permanent side effects. Of the adverse effects experienced by five patients in our study, tingling of the skin and/or teeth was transitory, and headache and bruising were likely independent of the vibration stimulus.

Experience has shown that the best measures for minimizing injection site pain include a gentle injection technique, the use of small-gauge needles, prompt replacement of dulled needles, and injection of the least possible volume. Other modalities commonly utilized to minimize injection pain, with varying degrees of effectiveness, are topical application of ice packs,^{21,22} cryoanalgesia,^{5,23} or vapocoolant sprays,^{3,22} and anesthetic creams.^{5,21,24} Contact cooling is most widely used,^{3-5,22,23} and, intuitively, contact cooling (typically with ice) followed by injection with small-gauge needles has become the standard of comparison for achieving patient comfort during injections. We elected not to compare vibration with other types of topical anesthesia, because in our experience, vibration is equally effective, with improved patient tolerability. Inherent advantages of vibration over other forms of topical anesthesia include ease of application, rapid onset of action, and a minimal side effect profile. Handheld vibrating devices are readily available at low cost. The application technique is unobtrusive and may be adapted to eliminate the need for an assistant, since the injector can place a fingertip massager on his or her nondominant hand.

In comparison and despite their popularity, topical coolants do have some drawbacks. Ice packs are cumbersome to apply and are not completely effective in reducing or eliminating injection pain. Vapocoolant sprays (or topical anesthetic skin refrigerants) do have a quick onset of action but may lead to frostbite and subsequent tissue necrosis if not properly applied.³ Particular care must be taken when administering vapocoolants around the periorbit, necessitating protective eye shields.³ Vapocoolant sprays have also been associated with skin hypopigmentation or hyperpigmentation.⁵ The anesthetic effect of ice or cooled air is often variable, as these modalities cannot be administered accurately or precisely.

Topical anesthetic ointments such as EMLA (lidocaine 2.5% and prilocaine 2.5%) have a topical application time of 20 to 60 minutes,^{7,24} limiting their applicability for in-office procedures. Topical anesthetics may also cause

transient local skin blanching, followed by erythema, in up to 55% of patients,⁷ or they may cause a localized contact dermatitis.^{6,7} Additionally, anesthetic ointments may not be appropriate in conjunction with BTX-A. One study showed that topical anesthetics may reduce the efficacy of BTX-A, perhaps because the nerve-inactivation effect of topical anesthetics interferes with the nerve stimulation necessary for BTX-A effect.²⁵ That study relied on cryoanalgesia in conjunction with a numbing cream, which may have had an additive effect.

Further study is needed to determine the optimal parameters of vibration as an anesthetic. In our study, 41 of 50 of patients experienced less pain when BTX-A injections were coadministered with vibration, while nine patients reported no pain alleviation. The difference in mean injection pain between these cohorts was statistically significant. This could be due to either the subjective nature of grading or an elevated or lowered global pain tolerance in certain patients. It is also possible that variations in vibration amplitude, frequency, or time of application may provide a greater anesthetic effect. Additionally, the combination of vibration with other counterstimulatory techniques, such as skin pinching^{4,25} or stroking,^{4,19} may have a synergistic effect on pain relief.

One limitation to this study is the lack of a placebo. It is difficult to mimic the administration of vibration without relying on other counterstimulatory techniques. In another study of vibration-assisted anesthesia, the placebo consisted of a “switched-off” vibrating device applied to the test sites, while a second “switched-on” vibrating device was held nearby.¹⁰ This may not represent a true placebo, as merely placing the vibrating device on the skin may have a counterstimulatory effect similar to skin stroking. Another possible weakness is the absence of a control group, which would be challenging given the variability in pain experiences among individuals.

In our study design, patients graded injection pain post-treatment rather than during the injection itself, which may have affected the accuracy of the data due to errors in recollection. We attempted to minimize the potential for error by informing the participants pretreatment that they would be making posttreatment comparisons of the injections and by administering the questionnaire immediately posttreatment. Additionally, the individual tendency of participants to overrecall or underrecall pain would likely apply to injections on both sides of the face, still permitting comparisons between the sides. Finally, patients rated overall pain for all vibrated versus nonvibrated injections, rather than per injection, because we did not anticipate significant variability in pain within various sites on the forehead and glabella. It is unlikely that this aspect of the study protocol significantly affected our results.

CONCLUSIONS

Vibration is a safe and effective means of achieving local anesthesia and maximizing patient comfort during cosmetic BTX-A injections. Vibration may be applied during

a variety of medical and cosmetic procedures, and the advantages of vibration include ease of application, rapid onset to action, and affordability.

Disclosures

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Plastic Surgery Marketing in a Generation of “Tweeting”

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Abstract

Background: “Social media” describes interactive communication through Web-based technologies. It has become an everyday part of modern life, yet there is a lack of research regarding its impact on plastic surgery practice.

Objectives: The authors evaluate and compare the prevalence of classic marketing methods and social media in plastic surgery.

Methods: The Web sites of aesthetic surgeons from seven US cities were compared and evaluated for the existence of Facebook, Twitter, or MySpace links and promotions. To find the sites, the authors conducted a Google search for the phrase “plastic surgery” with the name of each city to be studied: Beverly Hills, California; Dallas, Texas; Houston, Texas; Las Vegas, Nevada; Miami, Florida; New York City, New York; and San Francisco, California. The trends of social networking memberships were also studied in each of these cities.

Results: In comparison to aesthetic surgeons practicing in other cities, those in Miami, Florida, favored social media the most, with 50% promoting a Facebook page and 46% promoting Twitter. Fifty-six percent of New York City aesthetic surgeons promoted their featured articles in magazines and newspapers, whereas 54% of Beverly Hills aesthetic surgeons promoted their television appearances. An increase in the number of new Facebook memberships among cosmetic providers in the seven cities began in October 2008 and reached a peak in October, November, and December 2009, with subsequent stabilization. The increase in the number of new Twitter memberships began in July 2008 and remained at a steady rate of approximately 15 new memberships every three months.

Conclusions: Social media may seem like a new and unique communication tool, but it is important to preserve professionalism and apply traditional Web site-building ethics and principles to these sites. We can expect continued growth in plastic surgeons’ utilization of these networks to enhance their practices and possibly to launch direct marketing campaigns.

Keywords

marketing, advertising, social media, social networking, Facebook, Twitter

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The Internet is indisputably one of the most valuable tools for communicating; e-mail, networking Web sites, real-time video chat, and convenient access to information have increased communication ease and, in many cases, brought people closer together. In the past, classic media outlets such as television, print advertisements, and radio were the primary means of relaying messages to the public. The newer generation of outlets, social media, involves interactive communication and interaction through Web-based technologies. Popular examples include social networking sites, Web logs (blogs), microblogs (sites that allow short “status” posts), podcasts, virtual game worlds, online forums, and picture- and video-sharing communities (Table 1).

Recent statistics have revealed the overwhelming impact of social media in modern life. Facebook.com





















boasts more than 500 million active users, who spend over 700 billion minutes monthly on the site.¹ More than 1 million Web sites, developers, and entrepreneurs from over 180 countries have integrated Facebook.com into their businesses. Twitter.com also cites impressive statistics,

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Table 1. Popular Social Networking Programs

Social networking	Facebook  LinkedIn  MySpace  Hi5  Bebo  Friendster 
Microblogs	Twitter  Google Buzz 
Blogs	WordPress  Blogger  LiveJournal  Xanga 
Multimedia sharing	Picasa  YouTube  Photobucket  Flickr 
Live-casting	Skype  Qik  Livestream  Ustream 

with over 100 million registered users posting an average of 55 messages, or “tweets,” daily.² Approximately 600 million search queries are entered into Twitter’s search engine each day. With these statistics in mind, it was inevitable that business-savvy plastic surgeons would respond to these impressive numbers by utilizing these sites as a marketing adjunct to increase their online presence.

Today, the true impact of social media on our society cannot be adequately discussed without understanding the history of programs such as Facebook and Twitter. The roots of these social networking services lie in the rise and fall of other predecessors, each more influential than the last. The first social networking site, launched in 2002, was Friendster.³ LinkedIn.com, a more business-oriented networking site, was launched in 2003. Myspace.com transitioned from an online data storage site to a social networking site the following year. Facebook was also launched in 2004 but was exclusive to Harvard students at

the time. Subsequent expansion allowed students of all Ivy League colleges (and, later, other US universities) to join, provided they registered with an e-mail address carrying an “edu” domain name. Membership to Facebook.com has since progressed and is now available worldwide to registrants age 13 and older who have a valid e-mail address. Twitter, a microblogging service, was the most recent network to gain extreme popularity; it was made public in 2006.

Social networking sites have had an undeniable impact on American culture, but there has been a lack of research regarding the impact of social media on the practice of plastic surgery. We have probably all heard references made to utilizing social media at regional and national plastic surgery conferences, and we know that a significant number of patients between the ages of 20 and 50 are obtaining knowledge on plastic surgery from the Internet for subsequent decision making,⁴ but no formal, data-driven evaluation exists about how this valuable modality is being incorporated by aesthetic surgeons. To that end, we evaluated the prevalence of both classic and social media outlets in plastic surgery and compared how they were being utilized to market aesthetic practices/procedures.

METHODS

An Internet search was conducted through Google.com with the phrase “plastic surgery” entered concurrently with the name of one of seven cities we identified as being sites of high-volume plastic surgery: Beverly Hills, California; Dallas, Texas; Houston, Texas; Las Vegas, Nevada; Miami, Florida; New York City, New York; and San Francisco, California. The Web site address of each resulting cosmetic provider was recorded. To avoid inconsistency, providers from surrounding cities were not included in this study, nor were providers who practiced exclusively in a hospital setting. For the purposes of this study, Web sites including three or more cosmetic providers were considered larger multisurgeon groups and were not included in the data, as applying the same social media membership to all corresponding surgeons would be inaccurate. The search for cosmetic surgeons in each city was considered complete when 30 consecutive results no longer yielded new providers.

Each Web site was evaluated for the existence of Facebook, Twitter, or MySpace links, as well as the presence of a blog. Promotions of classic media (magazine articles, newspaper articles, or television appearances) in which the aesthetic surgeon was featured were also recorded. The results from each site were categorized by geographic location. Of note, although many aesthetic surgeons maintain personal Facebook or Twitter sites, these are not for practice marketing and were not included in this study. To study the trends of new Facebook and Twitter memberships among cosmetic providers, the date on which each practice joined the social media provider was also recorded.

Table 2. Social and Classic Media on the Practice Web Sites of Surgeons in Seven US Cities^a

		Beverly Hills, CA	Miami, FL	San Francisco, CA	Las Vegas, NV	Houston, TX	Dallas, TX	New York City, NY
Surgeon-to-resident ratio		1:340	1:8329	1:17,348	1:20,272	1:33,204	1:40,192	1:71,725
Social media	Facebook, %	35	50	34	21	35	27	39
	Twitter, %	35	46	28	11	22	9	30
	MySpace, %	6	10	0	4	1	0	2
Classic media	Television appearances, %	54	33	19	29	28	18	34
	Magazine/newspaper features, %	39	27	17	36	29	17	56
Blog, %		31	27	17	32	25	25	33

^aResults are displayed as percentages of cosmetic providers who promoted media on their Web sites. A surgeon-to-resident ratio is provided to demonstrate the differences in competition density between each city.¹¹ The numbers in bold indicate the city with the largest number of providers for each respective social media category.

RESULTS

Differences in Social Media Utilization

There was a clear difference among the cities in terms of social media utilization by plastic surgeons in each location. In comparison to aesthetic surgeons of other cities, those practicing in Miami, Florida, favored the social media the most, with 50% featuring a link to Facebook and 46% to Twitter (Table 2). The proportion of aesthetic surgeons in Beverly Hills, Dallas, Houston, New York City, and San Francisco who linked to Facebook ranged from 27% to 39%, with a range of 9% to 35% for Twitter. Interestingly, the percentage of aesthetic surgeons in Las Vegas who utilized Facebook and Twitter was remarkably less (21% and 11%, respectively) in comparison to plastic surgeons from other cities. The percentage of cosmetic surgeons who promoted a blog was generally comparable among all cities, ranging from 17% to 33%.

Differences in Classic Media Utilization

The promotion of classic media also varied between aesthetic surgeons in different cities. Fifty-six percent of New York City aesthetic surgeons promoted magazine and newspaper articles in which they had been featured on their Web sites, perhaps because this city has such strong roots in press relations. Aesthetic surgeons in Beverly Hills had the largest proportion of television appearance promotions on their Web sites (54%). This is likely because there are more opportunities to be featured on television. (For example, *Dr. 90210*, a popular show, is filmed in Beverly Hills.) The proportion of aesthetic surgeons who promoted their classic media features was comparable among the remaining cities (range, 17%-39%).

Trends in New Social Media Memberships

An increase in the number of new Facebook memberships among cosmetic providers in the seven cities began in October 2008 and reached a peak in October, November, and December 2009, with 43 new memberships within this three-month interval (Figure 1). The numbers subsequently decreased and stabilized at approximately 20 new memberships every three months. An increase in the number of new Twitter memberships began in July 2008 and remained at a steady rate of approximately 15 every three months. An independent review of Twitter users did not parallel this growth pattern; rather, it demonstrated continued expansion from January 2009 to August 2010.⁵

DISCUSSION

In the modern “virtual” world, business owners—including aesthetic surgeons in private practice—have found it beneficial to enhance their visibility to potential consumers through social media networks. Web sites such as Facebook, which is free, provide a cost-effective portal for disseminating readily accessible information.⁶ Even plastic surgeons who have been in practice for many years have made an effort to connect with a new generation of patients who text and “tweet.” Furthermore, the American Society for Aesthetic Plastic Surgery (ASAPS) and the American Society of Plastic Surgeons (ASPS) have also found value in promoting social media and now have links to Facebook and Twitter that encourage visitors to “interact” with these professional organizations. Select articles from *surgery.org* are highlighted on the ASAPS Facebook page approximately twice per day, thereby potentially increasing the size of the audience for the same information. An attractive feature of social networking

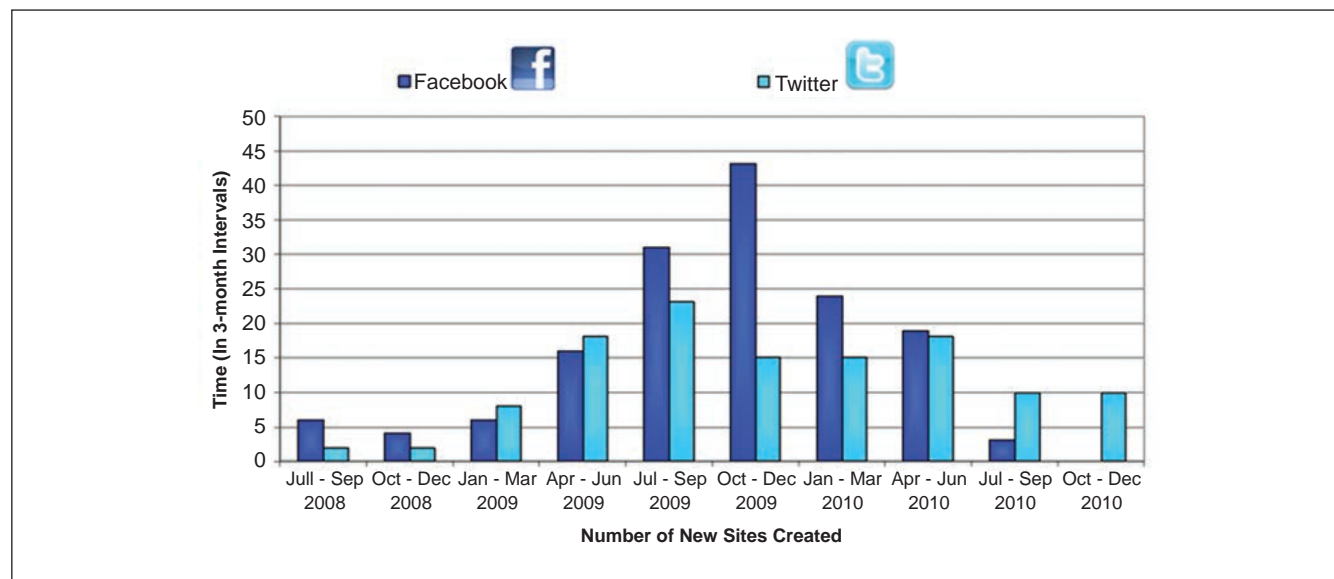


Figure 1. Trends in new memberships to Facebook and Twitter among cosmetic surgeons in Beverly Hills, Dallas, Houston, Las Vegas, Miami, New York City, and San Francisco.

sites is their convenience; it takes mere minutes to relay information to patients with a simple post.

Within the past two years, a number of surveys have been conducted to investigate the common characteristics among patients who utilize social media networking. These patients tend to be younger, employed, and educated.^{4,7} Also, 59% to 70% of these patients stated that they would use the Internet as a source of information on plastic surgeons and surgical procedures.^{4,8,9} All of these studies came to a similar conclusion: the number of patients utilizing the Internet is significant and rising; thus, it is important for cosmetic surgeons, as business owners, to connect with this patient population by becoming educated about and involved in social networking. Understandably, plastic surgeons who have already tapped into the social media network are more likely to update their Web sites frequently, thereby increasing the dynamic content on their sites and enhancing their rankings by top search engines.¹⁰ This may offer an explanation about why Web sites that promoted social media appeared within the first three pages of search engine results during our study, whereas those that did not appeared after the tenth page. However, this observation may reflect a study bias and warrants future evaluation.

Social media may seem like a new and unique communication tool, but it is important to apply traditional, well-established Web site-building principles to these sites.¹¹ Plastic surgeons must strive to maintain clear branding with any site involving their practice, regardless of whether a specific template must be used (as determined by a proprietary Web site platform). An appropriate target audience should be defined to clarify the focus of the Web site. Taking advantage of social media as a means to contact existing patients, rather than attempting to

increase practice volume, is one strategy. Another common function is to use the Facebook or Twitter page for posting links to press-related plastic surgery events and special discount offers. In this study, blogs were used by a number of plastic surgeons primarily as a tool for educating patients on various plastic surgery procedures. Any of these approaches are reasonable and effective for a plastic surgery practice, but determining the goal ahead of time will help to streamline the page and appropriately target certain populations.

When revolutionary technological advances come along with medicine, it is inevitable that people will question whether appropriate ethical conduct is being exercised. Social media sites have been perceived as problematic and even detrimental to the patient-doctor relationship. The “extraneous” correspondence that takes place on these sites (outside the confines of a clinic or office) may potentially pose a threat to privacy, minimize the value of individual patient care, and provide personal patient information not intended for public consumption.¹² Concern for these risks has forced hospitals and medical schools to adopt guidelines regarding the online networking activities of providers, nurses, and medical students. As most plastic surgeons in private practice do not have institutional policies, we must make a special effort to maintain high ethical standards and sustain our integrity. Preserving professionalism and adopting appropriate caution with social media networks is possible when we adhere to a few caveats. First, communication through these sites should never serve as a substitute for an office visit or telephone call.^{6,13} One previous study showed an apparent lack of information regarding possible complications and postoperative care on Web sites intended to target potential patients.⁸ As such, a reliance on physician-patient

communication via the Web should not be encouraged, as proper informed consent (and documentation of such contact) can only occur in the office setting. This type of consultation still remains the gold standard for appropriate physician-patient exchanges and for combating potential litigation. Second and most important, protected health information should remain private at all times, as a breach in confidentiality can result in litigation for compensation, termination from work, and disciplinary measures by licensing boards.^{7,14}

It is expected that Internet-based marketing with social media will continue to grow in tandem with the public popularity of these Web sites. Interest in Facebook itself reached a new pinnacle with the October 2010 release of a movie about its founders—one of whom, Mark Zuckerberg, was also named *Time* magazine's 2010 Person of the Year. The Internet has had a phenomenal impact on the way the general public approaches health care, as over 60% of potential patients turn to the Web as a primary source of physician and procedural information.⁹ Our data show that the plastic surgery community has already taken these trends into account, and surgeons are continuing to establish new Web site memberships to enhance their practices. Further evaluation of the success of these online profiles at increasing practice volume and community presence will indicate whether social media are a true influence on tomorrow's marketplace. If the number of new social media accounts found in our study is any indication, we can expect Web sites such as Facebook and Twitter to continue thriving in the plastic surgery market. Aggressive direct marketing campaigns via social media were not noted at this time, but it would not be surprising to see plastic surgeons take this next step to recruit new patients in the years to come.

This is the first focused evaluation of the growth and prevalence of social media in the plastic surgery community. As a follow-up, we are currently studying the association between search engine ranking and social media presence, as well as whether social networking is the best form of exposure for US plastic surgeons. Subsequent data will enhance our understanding of the complex impact that social media have had on our generation.

CONCLUSIONS

Social media marketing is highly relevant in today's general marketplace, and the level of utilization is increasing in the world of aesthetic surgery. Our data showed that, to connect with the millions of patients who network via the Web, a growing percentage of plastic surgeons have joined social networking sites. Although it is still uncertain how much of a role social media will play in future medical communication, many plastic surgeons have already found these portals to be useful for patient education, practice marketing, and clinic branding.

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“What Not to Wear” and Other Aspects of Professionalism

Foad Nahai, MD, FACS

In a recent editorial, I discussed medical professionalism in the context of patient-centered care, a well-recognized concept in today’s health care environment. But as I read the two excellent guest editorials on cosmetic surgery training in the United Kingdom and the United States appearing in this issue of *Aesthetic Surgery Journal*—authored, respectively, by medical students Mr. Joseph George¹ (with Dr. Beryl deSouza) and Mr. Kyle Edwards² (with Dr. Clyde Ishii)—I am reminded of the many facets of professionalism about which some trainees (not necessarily the above-mentioned authors) and young doctors remain as yet blissfully unaware.^{1,2}

Most medical students understandably are focused on the clinical aspects of their training. In fact, clinical knowledge and technical proficiency undoubtedly overshadow every other thought in a young doctor’s mind as he or she prepares to navigate the challenging terrain of medical/surgical practice. While a key issue such as patient-informed consent is presumably on the radar screen, issues such as professional courtesy, operating room (OR) behavior, and even “what not to wear” seldom make the top 10 list of “Things I Need to Remember When I Become a Doctor.” Yet these are in fact important aspects of professionalism that deserve more attention than they currently receive in the education of young surgeons.

DON’T UNDERESTIMATE THE IMPORTANCE OF PROFESSIONAL COURTESY

As plastic surgeons, all of us have had the experience of working with a variety of medical colleagues in the course of providing patient care. Some of these experiences are highly positive, while others may fall short of expectations—either ours or theirs. There are countless examples of situations in which we have the opportunity to exhibit professionalism in our dealings with other medical personnel—whether doctors, nurses, technicians, or hospital administrators. How we handle these situations, both in and out of the OR, not only reflects our personal professionalism but also contributes to the general reputation of our specialty.

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A published statement on interprofessional relations issued by the American College of Surgeons reminds us that “team medicine has become the norm.”³ In plastic surgery, nowhere is this more evident than in the burgeoning field of postbariatric body contouring. Plastic surgeons seeking to help patients complete their journey from obesity to normalcy often work with a team of professionals, including bariatric surgeons, internists, anesthesiologists, nutritionists, and even mental health professionals. To a great extent, the ultimate success of our surgical enterprise depends on the effective coordination of patient care among all these individuals.

Beyond basic cooperation, professionalism means being both respectful and responsive. I doubt that there is one among us who has not occasionally been frustrated by waiting for the electrocardiogram report that never arrives and having to deal with a personal physician who seems not in the least concerned that our mutual patient’s surgery is scheduled for tomorrow and medical clearance is still pending! Usually such unresponsiveness is due to office inefficiency of which the physician is not even aware, but repeated offenses can lead to a perception of unprofessionalism. Every physician and surgeon should instruct their office staff that communications between doctors have the highest priority—whether it’s the delivery of a requested report, a timely response to a personal phone call, or other matters involved in the delivery of quality patient care.

When a professional courtesy is extended, it should elicit a reciprocal response. In today’s Internet age, referrals from physicians may be a less important source of cosmetic surgery patients than in the past, but such referrals still require careful attention to professional etiquette. Whether it is by phone or a personal note, a physician deserves to know that his or her referral patient has been seen and evaluated. Yet it is surprising how often this simple act of professional courtesy is overlooked.

Sometimes a plastic surgeon’s patient may come to see me for an opinion on a problem perceived to be the result of an unsuccessful surgery. We have all been at both ends

of this situation one time or another. In such cases, I always inform the original surgeon (unless the patient asks that I refrain from doing so). I consider this not only a matter of professional courtesy but also one of benefit to the patient, whose interests usually will be best served by returning to the operating surgeon for a resolution of the problem.

These are only a few examples of how professional courtesy plays an important role in our practices and in our relationships with colleagues, other specialists, and patients.

TREAD LIGHTLY IN THE OR

In the “old days,” despite the overriding atmosphere of seriousness in the OR, a relaxed moment might be an opportunity to try out your latest slightly-indelicate joke or at least kid around with the nurses and other attending staff in a casually familiar way. Today, while a sense of OR camaraderie still thrives, medical professionals have become increasingly sensitive to maintaining certain boundaries in their OR behavior.

The legal definition of harassment can conceivably include a range of behaviors that some might regard as innocuous but that nevertheless are inappropriate in a professional setting. Creating an uncomfortable working environment on the basis of personal attributes (sex, race, religion, etc) is obviously reprehensible, but one must be aware that the threshold for discomfort varies considerably among individuals. What seems like a harmless quip to one person may be deeply insulting to another. Needless to say, acts of aggression or intimidation, whether overt or subtle, have no place in the patient care environment. While sometimes it is necessary to be firm in commanding the OR team, especially in response to a crisis situation or to the failure of a team member to fulfill his or her responsibilities, there is never an excuse for “losing it” (using abusive language, throwing instruments, etc) in the heat of the moment.

Perhaps the most important aspect of OR behavior is consideration for the patient. With a patient under anesthesia, medical professionals in the OR should never engage in conversation that could not take place if the patient were conscious. Comments concerning the patient’s body shape or weight, deformities or conditions, or personality or behaviors for the sake of banter or ridicule are offensive and unacceptable. Exposure of the patient’s body should be limited to the parts needed and to the required personnel only. In every way possible, the patient’s right to privacy should be respected.

Patients should be informed if the primary surgeon plans to allow another surgeon to perform a significant part of the operation. Patients also have the right to know if their operation will be observed by trainees or anyone other than the operating team; they should be given the opportunity to provide or withhold their consent. The merits of teaching do not lessen the surgeon’s responsibility to respect the privacy and rights of patients.⁴

OBSERVE THE UNSPOKEN RULES OF WHAT NOT TO WEAR

It may seem like a physician’s attire is among the least important aspects of professionalism. However, several studies have suggested that what a physician wears may affect patients’ perceptions of competence, even if patients are not consciously aware of their preferences. One study found that patients had a higher opinion of competence when residents wore a white coat compared to more casual dress.⁵ A similar study in Hawaii revealed that patients were more accepting of informal attire, but extremes such as shorts and flip-flops still were not approved by the majority of them.⁶

On a personal note, I recall a couple of incidents with medical students and residents who appeared for rounds dressed in a manner that I considered unprofessional. In one instance, the young man thought I was joking when I told him I would be unable to take him on rounds with me. In the other case, a medical student was actually offended and took the matter up with his surgical tutor! Though both these examples involved young men, inappropriate dress can be a problem for women professionals as well. An article appeared a few years ago in *The New York Times* entitled “When Young Doctors Strut Too Much of Their Stuff.”⁷ While it focused, perhaps unfairly, on female physicians who wear provocative clothing on the job, the point that patient confidence can be negatively affected by an unprofessional appearance is applicable across the board. I feel as strongly today as I did 20 years ago when I asked a resident wearing no tie and a dirty white coat and a medical student wearing sneakers to wait in the hallway during rounds—that neat, clean, and appropriate attire is essential for any medical professional.

THERE’S ALWAYS SOMETHING TO LEARN

While young doctors perhaps have the most to learn about professionalism, that doesn’t mean that older physicians (and I include myself in this category!) don’t need a refresher course. As many of us seek to fulfill Maintenance of Certification requirements, not only our continued competence but our professionalism will be under scrutiny. In fact, a letter attesting to our professionalism (or lack thereof) from our hospital chief of staff goes directly to the American Board of Plastic Surgery as part of the certification process.

Even more important, we have a responsibility to our patients and our colleagues to exemplify the highest standards of professionalism. I believe that the majority of plastic surgeons fulfill this lofty goal on a daily basis and in every aspect of their work, but it never hurts to reexamine old habits—just to make sure that we are taking every precaution against even the suggestion of unprofessional conduct.

It is my observation that, for the experienced surgeon, arrogance and impatience are perhaps the two most insidious enemies of professionalism. Arrogance is an affectation that can arise from a misplaced sense of confidence or, in some instances, from a lack of genuine confidence.

Impatience is often habitual, and we may not even realize that we are exhibiting such behavior with staff and even with patients. There are, of course, situations in which our impatience is entirely justified. Nevertheless, cultivating an attitude of calm in dealing with the inevitable irritations, errors, and delays involved in our day-to-day dealings with colleagues and staff not only helps keep our blood pressure down but also creates a work environment based on mutual respect. By nurturing such an environment based first on our observance of professional behavior, we help to ensure the optimal environment for quality patient care. That, ultimately, is the overriding goal of medical professionalism—to serve the best interests of our patients.

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Cosmetic Surgery Training in the United States

Kyle Edwards; and Clyde Ishii, MD

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Cosmetic surgery training in the United States continues to evolve, with noticeable improvement having occurred over the past several years. As expected, the curriculum at the medical school level remains fairly stable with regard to cosmetic surgery exposure. Medical students spend most of their early years learning the basic sciences. Students may seek out clinical experience in plastic surgery during their free time through shadowing or research. Their exposure to plastic surgery in general and cosmetic surgery in particular is largely determined by whether their hospital system has a plastic surgery training program, whether there are staff surgeons who are willing accommodate student training, and ultimately, the amount of free time the students themselves possess.

The medical school curriculum during the clinical years has a strong focus on primary care. In some instances, medical students may find themselves spending their entire surgery clerkship in general surgery, with limited exposure to the surgical subspecialties. The final year of medical school offers the greatest opportunity for those students with a plastic surgery career path in mind. Although students must abide by certain requirements, they may seek out plastic surgery rotations at their home institutions or participate in “externships” in plastic surgery programs at separate institutions.

Several national plastic surgery organizations have established medical student groups for those interested in pursuing plastic surgery. For instance, the American Society for Aesthetic Plastic Surgery has a Medical Student Group at its website (<http://www.surgery.org/professionals/medical-students>), as well as a listing on its Facebook page. These sites contain information pertinent to medical students, articles from the *Aesthetic Surgery Journal*, and selected sessions from the annual meeting available for download. Medical students are offered complimentary admission to the national meetings, and special programs have been established to assist students with an interest in plastic surgery.

Admission to a US plastic surgery residency is very competitive. There are 71 accredited plastic surgery training programs across the United States and many more applicants than available positions. Over the past several

years, there has been a movement to improve cosmetic surgery training during the residency. In 2006, Morrison et al surveyed program directors and their senior residents on the status of cosmetic surgery training in their plastic surgery residency programs.¹ This survey revealed that 76% of the program directors felt that their senior residents were satisfied with the cosmetic surgery portion of their training but only 51% of senior residents felt satisfied with their cosmetic surgery training and 36% felt that a cosmetic surgery fellowship would be helpful. Program directors and residents agreed that resident cosmetic clinics provided a vital part of cosmetic surgery training. Of those polled, 64% reported participating in a resident cosmetic clinic. Based on the findings of the survey, the authors offered several recommendations for improving cosmetic surgery training in the United States. These suggestions included establishing a nationally-standardized core curriculum in cosmetic surgery, including a resident clinic in all training programs, and developing postgraduate cosmetic surgery fellowships. Following this 2006 survey, plastic surgery residencies were lengthened by one year, and training in cosmetic surgery was enhanced through the Association of Academic Chairmen in Plastic Surgery.

In 2009, a second survey was conducted by Oni et al as a follow-up to the Morrison study.² Of those contacted, 48% of program directors and 29% of senior residents responded to the survey. Seventy percent of program directors were “satisfied” or “very satisfied” with the cosmetic surgery training in their program, as compared to 57% of senior residents. The same percentage of residents reported participating in a resident clinic. Compared to the 36% of senior residents in 2006 who felt that a postgraduate cosmetic sur-

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gery fellowship would be beneficial, only 31% of residents felt the need for such a fellowship in the 2009 survey. There are now 19 cosmetic surgery fellowships in the United States. A core curriculum for these postgraduate fellowships has been developed by the American Society for Aesthetic Plastic Surgery. Twelve of these fellowships are always one year in length, three are always six months, and three are either six or 12 months in duration. The results of the studies cited above suggest that training in cosmetic surgery has improved since 2006 but further progress is still welcome. Since aesthetic surgery remains such a vital component of most plastic surgery practices, comprehensive training in the formative years before practice is essential.

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Cosmetic Surgery Training in the United Kingdom

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To an average uninitiated UK medical student thrown headlong into the world of hospital medicine, the world of plastic surgery might seem to belong to pinstriped glory-hunters seeking financial rewards, if his or her experience of the specialty is derived solely from popular mass media. One certainly hopes that this perception would drastically change by the time that the student completes three years in clinical medicine, but without proper training, this isn't always the case.

Knowledge of our specialty is important to any surgical trainee, as it deals with the science and art of wound healing. The basic principles of wound healing and aesthetics are useful for all specialties, not just cosmetic surgery. Appropriate understanding of the plastic surgeon's role allows for more effective referrals to the department of plastic surgery. In addition, the surgical management of skin cancers is undertaken by plastic surgeons in collaboration with their dermatology colleagues, so establishing a cooperative relationship during training is essential.

Exposure to our specialty in medical school can be instrumental in allowing students to make an informed choice in terms of their career path. Inspiring mentors can attract students, and contact with plastic surgeon role models can go a long way toward encouraging students in a particular specialty. Medical students can then direct their extracurricular efforts to their specialty of choice.

Green and May,¹ in their survey of plastic surgery residency applicants, concluded that exposure to the specialty during training was the most influential factor in helping medical students decide to embark on a career in plastic surgery. They also emphasized the importance of having this exposure before the third year of medical school. In the United Kingdom, the time spent in surgical training has been shortened as a result of the European Working Time Directive and the Modernising Medical Careers reforms, so it has become particularly advantageous for trainees to make an early choice of career pathway, even during medical school.

To address the shortcomings in the undergraduate courses, student-led surgical societies in the United Kingdom regularly conduct practical workshops and lecture-based

tutorials for the benefit of their undergraduate members. For example, Imperial College School of Medicine Surgical Society offers "Basic Surgical Skills for Medical Students," a series of practical workshops in plastic surgery techniques taught by plastic surgery trainees and well-recognized lecturers. The thrill of learning suturing methods and performing basic flaps and Z-plasties on animal skin is a major attraction for many. The society is also offering, on a trial basis, weekend seminars on underexposed surgical specialties (eg, plastic surgery). These programs provide students with time in the operating theater when the weekend teams are on call. The British Association of Plastic Reconstructive and Aesthetic Surgeons also supports students undertaking research or electives in plastic surgery through their "elective awards."

Although such adjunct programs are important in furthering the specialty, it is incumbent upon medical schools to educate students about all potential specialties and subspecialties, including plastic surgery. Some schools are fulfilling that duty; Imperial College London offers three-week optional special study modules in plastic surgery (hand surgery and craniofacial surgery). Granick et al² discussed the need for required clinical clerkships in American schools, which has led to an improvement in student awareness of plastic surgery in the United States. However, more can be done in both the United Kingdom and the United States by way of incorporating plastic surgery rotations within the curriculum as a starting point. As

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plastic surgeons, we must be the ambassadors of our specialty, encouraging medical students to explore the world of cosmetic surgery and supporting them as they make informed choices in their surgical careers.

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Back to Basics: Understanding the Terminology Associated With Light- and Energy-Based Technology

Michael I. Kulick, MD

How do we make sound decisions about when to acquire new technology in our clinics and which devices will most benefit our patients? There are many options but no formula or algorithm that works for every practice.

Light- and energy-based devices provide us with many treatment alternatives, including options for hair reduction, vascular and pigmentation corrections, contour improvements for fat deposits, and nonsurgical wrinkle reduction. However, the sheer scope of the engineering advancements associated with these devices places a burden on the physician in terms of research and understanding. The companies promoting these technologies invest considerable resources in direct-to-consumer marketing to highlight their solutions to patients' aesthetic concerns, but how do we as clinicians make a decision to incorporate a device into our practices?

The first step is to evaluate our patient population and our budget. Next, we should evaluate our goals: Will this device allow us to provide a new service to our current patient base, or is it intended to attract new patients? A significant element in the decision process is our understanding of the mechanisms behind, and efficacy associated with, a particular technology or device. To this end, the American Society for Aesthetic Plastic Surgery (ASAPS) offers web-based presentations, printed literature, and peer-reviewed studies (through *Aesthetic Surgery Journal*) as a foundation for education. Spending time with the manufacturer's representatives can also provide valuable information. During any presentation from a manufacturer, be sure to remain wary of claims that seem unsubstantiated. Most important, be sure to fully understand the Food and Drug Administration clearance specifications and request supporting documentation when terms such as *clinically proven* are used. Speaking with other physicians who currently own the device can also be helpful. Another source of information is afforded by attendance at meetings, where such tools are displayed in the exhibit hall. Sometimes actually seeing the device and other alternatives can clarify questions.

During the educational process about any device, we are exposed to many viewpoints, which may lead to confusion. Because we rely so heavily on studies published in the literature along with the presentations made by manufacturers and the comments made by colleagues to facilitate our decisions, opportunities exist for misinterpretation of the semantics. Companies are also frustrated by what they feel are occasional overstatements regarding efficacy claims, and statements made in marketing materials can be misunderstood. For example, claims of "no downtime" may result from a device's comparison to another existing technology that is similar but not identical. In these cases, we need to question the validity of the comparisons and ask specifically, "What does 'no downtime' really mean to me and my patients?"

In order to foster fair, standardized, and impartial discourse about devices, the terminology associated with reporting data and marketing in the aesthetic field is in need of clarification. However, even among plastic surgeons, there is often a lack of consensus about the words describing our procedures, techniques, and results. There currently exists a list of standardized terminology in medicine, the Systemized Nomenclature of Medicine (SNOMED),^{1,2} which provides a list of terms and definitions. However, one study showed that when three ophthalmic plastic surgeons tried to apply these terms to their practice, the majority of aesthetic concepts were not represented.³ Furthermore, the lack of uniform terminology in the "claims" reported in the cosmetic industry (specifically, those related to topical creams) and the lack of regulation by the US Food and Drug Administration has

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contributed to misunderstandings and unrealistic expectations by patients and physicians.^{4,5}

To facilitate a baseline for communication in the aesthetic realm, the Light- and Energy-Based Therapies Subcommittee of ASAPS (Figure 1) has identified a list of terms utilized by companies to promote their products. The initial focus was on terms associated with the recovery process. After coming to a consensus, the subcommittee forwarded these terms and definitions to the ASAPS board for approval. This list will be provided to manufacturers in the aesthetic industry, who can to incorporate these definitions in their collateral and marketing efforts. The committee also stressed the importance of standardized photography in marketing. In addition to having standardized lighting and patient positioning, the subcommittee advises that pre- and posttreatment photographs be labeled with the patient's age and the name of the device (on the pretreatment photo), along with the number of treatments performed, the application of other modalities in the patient's treatment, and the length of time after the last treatment at which the patient is shown (on the posttreatment photo). While companies are not required to abide by the subcommittee's recommendations, the subcommittee strongly believes that cooperation by the manufacturers will help facilitate acceptance/adoption of their devices, since physicians will be able to understand their claims more readily. In addition, those companies that do abide by the recommendations will be acknowledged at the ASAPS annual meeting.

The following is a list of the terms approved by the subcommittee and the ASAPS board.

Downtime—indicates the expected time after which a patient can resume his or her normal lifestyle.

- Essentially no downtime: less than 24 hours
- Minimal downtime: 24 to 72 hours
- Moderate downtime: three to seven days
- Significant downtime: more than seven days

Bruising—ecchymosis that is visible on the skin without concealer applied.

- Essentially no bruising: no ecchymosis/bruising, but patients may have some immediate change in skin tone
- Minimal bruising: ecchymosis that resolves in less than one week
- Moderate bruising: ecchymosis that resolves in one to two weeks
- Significant bruising: ecchymosis that takes more than two weeks to resolve

Redness—skin demonstrating increased redness without concealer applied.

- Essentially none: skin returns to normal (pretreatment or improved) coloring in less than 24 hours, but patients may have some immediate change in skin tone
- Minimal: hyperemia that resolves in one to three days
- Moderate: hyperemia that resolves in four to seven days
- Significant: hyperemia that takes more than seven days to resolve

Swelling—obvious swelling in the treated areas.

- Essentially none: swelling that resolves in less than three days
- Minimal: swelling that resolves in three to seven days
- Moderate: swelling that resolves in eight to 14 days
- Significant: swelling takes more than 14 days to resolve

Pain—discomfort/pain associated with treatment.

- Essentially none: no pretreatment medication, local anesthesia during treatment, or posttreatment pain management is required; over-the-counter medications may be applied
- Minimal pain: requires pretreatment oral medications (prescriptions), topical agents and/or skin cooling during treatment, and/or posttreatment prescriptions for pain management
- Moderate pain: same requirements as “minimal pain” but with pretreatment local anesthesia needed to obtain anticipated results
- Significant pain: same requirements as “minimal pain” but with pretreatment intravenous sedatives or general anesthesia needed to obtain anticipated clinical results

The subcommittee is hopeful that marketing materials and photographs presented by manufacturers will incorporate these definitions and standards to help reduce confusion. Its recommendations should be perceived as a step toward helping physicians better understand the recovery process associated with any device. Other potentially-confusing terms will be added to this list as the subcommittee moves forward to develop a full and comprehensive nomenclature. We all—industry manufacturers, physicians, and patients—are best served by a full understanding of the technologies and a standardized list of terms associated with them.

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Staff Liaison - Debi M. Toombs

Figure 1. The Light- and Energy-Based Therapies Subcommittee of the American Society for Aesthetic Plastic Surgery.

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Aesthetic Outcomes of Labioplasty

Christine Hamori, MD, FACS

The existing techniques for reduction of protuberant labia minora (ie, labioplasty) were well reviewed by Tepper and Matarasso in the July 2011 issue of *Aesthetic Surgery Journal* (31:511-512). However, I would like to address the potential limitations of the modified “star” technique they presented.

Patients requesting labioplasty in my practice are concerned primarily with the appearance of their genital area. Specifically, they would like to have minimal (if any) postoperative labia minora “show” beyond the majora on standing view. Resection techniques that address the redundant minora centrally but not the persistent laxity between the anterior labial commissure and the labia minora give patients the appearance of excess clitoral hood and, in my opinion, cause a visual imbalance in the area. No standing views were shown in Drs. Tepper and Matarasso’s article, but in my experience, this persistent anterior fullness would be troublesome to most patients upon standing.

I have performed approximately 280 primary labioplasties in my practice, mostly utilizing the techniques described by Gary Alter. Of the secondary labioplasties I have performed, most of the original surgeries were performed with a variant of an edge technique resulting in cosmetic dissatisfaction. These patients complain of feeling like they have a “penis” of tissue anteriorly. I believe that edge techniques with minimal wedge resections cause superior retraction of the upper labia minora and clitoral hood, giving this area the appearance of excess fullness as compared to the resected portion.

Correction of anterior fullness is difficult and requires potentially visible incisions near the clitoral hood and the anterior labial commissure. Prevention of this postoperative imbalance may perhaps be addressed by widening the wedge of the modified “star” suggested by the original authors or adding the hockey-stick modification described by Dr. Alter.¹ As more attention is paid to the postoperative desires of these patients, I believe our surgical techniques will continue to evolve for the better. More research is needed to define the desired postoperative appearance in this area.

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Authors' Response

Oren M. Tepper, MD; and Alan Matarasso, MD

We would like to thank Dr. Christine Hamori for the comments regarding our article "Labioplasty: Anatomy, Etiology, and a New Surgical Approach" in the July 2011 issue of *Aesthetic Surgery Journal* (31:511-512). Dr. Hamori's comments—specifically, her observation that "resection techniques that address the redundant minora centrally but not the persistent laxity between the anterior labial commissure and the labia minora give the patients the appearance of excess clitoral hood and cause a visual imbalance in the area"—underscore the importance of a versatile technique and validate our approach. In comparison to a standard wedge excision, the modified "star" technique provides the surgeon with another option that adds greater flexibility in removing additional tissue anteriorly, thus actually avoiding the anterior fullness that Dr. Hamori points out as undesirable to patients.

It should be noted that the illustration of the modified "star" technique published with our article was intended to show the general shape/markings of the technique. The relationship of the various limbs is rarely equidistant and symmetrical (as illustrated) but rather is adjusted according to the specific areas of labial excess. This enables the surgeon to tailor the incisions to the patient's anatomy and is one of the important advantages with this technique. Dr. Hamori raises an important point about achieving satisfactory results when the patient is in a standing position, and

this is an important factor in postoperative assessment. In light of her extensive insight, we encourage Dr. Hamori to contribute her experience to the literature.

Disclosures

Dr. Jewell is a paid consultant for Mentor, Inc. (Santa Barbara, CA); Allergan, Inc. (Irvine, CA); Medcis Pharmaceutical (Scottsdale, AZ); Kythera Biopharmaceuticals (Calabasas, CA); Sound Surgical Technologies (Louisville, CO); and Excaliard Pharmaceuticals, Inc. (Carlsbad, CA). He is a paid adviser for Allergan; Medcis; COAPT Systems, Inc. (Palo Alto, CA); Sound Surgical; AorTech Biomaterials (Rogers, MN); Keller Medical, Inc. (Stuart, FL); and New Beauty Magazine (Sandow Media Corporation; Boca Raton, FL).

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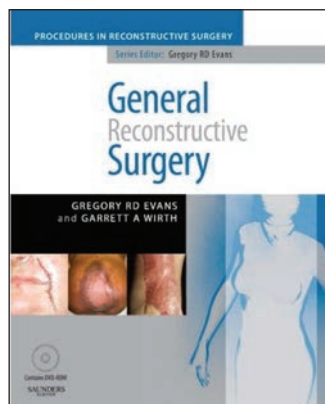
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Book Review



Gregory R. D. Evans, MD, and Garrett A. Wirth, MD. *General Reconstructive Surgery*. Procedures in Reconstructive Surgery Series. Philadelphia, PA: Saunders Ltd; 2008. Hardcover and DVD. ISBN-10: 0702029254. ISBN-13: 978-0702029257.

Reviewed by: Jeffrey E. Janis, MD, FACS
DOI: 10.1177/1090820X11421906

One of the most useful books on my shelf, especially as I prepared for cases in the operating room or studied for the oral American board exams, was *Operative Plastic Surgery*, published in 2000 by McGraw-Hill and edited by Dr. Greg Evans. That textbook was a commonsense, organized, relevant approach to many of the bread-and-butter procedures in plastic surgery. To this day, I cite it as a necessary volume to those who ask for recommendations. I recently read the follow-up text *General Reconstructive Surgery*, which was coedited by Drs. Evans and Wirth. This book is one of a four-volume set meant to update that classic book from almost 10 years ago. (The other three volumes—*Head and Neck Reconstruction*, *Hand and Upper Extremity Reconstruction*, and *Cosmetic and Reconstructive Breast Surgery*—are reviewed separately.) Dr. Evans served as the series editor for all four books, which adds consistency across volumes.

This 186-page installment is divided into 11 chapters with general topics such as lower extremity reconstruction; genital reconstruction, hip/pelvic wall reconstruction; and soft tissue reconstruction after cancer, burns, and pressure sores. It also contains specific chapters on melanoma, latissimus flaps for chest wall reconstruction, and lymphedema—even a chapter on suturing techniques, which is situated somewhat strangely as the last chapter in the volume, even though it is the most basic and perhaps the most universal subject matter.

Each chapter provides a general overview of the named topic, including concepts and principles as well as technical

aspects of fundamental procedures. The chapters are richly enhanced with clear photographs, color figures, tables, diagrams, and illustrations that reinforce the points addressed in the text. In several chapters (though not all) there are insets containing “clinical pearls,” which add nuance to the volume by providing tips and tricks to assist during execution of some of the techniques. These sections lend added value to the volume, and the book would be more powerful if all chapters included this convenient feature.

Although none of the chapters are exhaustive in their content, that is not the goal of the book. Rather, each chapter attempts to outline or highlight the existing information and then provide references to dive deeper into a particular subtopic. For those looking for a definitive “one-stop shop” tome, this is not the book for you. For those seeking an overview of basic reconstructive techniques in an atlas-type style, this fits the bill perfectly. An accompanying 15-minute DVD demonstrates procedures on tangential excision, skin grafting, and jejunal flap vaginal reconstruction, among others. Unfortunately, only three of the 11 chapters have this added video content. Perhaps the next iteration can provide more comprehensive video coverage, as this type of content is extremely valuable.

In sum, *General Reconstructive Surgery* is a valuable update to the classic from 2000 and, when considered as a set with its three sister volumes, provides clinically-relevant and practical information on many essential procedures in plastic surgery. That is its goal, and it hits the mark.

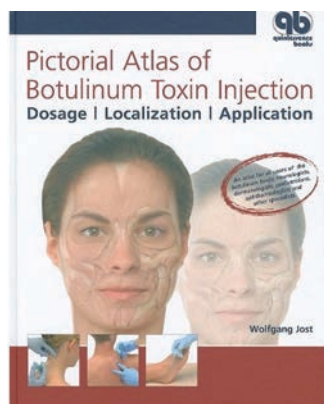
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Book Review



Wolfgang Jost, MD. *Pictorial Atlas of Botulinum Toxin Injection: Dosage, Localization, Application*. Hanover Park, IL: Quintessence Publishing Co; 2008. ISBN-10: 1850971757. ISBN-13: 978-1850971757.

Reviewed by: Mark Jewell, MD

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With his *Pictorial Atlas of Botulinum Toxin Injection: Dosage, Localization, Application*, Dr. Jost has compiled a detailed atlas of neurotoxin injection techniques. This is a complete volume covering injection locations for treating specific muscles, as well as the requisite injection technique for each area. It features a variety of superbly illustrated anatomical images, models, and demonstrations.

The first 180 pages deal largely with injection techniques applicable to psychiatrists and physical medicine practitioners treating musculoskeletal disorders with neuromodulators; the remainder of the text addresses injection techniques applicable for cosmetic medicine. From page 188 onward, there are excellent diagrams and images of injection techniques for the platysma and facial musculature. At page 244, injection techniques are detailed for hyperhidrosis of feet, axilla, and hands. While the majority of this atlas details injection techniques that address spasticity or “trigger points,” the part that is applicable to cosmetic medicine is worth the purchase as a reference and teaching tool.

This is an excellent reference atlas that will undoubtedly prove useful in helping injectors understand the recommended sites for toxin injection and doses of various toxins. Most of the techniques that Dr. Jost details are clearly off-label yet may be necessary to address the specific needs of patients. Dr. Jost gives excellent guidance in terms of recommended injection sites and dosages for some of the more esoteric or advanced cosmetic facial injection areas, such as the masseter. He also provides a physiological/anatomical background for his recommendations, which is both interesting and helpful. For example, I learned that even

after the masseter has been treated with neurotoxins, a patient still can chew through the action of the temporalis and the medial pterygoid muscles.

I was impressed with Dr. Jost's outline approach to the cosmetic use of neurotoxins in the face. These injection sites are well above the “danger zone” of toxin diffusion into the orbit and allow for predictable outcomes. Each diagram offers guidance on the ranges of toxin dosing for Dysport (Medicis Aesthetics, Inc., Scottsdale, Arizona), Botox/Botox Cosmetic (Allergan, Inc., Santa Barbara, California), and Xeomin (Food and Drug Administration approved; Merz Pharmaceuticals, LLC, Greensboro, North Carolina). One shortcoming is that the directions for use are not current, as compared to Food and Drug Administration-mandated updates pertaining to the boxed warning and medication guide (risk mitigation strategy) regarding diffusion. However, as clinicians, we all know that it is always better to consult the directions for use from the current product packaging than to rely on a textbook.

In our practice, we depend on detailed explanations of anatomy for operative management and injection therapy. This text is clearly the best that I have seen for written and visual explanations that will enhance the quality of neuromodulator injections.

Disclosures

Dr. Jewell is a paid consultant for Mentor, Inc., Santa Barbara, CA; Allergan, Inc., Irvine, CA; Medicis Pharmaceutical, Scottsdale, AZ; Kythera Biopharmaceuticals, Calabasas, CA; Sound Surgical Technologies, Louisville, CO; and Excaliard Pharmaceuticals, Inc., Carlsbad, CA. He is a paid adviser for Allergan; Medicis; COAPT Systems, Inc., Palo Alto, CA; Sound Surgical; AorTech Biomaterials, Rogers, MN; Keller Medical, Inc., Stuart, FL; and New Beauty Magazine, Sandow Media Corporation; Boca Raton, FL.

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Erratum

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Maricevich P, Gontijo de Amorim NF, Duprat R, Freitas F, Pitanguy I. Island Technique for Prominent Ears: An Update of the Ivo Pitanguy Clinic Experience. *Aesthetic Surg J* 2011;31:623-633. (Original DOI: 10.1177/1090820X11415975).

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On page 631, the authors' technique was incorrectly described as follows: "Instead, we attempted to build the cartilage island in a harmonious shape: narrow, long, curved, and in a continuous line with the tragus, as with a natural antihelix." Actually, the technique involves building the cartilage island in a continuous line with the antitragus.