Aesth Plast Surg (2018) 42:32–37
https://doi.org/10.1007/s00266-017-0965-1

ORIGINAL ARTICLE BREAST SURGERY

Capsular Contracture Rate After Breast Augmentation with Periareolar Versus Other Two (Inframammary and Transaxillary) Incisions: A Meta-Analysis

Shangshan Li[1] · Lin Chen[1] · Wenyue Liu[1] · Dali Mu[1] · Jie Luan[1]

Received: 22 May 2017 / Accepted: 18 August 2017 / Published online: 15 September 2017

Abstract

Background Capsular contracture has been the most common complication of cosmetic breast augmentation. The effect of incision pattern on capsular contracture is still unclear. This meta-analysis demonstrates current evidence with regard to the comparison of capsular contracture rate between periareolar and other two (transaxillary and inframammary) incisions.

Methods PubMed, EMBASE, and Cochrane databases were searched up to January 2017. The results of selected studies were meta-analyzed to obtain a pooled odds ratio of the effect of periareolar versus other two incision patterns (transaxillary or inframammary incision) of breast augmentation on capsular contracture rates. In addition, subgroup analyses were performed on periareolar versus transaxillary groups and periareolar versus inframammary groups with regard to capsular contracture rate.

Results Seven comparative studies were selected and meta-analyzed. Five of the seven studies reported a higher rate of capsular contracture on patients with periareolar incisions. The results showed a significantly higher rate of capsular contracture with periareolar incisions compared with other two incisions (OR, 1.83; 95% CI, 1.06–3.15, $p = 0.03$). Subgroup results showed no significant difference of capsular contracture between periareolar incisions and transaxillary incisions (OR, 0.94; 95% CI, 0.52–1.64, $p = 0.79$) and showed a significantly higher rate of capsular contracture in periareolar incisions compared to inframammary incisions (OR, 1.91; 95% CI, 1.06–3.43, $p = 0.03$).

Conclusion The results of this meta-analysis demonstrate the contributing effects of periareolar breast augmentation on the rate of capsular contracture. However, more studies with longer tracking periods and higher quality should be conducted to further verify this conclusion.

Level of Evidence III This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors www.springer.com/00266.

Keywords Capsular contracture · Breast augmentation · Periareolar incision

Introduction

Capsular contracture has been the most common complication and reason for reoperation after breast augmentation [1–3]. Reported rates of capsular contracture ranged from 0.59 to 18.9% [3–7]. Capsular contracture was affected by various factors including incision type [5, 7], usage of antibiotics [8], pocket location [5], implant surface type [9, 10], and filling type [11].

Periareolar augmentation was found to increase the rate of capsular contracture in several studies [6, 12]. A potential hypothesis is that the disruption of the nonsterile ductal system may cause subclinical infection which may be a stimulant of capsular contracture [3, 13]. However, some other studies found a lower contracture rate after

✉ Jie Luan
luanjieplastic@126.com

Shangshan Li
Lishangshan2008@163.com

[1] Department of Aesthetic and Reconstructive Breast Surgery, Plastic Surgery Hospital, Chinese Academy of Medical Sciences, Peking Union Medical College, 33 Badachu Road, Shijingshan District, Beijing 100144, China

periareolar breast augmentation [5, 7]. There was no convincing evidence to verify this hypothesis.

The objective of this study is to meta-analyze previous historical studies to explore the role of periareolar breast augmentation on the rate of capsular contracture to provide stronger evidence as well as persuasive instructions.

Patients and Methods

Literature Search and Study Selection

The PubMed, EMBASE, Cochrane Central Register of Clinical Trials, and Cochrane Central Register of Systemic Reviews were searched up to January 2017 using key words "breast augmentation," "augmentation mammaplasty," "complication," and "capsular contracture." Publication language was limited to English.

Selection Criteria

References that met the following criteria were included: (1) cosmetic breast augmentation; (2) comparison of at least two incision types including periareolar pattern with respect to capsular contracture rate; (3) human study. References that met the following criteria were excluded: (1) breast reconstruction with implants; (2) case reports, letters, comments, reviews; (3) the former publication of the same author that had repeated data. Two reviewers independently evaluated references. Firstly, all identified titles and abstracts were evaluated to meet the aim of the study. Secondly, all potentially relevant references were retrieved for full text.

Data Abstraction and Quality Assessment

Data abstraction was conducted independently by two authors using a standardized form including first author, publication country and year, study design, quality assessment, sample size, patients' age, BMI, follow-up years, implant type, Baker classification, incision pattern, and rate of capsular contracture. Methodological quality of randomized controlled trials was assessed using the Jalad score [14], and quality was categorized into good (Jalad score $\geq$3) and bad (Jalad score $<$3). The methodological index [15] was used to assess non-randomized studies, and the quality was categorized into high (score $\geq$16) and low (score lower than 16).

Statistical Analysis

Analyses were conducted in Review Manager version 5.3 from Cochrane Collaboration. Odds ratios (OR) and 95% confidence intervals (CI) were calculated and a p value <0.05 was judged as statistically significant. Statistical heterogeneity was tested using Chi-square and inconsistency (I^2) statistics, and an I^2 value of greater than or equal to 50% represented substantial heterogeneity. A random effect model was used if I^2 was greater than or equal to 50%, and a fixed effect model was used if I^2 was lower than 50%.

Results

Study Selection

The process of identifying eligible studies is shown in Fig. 1.

The characteristics of the included studies are summarized in Table 1.

Description of Included Studies

Three of the seven studies listed are prospective comparative studies [5, 6, 12], and the other four are retrospective studies [3, 4, 7, 16].

McGuire et al. [12] conducted a prospective multicenter study. Breast augmentation was performed, with a follow-up after 4.1 years on average, in 5059 subjects (10,091 breasts) of which 615 breasts received periareolar breast augmentation and 9232 breasts received inframammary breast augmentation. Periareolar breast augmentation had a higher incidence of capsular contracture than inframammary breast augmentation (6.0 vs. 2.0%). They concluded that in the primary augmentation cohort, subglandular placement of the device was the strongest univariate risk

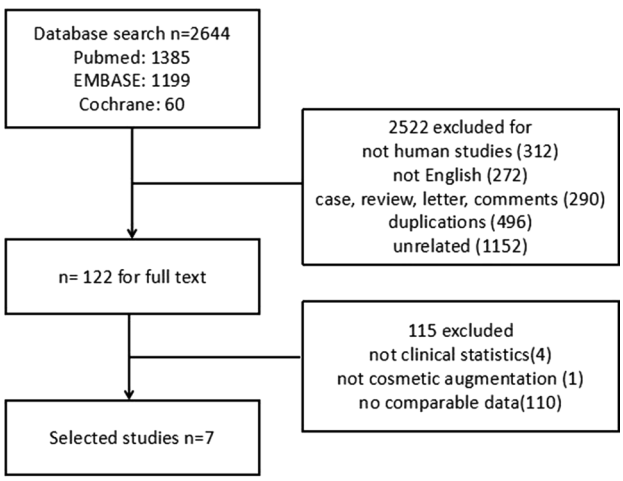

Fig. 1 Process of study selection

Table 1 Characteristics of the selected studies

Study	Country	Study design	Methodological quality	Sample size	Patients' age	BMI	Follow-up	Implant types	Baker classification
Wiener 2008 [3]	USA	Retrospective comparative study	Low	380 patients	IMF:30.5 PA:28.9	N/A	IMF:8.1 months PA:8.6 months	Round, smooth Allergan/Inamed (Irvine, CA) saline implants	III,IV
Jacobson 2011 [4]	USA	Retrospective comparative study	Low	336 implants	36.5	N/A	1.1 years	N/A	III,IV
Stutman 2012 [7]	USA	Retrospective comparative study	Low	619 patients (1238 implants)	N/A	N/A	1.4 years	Mentor	III,IV
Stevens 2013 [6]	USA	Prospective comparative study	High	5109 implants	36	20.8	5 years	Sientra round	III,IV
Spear 2014 [5]	USA	Prospective control study	High	455 subjects	34	20.7	10 years	Natrelle round silicone-filled implants	III,IV
Ruiz 2016 [16]	Spain	Retrospective comparative study	Low	373 patients	TA:31.7; PA:31	TA:22.15; PA:20.85	5 years	N/A	III,IV
McGuire 2017 [12]	USA	Prospective comparative study	High	10,091 implants	36	20.9	4.1 years	Natrelle 410	N/A

N/A not applicable, *TA* transaxillary, *PA* periareolar, *IMF* inframammary

factor for capsular contracture ($p < 0.001$). Older-aged devices and periareolar incisions were also significantly associated with the risk of capsular contracture (both $p < 0.0001$).

Scott et al. [5] conducted a prospective, multicenter 10-year study. There were 455 subjects receiving breast augmentation, and the overall 10-year Kaplan–Meier complication rate was 18.9%. Among the total 455 subjects, 179 received periareolar breast augmentation with a capsular contracture rate of 18.6%, 209 received inframammary breast augmentation with a rate of 17.4%, and 61 received transaxillary breast augmentation with a rate of 23.6%. The overall rates of capsular contracture were 6.5% at 1 year, 15.3% at 5 years, and 18.9% at 10 years, which demonstrated a persistent growth over time.

Stevens et al. [6] conducted a large prospective 5-year study. This study included 5109 implants in 2560 patients implanted by 34 plastic surgeons. Among them, 1469 implants were performed with periareolar incisions with a capsular contracture rate of 6.9%, and 3640 implants were performed with inframammary incisions with a rate of 4.5%. The periareolar pattern had a significantly higher rate of capsular contracture ($p < 0.05$).

A retrospective chart review was conducted on 619 patients (1238 implants) who underwent primary breast augmentations from July 1994 to June 2009 [7]. Of them, 59 patients underwent periareolar breast augmentation, 438 of them received inframammary breast augmentation, and 122 of them received transaxillary breast augmentation. The rates of capsular contracture of periareolar, inframammary, and transaxillary incisions were 5.1, 8.9, and 4.1%, respectively.

Another study indicates the rates of contracture after breast augmentation were 9.5% in the periareolar group and 0.59% in the inframammary group [3]. The increasing rate of capsular contracture with a periareolar incision was statistically significant. However, the mean follow-up period in this study was 8 months, and the long-term follow-up rate of contracture might be higher.

A retrospective study of 373 patients with a 5-year follow-up was conducted [16]. The rates of grade III or IV capsular contracture were 4.2% with periareolar incision and 3.3% with axillary incision.

Jacobson et al. [4] conducted a retrospective review of 183 primary breast augmentation patients (336 breasts) between 2003 and 2009 with a mean follow-up of 1.3 years. Transaxillary incisions produced the highest incidence of contracture (6.4%), followed by periareolar (2.4%) and inframammary (0.5%). However, grade II capsular contracture was also included in these data. The rates of grade III or IV capsular contracture were 1.2% (periareolar incisions), 0% (transaxillary incisions), and 0% (inframammary incisions).

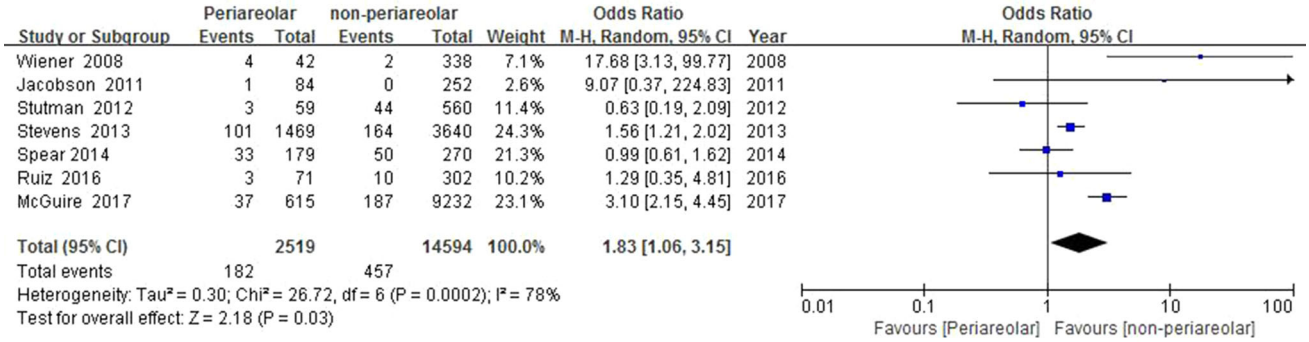

Fig. 2 Forest plot demonstrating the odds ratio of periareolar incision group versus non-periareolar (transaxillary and inframammary) group with random effects model meta-analysis (Mantel–Haenszel)

Methodology Quality Assessment

The prospective comparative studies performed by McGuire et al. [12], Spear and Murphy [5], Stevens et al. [6] are of good qualities, with a methodological index for non-randomized studies score greater than 16, and the others are of low qualities, with a methodological index for non-randomized studies score <16.

Periareolar Incisions and Capsular Contracture Rate After Breast Augmentation

Subjects with periareolar incisions were categorized into the periareolar group, and those with trasaxillary or inframammary incisions were categorized into the non-periareolar group. As a result, 2519 subjects were selected into the periareolar group, and 14,594 were selected into the non-periareolar group.

A high heterogeneity was observed in this study pool with a I^2 value of 78% ($\text{Chi}^2 = 26.72$, $p = 0.0002$), and a random effect model was adopted in this meta-analysis. The results showed a significantly higher rate of capsular contracture in the periareolar group compared with the non-periareolar group (7.2 vs. 3.1%; OR, 1.83; 95% CI, 1.06–3.15, $p = 0.03$) (Fig. 2).

Discussion

Capsular contracture remains the most common complication after breast augmentation [1–3]. The etiology of capsular contracture is unclear, and there are various factors including subclinical infection, incision pattern, pocket location, implant surface, and filling type [5, 7–11]. There are reported meta-analyses with regard to infection, pocket location, implant surface, and filling type. Georgia C. Yalanis [12] performed a meta-analysis that perioperative povidone–iodine irrigation reduces Baker class III/IV capsular contracture and is not associated with implant rupture. El-Sheikh et al. [11] conducted a meta-analysis where higher rates of capsular contracture were found in patients who received silicone implants compared with saline implants. Wong et al. [9] and Barnsley [10] both performed meta-analysis and demonstrated the superiority of textured implants over smooth implants in decreasing the rate of capsular contracture in the subglandular plane. Though there are many reports regarding the relationship between incision type and capsular contracture, no meta-analysis was reported to further analysis.

Each type of incision has its merits and demerits. The periareolar incision is appropriate for patients with larger areolas or for patients who want to hide the incision in the social life. The transaxillary incision has been favored by our institution mainly because the incision was not in the breast area, especially in small breasts with small areolas. The inframammary incision has been favored by Western countries, particularly when the patient had a well-defined inframammary fold in the appropriate location [4].

The periareolar incision, in some techniques, may cut through large end ducts with the largest caliber and greatest potential volume of intraductal material near the nipple–areola complex. They have large amounts of bacteria and potential for bacterial colonization and continue to exude bacteria-colonized material until the transected ducts have scarred and healed [3, 17, 18]. However, in some countries, there are some modified periareolar techniques that avoid the lactiferous ducts. Thus, the definitive effect of periareolar approaches to capsular contracture remains unclear. However, in most of the included studies, no specific surgical detail regarding whether the surgeons cut the lactiferous ducts was provided.

A combined odds ratio of 1.83 was calculated in the periareolar group compared with the non-periareolar group. Among the seven studies, five indicated a higher rate in the periareolar group [3, 4, 6, 12, 16]. A study [5] with 455 subjects stated similar contracture rate between periareolar and other two incisions (18.4% with periareolar incisions versus 18.5% with other two incisions). This study had a

10-year follow-up period and showed a steady increase in capsular contracture rate over the course of 10 years. The overall rate of capsular contracture at postoperative 1 year was 6.5%, whereas the rate at postoperative 10 years was 18.9%. There are some other non-comparative, with regard to incision type, 10-year follow-up studies demonstrating the results that the accumulated rates at the 10-year follow-up were higher than the rates in the 5- and 1-year follow-up [19, 20]. The increasing tendency of capsular contracture over time was also confirmed by many other studies [7, 21, 22]. However, most of these studies contain no comparative data with regard to incision types. Because most of the included comparative studies, in our meta-analysis, recorded a follow-up time <5 years, more comparative studies with a longer follow-up time should be conducted. One study [7] demonstrated a higher capsular contracture rate in the other two incisions compared with periareolar incisions (7.9% with other two incisions vs. 5.1% with periareolar incisions).

Among the seven studies included in our meta-analysis, four have data from both periareolar and transaxillary incisions [4, 5, 7, 16], and six have data from both periareolar and inframammary incisions [3–7, 12]. We further analyzed these two subgroups with regard to the rate of capsular contracture.

In the periareolar versus transaxillary subgroup, a low heterogeneity was observed in this study pool with a I^2 value of 0%, and thus a fixed effect model was adopted in this subgroup meta-analysis. The results showed no significantly higher rate of capsular contracture with periareolar incision compared with transaxillary incision (OR, 0.94; 95% CI, 0.52–1.64, $p = 0.79$) (Fig. 3). One possible explanation is that although having less risk of subclinical bacterization, transaxillary breast augmentation might cause more severe trauma than the other two patterns which might contribute to capsular contracture. Another possible explanation is that, as mentioned above, there are multifactorial effects on the rate of capsular contracture such as subclinical infection, incision pattern, pocket location, implant surface and filling type, and surgical techniques. Because none of the included studies was a univariate study, the other factors except incision also affect the rate of capsular contracture between periareolar and the other two patterns.

In the periareolar versus inframammary subgroup, a high heterogeneity was observed in this study pool with a I^2 value of 80%, and thus a random effect model was adopted in this subgroup. The results showed a significantly higher rate of capsular contracture with periareolar incisions compared with inframammary incisions (OR, 1.91; 95% CI, 1.06–3.43, $p = 0.03$) (Fig. 4).

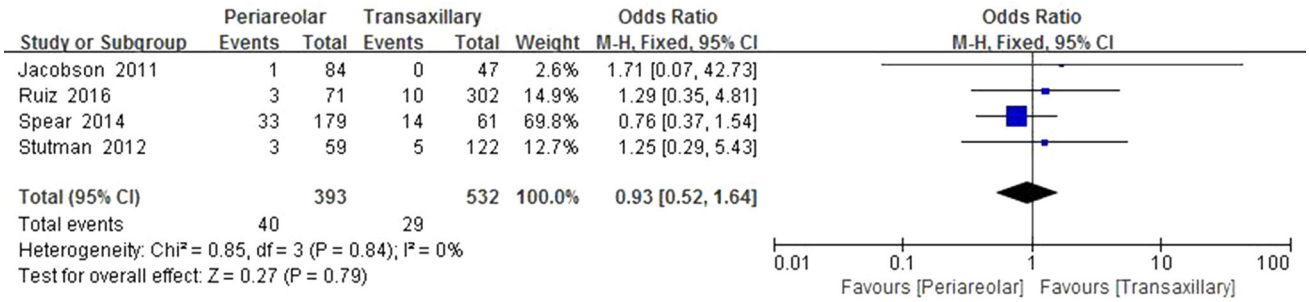

Fig. 3 Forest plot demonstrating the odds ratio of periareolar incision group versus transaxillary group with fixed effects model meta-analysis (Mantel–Haenszel)

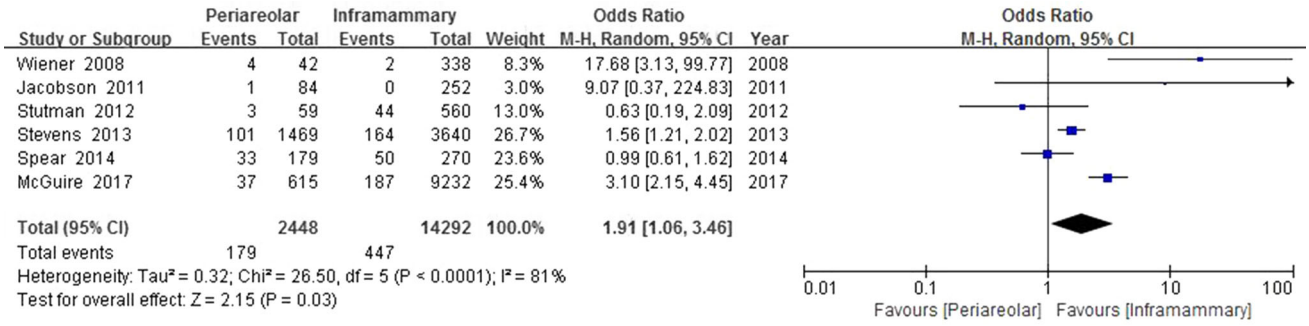

Fig. 4 Forest plot demonstrating the odds ratio of periareolar incision group versus inframammary group with random effects model meta-analysis (Mantel–Haenszel)

However, there are some limitations in our meta-analysis. First, because the rate of capsular contracture is considered multifactorial and there was a lack of univariate studies only regarding the effect of incision pattern, heterogeneity was high for the selected study for having many other variables such as differences in follow-up period, pocket location, the use of povidone–iodine, implants filling, and surface type. Second, no randomized controlled trial (RCT) was searched with regard to comparison between periareolar and other incisions. All of the selected studies were comparative studies which were less convincing. Thus, more RCTs with high quality should be performed for further analysis. Third, because of the increasing tendency of capsular contracture over time, more longer follow-up period comparative studies should be conducted to validate this conclusion. Moreover, only studies in English were selected in this analysis which could not be enough to represent the whole published data.

Conclusions

The results of our meta-analysis demonstrate a significantly higher rate of capsular contracture with periareolar incisions in comparison to the other two incisions. However, a lack of high-quality studies may influence the results. Meanwhile, further studies with longer follow-up periods are required to verify this conclusion.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest to disclose.

Ethical Approval All analyses were based on previous published studies, and thus ethical approval is unnecessary.

Informed Consent This study was based on previous published studies that informed consent was unnecessary.

References

1. Alpert BS, Lalonde DH (2008) MOC-PS(SM) CME article: breast augmentation. Plast Reconstr Surg 121(4 Suppl):1–7
2. Adams WP (2008) The process of breast augmentation: four sequential steps for optimizing outcomes for patients. Plast Reconstr Surg 122(6):1892–1900
3. Wiener TC (2008) Relationship of incision choice to capsular contracture. Aesthet Plast Surg 32(2):303–306
4. Jacobson JM, Gatti ME, Schaffner AD et al (2012) Effect of incision choice on outcomes in primary breast augmentation. Aesthet Surg J 32(4):456–462
5. Spear SL, Murphy DK (2014) Natrelle round silicone breast implants: core study results at 10 years. Plast Reconstr Surg 133(6):1354–1361
6. Stevens WG, Nahabedian MY, Calobrace MB et al (2013) Risk factor analysis for capsular contracture: a 5-year Sientra study analysis using round, smooth, and textured implants for breast augmentation. Plast Reconstr Surg 132(5):1115–1123
7. Stutman RL, Codner M, Mahoney A et al (2012) Comparison of breast augmentation incisions and common complications. Aesthetic Plast Surg 36(5):1096–1104
8. Yalanis GC, Liu EW, Cheng HT (2015) Efficacy and safety of povidone-iodine irrigation in reducing the risk of capsular contracture in aesthetic breast augmentation: a systematic review and meta-analysis. Plast Reconstr Surg 136(4):687–698
9. Wong CH, Samuel M, Tan BK et al (2006) Capsular contracture in subglandular breast augmentation with textured versus smooth breast implants: a systematic review. Plast Reconstr Surg 118(5):1224–1236
10. Barnsley GP, Sigurdson LJ, Barnsley SE (2006) Textured surface breast implants in the prevention of capsular contracture among breast augmentation patients: a meta-analysis of randomized controlled trials. Plast Reconstr Surg 117(7):2182–2190
11. El-Sheikh Y, Tutino R, Knight C et al (2008) Incidence of capsular contracture in silicone versus saline cosmetic augmentation mammoplasty: a meta-analysis. Can J Plast Surg 16(4):211–215
12. McGuire P, Reisman NR, Murphy DK (2017) Risk factor analysis for capsular contracture, malposition, and late seroma in subjects receiving Natrelle 410 form-stable silicone breast implants. Plast Reconstr Surg 139(1):1–9
13. Steiert AE, Boyce M, Sorg H (2013) Capsular contracture by silicone breast implants: possible causes, biocompatibility, and prophylactic strategies. Med Dev (Auckl) 6:211–218
14. Jadad AR, Moore RA, Carroll D et al (1996) Assessing the quality of reports of randomized clinical trials: is blinding necessary? Control Clin Trials 17(1):1–12
15. Slim K, Nini E, Forestier D et al (2003) Methodological index for non-randomized studies (minors): development and validation of a new instrument. ANZ J Surg 73(9):712–716
16. Benito-Ruiz J, Manzano ML, Salvador-Miranda L (2017) Five-year outcomes of breast augmentation with form-stable implants: periareolar vs transaxillary. Aesthet Surg J 37(1):46–56
17. Tamboto H, Vickery K, Deva AK (2010) Subclinical (biofilm) infection causes capsular contracture in a porcine model following augmentation mammaplasty. Plast Reconstr Surg 126(3):835–842
18. Chong SJ, Deva AK (2015) Understanding the etiology and prevention of capsular contracture: translating science into practice. Clin Plast Surg 42(4):427–436
19. Maxwell GP, Van Natta BW, Bengtson BP et al (2015) Ten-year results from the Natrelle 410 anatomical form-stable silicone breast implant core study. Aesthet Surg J 35(2):145–155
20. Stevens WG, Calobrace MB, Harrington J et al (2016) Nine-year core study data for Sientra's FDA-approved round and shaped implants with high-strength cohesive silicone gel. Aesthet Surg J 36:404–416. doi:10.1093/asj/sjw015
21. Rheingold LM, Yoo RP, Courtiss EH (1994) Experience with 326 inflatable breast implants. Plast Reconstr Surg 93(1):118–122
22. Handel N, Cordray T, Gutierrez J et al (2006) A long-term study of outcomes, complications, and patient satisfaction with breast implants. Plast Reconstr Surg 117(3):757–767