The Journal of Foot & Ankle Surgery

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The Gastrocnemius Intramuscular Aponeurotic Recession: A Simplified Method of Gastrocnemius Recession

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Gastrocnemius recession is performed as an ancillary procedure in the treatment of a variety of pathologic foot and ankle conditions, most notably symptomatic adolescent and adult pes planovalgus, plantar fasciitis, and diabetic foot pathology (1–4). Several technique modifications have been introduced to potentially decrease complications (especially sural nerve–related problems), anticipate anatomic variation, improve function, decrease postoperative convalescence, and improve cosmesis (5–16).

We present an open method of gastrocnemius recession for the neurologically normal individual that allows for isolated lengthening of gastrocnemius, avoidance of the sural nerve, and potentially less weakening of the gastrocnemius complex. The procedure involves a single transection of only the gastrocnemius aponeurosis, supporting the gastrocnemius muscle bellies through a limited, open, medial approach in the calf. Unlike the modified Strayer procedure, where the gastrocnemius aponeurosis is completely severed from its insertion into soleus, this technique preserves the insertion of gastrocnemius, allowing for both an intramuscular and aponeurotic lengthening. We better term this procedure the gastrocnemius intramuscular aponeurotic recession (GIAR).

Operative Technique

The surgical technique is a combination or modification of two procedures, the ventral aponeurosis disconnection for spastic conditions and the medial approach, modified Strayer technique described by Hansen for musculoskeletal deformity (7, 8, 11, 12). It is performed with the patient supine and the limb elevated, with the heel resting on a well-padded Mayo stand. Alternatively, an assistant could hold the leg throughout the procedure. A tourniquet is not necessary in most cases.

A medial, longitudinal incision is made at the midsubstance of the gastrocnemius muscle belly proximal to the distal aspect of gastrocnemius muscle. Adequate visualization may be achieved with an incision measuring approximately 3 to 5 cm. Sharp dissection is carried down to the crural fascia, avoiding the sapheneous vein (Fig 1). The deep fascia is sharply incised in a longitudinal fashion for the entire length of the incision. This layer should be carefully handled for reapproximation when closing.

The interval between the gastrocnemius musculature is identified and followed distally toward the aponeurosis insertion. A Cobb elevator or the surgeon's index finger is

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1067-2516/07/4602-0013$32.00/0

doi:10.1053/j.jfas.2007.01.004

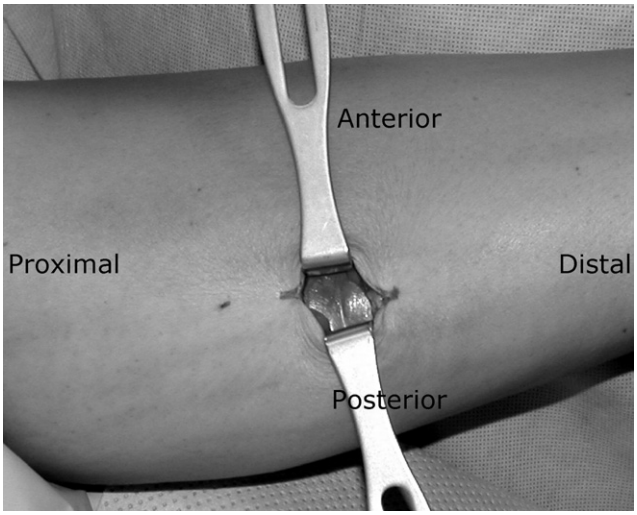

FIGURE 1 Medial view of leg demonstrating that incision placement is proximal to the gastrocnemius insertion. Skin and subcutaneous tissue are retracted, exposing intact deep fascia.

bluntly used to better define this plane for adequate visualization. It is important to disrupt any aberrant fascial (aponeurotic) interconnections between the gastrocnemius and soleus if they are encountered. Gastrocnemius is located posterior, and the soleus is anterior. The aponeuroses of these muscles are adjacent to each other and define the surgical plane (Fig 2).

Deep retraction is used to lift the soleus anteriorly and the gastrocnemius posteriorly. This maneuver allows the surgeon to visualize the lateral aspect of the gastrocnemius aponeurosis. The gastrocnemius aponeurosis is transected from lateral to medial with a curved-belly scalpel (Figs 3 and 4). Larger patients may require a longer incision to completely visualize the lateral gastrocnemius aponeurosis. Attention is placed on transecting only the aponeurosis and not the associated underlying muscle supporting the aponeurosis. Otherwise, an intramuscular vessel (artery and/or vein) may be transected, and, because the approach is medially based, it may be difficult to localize and isolate a deep bleeder. A Mayo scissors may be used to transect any remaining lateral aponeurosis as long as the aponeurosis is isolated from the underlying muscle, and is particularly useful in larger patients. If identified, the plantaris tendon is transected, and a 1- to 2-cm section is removed.

Once the gastrocnemius aponeurosis is sectioned, the foot is dorsiflexed with the knee extended, and an intramuscular lengthening of approximately 1 to 3 cm may be achieved. One should monitor the amount of dorsiflexion as the foot is dorsiflexed to avoid overlengthening. The GIAR should be performed above the nonmuscular-bound portion of the gastrocnemius aponeurosis (gastroc run-out). A gastrocnemius transection too close to the gastroc run-out in patients

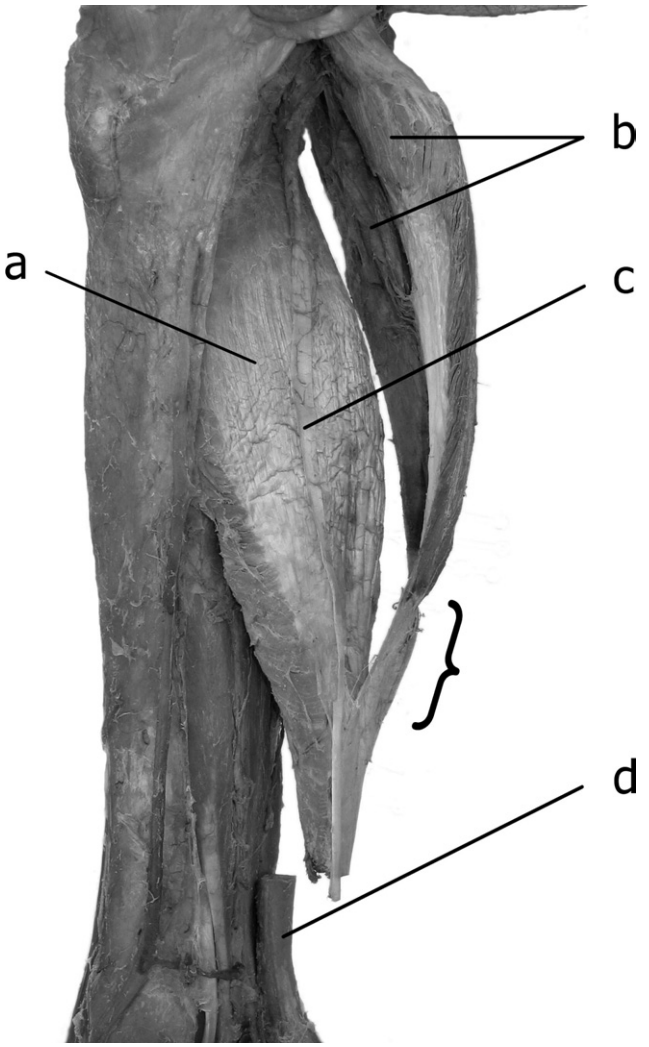

FIGURE 2 Medial view of cadaveric specimen demonstrating the posterior compartment of the leg. Skin, subcutaneous tissue, and superficial fascia are removed. Soleus muscle (*A*), gastrocnemius muscle (*B*), plantaris (*C*). The gastrocnemius muscle fibers are posterior to its aponeurosis, whereas the soleus muscle fibers are anterior to its aponeurosis. The gastrocnemius aponeurosis (without associated overlying muscle) continues for a variable distance (*bracket*) inferior to the distal ends of the medial and lateral heads of gastrocnemius to reach its line of attachment to the soleus aponeurosis. The GIAR is preformed proximal to the muscular-free portion of the gastrocnmeius aponeurosis. Combined aponeuroses of soleus and gastrocnemius fuse to ultimately form the Achilles' tendon (*D*). (Reproduced with permission from the author and publisher, Elsevier, from Blitz NM, Eliot DJ. Anatomical aspects of the gastrocnemius aponeurosis and its insertion. A cadaveric study. J Foot Ankle Surg 46:101–108, 2007.)

with a thin gastrocnemius muscle may result in a full-thickness muscle tear.

If more dorsiflexion is needed to achieve the clinical result, parallel transections of the gastrocnemius aponeurosis may be performed. One could also transect the soleus aponeurosis as well, if clinically necessary; however, this

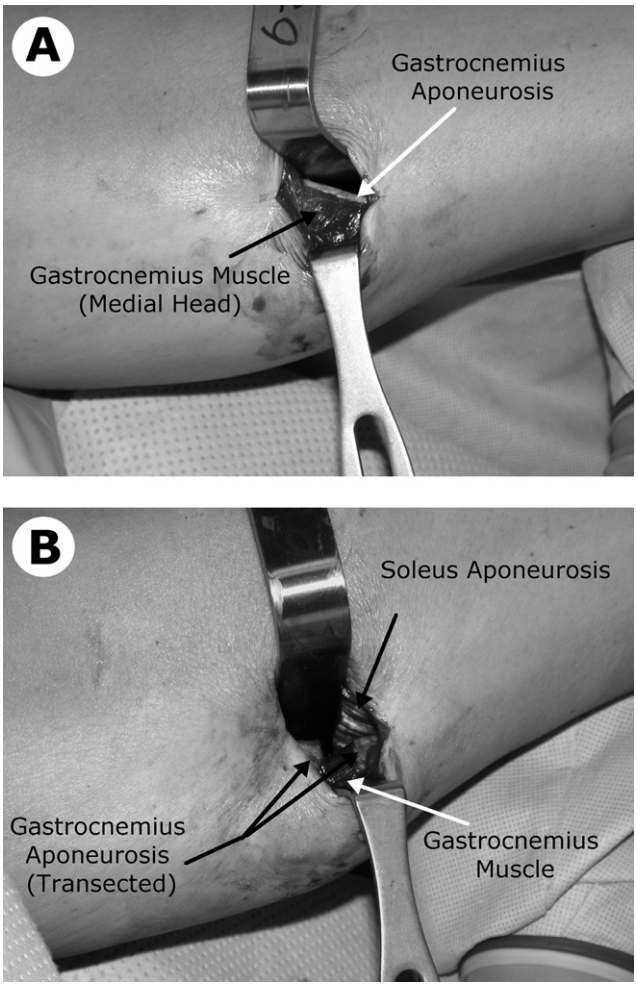

FIGURE 3 (*A*) Interval between gastrocnemius and soleus muscles is easily identified and separated at this level in the leg. Medial head of gastrocnemius muscle and its supporting aponeurosis is evident. (*B*) Only the gastrocnemius aponeurosis is targeted for complete transection from lateral to medial. Note the underlying gastrocnemius muscle is cautiously spared. Deep retraction is obtained with a deep retractor, and the soleus muscle is lifted upwards.

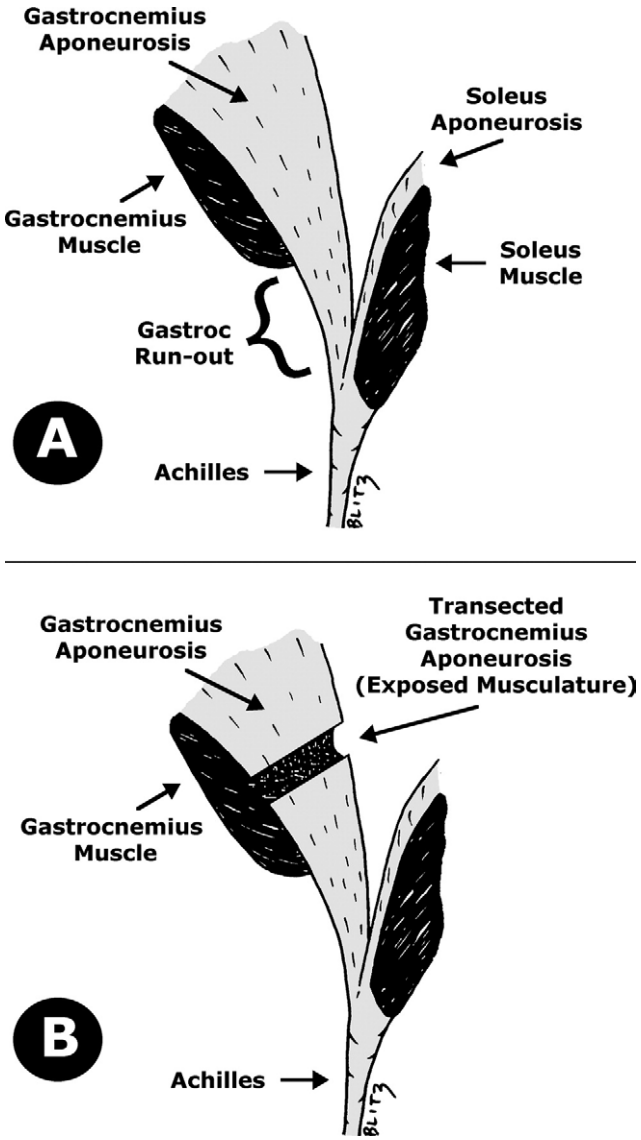

FIGURE 4 Drawings illustrating pertinent anatomy (*A*) and location for transverse sectioning of the gastrocnemius aponeurosis (*B*). Note that the transection occurs at the muscular-bound portion of the gastrocnemius aponeurosis. The gastroc run-out is the portion of the gastrocnemius aponeurosis that is not bound by gastrocnemius musculature, and the GIAR is performed above this area. One should be careful not to perform the GIAR too close to the distal aspect of the gastrocnemius muscle to avoid the occurrence of a full-thickness muscle tear with dorsiflexion of the foot, which is especially important in patients with a thin muscle belly.

should not be performed at the same level as the aponeurotic transection of gastrocnemius because this may result in adherence of the gastrocnemius to soleus, which has been specifically noted by surgeons with experience with extensive releases for spastic conditions (11).

The deep fascia is then securely reapproximated to avoid herniation of the underlying musculature as well as adhesions to the deeper tissues to the skin (Fig 5). The subcutaneous tissue and skin are closed in layers. Postoperative care requires that the foot be placed at 90° (neutral) to the leg for 4 weeks total. With isolated cases of GIAR, patients are placed in a removable boot, and immediate full weightbearing is allowed. As with most gastrocnemius recession techniques, some patients may experience muscle spasms that typically resolve after the first few postoperative days, which may be managed with an oral muscle relaxant. Patients are encouraged to remove the boot and perform gentle isometric calf stretching exercises. The boot is used as a night splint for 4 weeks postoperatively to allow for the correction to be maintained. After 4 weeks, they are rapidly transitioned into a regular shoe, and an aggressive stretching and strengthening program is initiated. Patients are expected

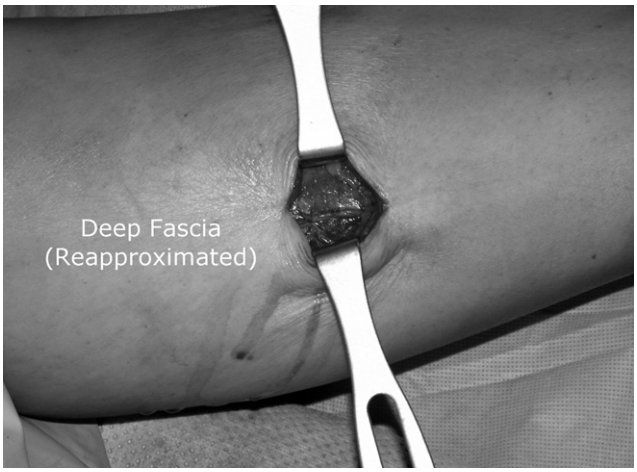

FIGURE 5 Deep fascia is reapproximated before subcutaneous and skin closure to avoid herniation of the underlying muscle and to prevent adhesions of the skin to the deep structures.

to gain full strength by 6 months. This is measured by the ability to do 10 toe rises on the operated leg.

Discussion

The gastrocnemius recession was initially performed in neurologically impaired individuals for the treatment of spastic equinus contractures of the lower extremity (5–11, 17–25). The procedure was first described by Vulpius and Stoffel in 1913 (5). They performed a chevron transection of the gastrocnemius aponeurosis as well as an incision of the deep fibers of the soleus at the middle of the leg. In 1924, Silfverskiöld released the gastrocnemius origins from the femoral condyles through a transverse incision in the popliteal crease and positioned the muscle below the knee (6). Strayer performed a transverse sectioning of the gastrocnemius aponeurosis where it attached to the soleus aponeurosis (7, 8). Baker performed a tongue-and-groove cut (9). Lamm, Paley, and Herzenberg advocate their technique of a gastrocnemius-soleus recession through a posterior midline approach (26). The high gastrocnemius recession refers to a medial approach, Strayer type of recession (27). Baumann performed multiple transections of the muscular-bound portion of the gastrocnemius aponeurosis with or without aponeurotic lengthening of the soleus through an 8-cm to 12-cm medial incision for spastic contractures in a pediatric population (11). To the authors' knowledge, the use of aponeurotic transection has not been described for the neurologically intact individual with musculoskeletal deformity. The simplified aponeurotic transection (GIAR) that we describe in this technique's article offers several potential advantages to other selective transection techniques for gastrocnemius recession.

Although morbidity with gastrocnemius recession is low, associated complications are still common enough that one should carefully consider the method of recession. The senior author (S. M. R.), along with Ford and Hamilton, reported a 6% complication rate in 126 patients who underwent a high gastrocnemius recession (27). Complications included scar and nerve problems, Chronic Regional Pain Syndrome (CRPS), wound dehiscence, and superficial infection.

Sural nerve–related complications are a known complication associated with gastrocnemius recession (26–28). In the senior author's (S. M. R.) series with a medial approach, Strayer-type recession, nerve problems accounted for 2.67% of complications (4 patients), one of whom developed CRPS (27). In 1989, Downey and Banks retrospectively reviewed 20 cases of posterior approach, Baker tongue-and-groove recessions and did not report any nerve-related problems, although it is not entirely clear if this was specifically evaluated (29). Sammarco et al identified 2 of 40 patients with sural paresthesias after unilateral gastrosoleus recession through a posterior approach (30). Endoscopic gastrocnemius recession has also been associated with sural nerve injury from 0% to 11% (16, 28, 31, 32). In our preliminary experience with the GIAR, we have not observed sural nerve complications. At this level in the leg, the sural nerve is located between the heads of the gastrocnemius musculature on the opposite side of the aponeurosis and not directly in the surgical field. In contrast, with the high gastrocnemius recession performed through a medial incision, the nerve must be identified and protected, which may produce postoperative nerve problems, such as neuropraxia (27). When gastrocnemius recession is approached through a posterior midline incision, the sural nerve is directly in the dissection plane and also vulnerable to transection, scarring, and entrapment. With the GIAR, the sural nerve should not be encountered.

In theory, a gastrocnemius recession should only influence the gastrocnemius muscle, and the effect of knee extension on foot dorsiflexion will be eliminated or greatly diminished. The high gastrocnemius recession (Strayer-type) involves complete detachment of gastrocnemius from soleus and potentially may disable the muscle. It is assumed that the transected gastrocnemius aponeurosis will adhere to the soleus aponeurosis in a lengthened position. The GIAR preserves the gastrocnemius insertion and potentially allows for gastrocnemius to maintain a "weakened" effect on the foot. Because of this, it is suggested that the amount of calf atrophy would be diminished with this technique. The extent to which gastrocnemius muscle fibers that originally inserted on the gastrocnemius aponeurosis proximal to the transection can transmit force to the Achilles' tendon through the remaining connective tissue of the muscle is unknown. Studies specifically evaluating the functional effects of isolated gastrocnemius recession are lacking. In

addition, studies comparing different methods of recession are needed.

Because the procedure is an open approach to gastrocnemius recession, we do not expect significant changes in the cosmetic aspects of the procedure. However, because the procedure is performed more proximal and avoids dissecting about the posterior calf superficial fascia, we expect less incisional complaints associated with induration. With the GIAR, a single transection of the aponeurosis allows the procedure to be performed through a "small" medial incision. When multiple gastrocnemius aponeurotic transections are required, the incision could be extensive, especially if the soleus aponeurosis is simultaneously transected. Experience with spastic conditions has cautioned against performing a gastrocnemius and soleus aponeurosis sectioning at the same level because the 2 muscular segments may adhere to each other (11).

GIAR lends itself to avoiding the intraoperative pitfalls associated with anatomic variation of the gastrocnemius insertion. The primary author (N. M. B.) recently demonstrated, in a cadaveric study, that the gastrocnemius muscle has a variable length insertion onto the soleus aponeurosis (33). In the sample of this study, 53% of the specimens had a lengthy, muscle-free portion of the gastrocnemius aponeurosis, which would lend itself toward an easy, selective transection with any method of gastrocnemius recession. However, 38% had no insertional aponeurosis of either the medial and/or lateral muscle bellies (direct attachment), and 9% had an insertional aponeurosis of less than 1 cm. It is suggested that selective, isolated transection would be more challenging with a short gastrocnemius aponeurosis and/or direct attachment, which accounts for approximately 50% of the sample. Potential problems include transection of the gastrocnemius muscular insertion or inadvertent transection of the soleus aponeurosis. The GIAR avoids these specific potential complications that may occur because of the gastrocnemius variable insertion. The location of the single transection of the gastrocnemius aponeurosis should be placed on the aponeurosis, where there is sufficient (thick) underlying gastrocnemius muscle that will support an intramuscular lengthening. A thin gastrocnemius muscle may rupture intraoperatively at the transection site when the foot is dorsiflexed to achieve the muscular separation needed for the procedure. Multiple, parallel gastrocnemius transections or a tongue-and-groove aponeurotic transection may lessen this possibility (Fig 6). Although we have not experienced this complication, it remains a potential risk, and we avoid performing the GIAR close to the muscular insertion.

We present an alternative method of gastrocnemius recession—the GIAR. This recession is a medially based procedure that spares the gastrocnemius insertion, is not affected by the variable gastrocnemius insertion, and avoids the sural nerve. The gastrocnemius is lengthened by transecting the muscular-bound portion of the aponeurosis and applying a dorsiflexory force that will also allow for an intramuscular lengthening. The method of recession should be based on the degree and location of equinus, indication for lengthening, patient expectations, and surgeon experience.

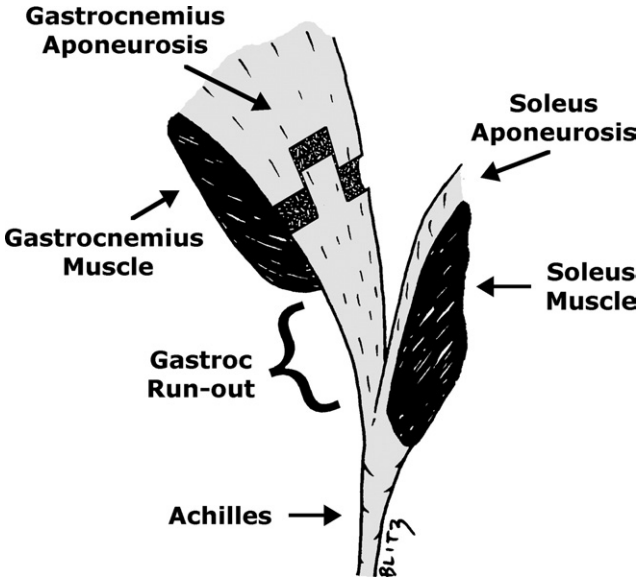

FIGURE 6 Drawing illustrating a tongue-and-groove aponeurotic transection modification.

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