Endoscopic Gastrocnemius Recession

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40.1 Introduction

Ankle joint equinus has been well known in the medical literature as a major deforming force connected with an assortment of foot and ankle pathologies. Ankle equinus is defined as a limitation of dorsiflexion at the ankle joint.[1,2] Limited ankle dorsiflexion has been defined as less than 3–15° with the knee extended. With the knee flexed, limited dorsiflexion has been described as less than 10–20°.[3] Traditionally, in the "normal" patient population, the accepted definition of range of motion continues to be the capability to dorsiflex the foot at the ankle joint a minimum of 10° with the knee extended.[1,2,4] For athletic patient populations, which will be discussed below, ankle dorsiflexion less than 10° may be considered "normal."[5]

There are numerous surgical approaches that have been well established for the correction of ankle joint equinus. Recently, endoscopic gastrocnemius recession (EGR) has gained worldwide recognition for the correction of ankle joint contracture, (specifically gastrocnemius equinus).[6-10] This is because of its relative ease, improved cosmesis, safety, ability to be performed supine and visualize neurovascular structures, along with a lower risk of complications.

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40.2 Indications

Decreased ankle joint range of motion during the gait cycle becomes a deforming force that affects the function and position of the foot, leg, knee, hip, and spine.[11] Underlying ankle joint equinus is a contributing factor to many pathologic conditions. Surgical correction of equinus should be considered for conditions such as clubfoot, pediatric and adult flatfoot, Achilles tendinopathy, hypermobility of the first ray, Charcot arthropathy, and plantar forefoot ulcers.[12-15] Operative management of equinus may also be performed in conjunction with other procedures such as amputations, posterior tibial tendon reconstruction, triple arthrodesis, and total ankle arthroplasty.[11,16,17]

The gastrocnemius muscle in particular is the predominant deforming force in the foot and ankle leading to chronic pathological changes.[13] It has been well established that there is an association between isolated gastrocnemius tightness and patients who have chronic forefoot and midfoot symptoms such as plantar fasciitis, hallux valgus, symptomatic adult acquired flatfoot, metatarsalgia, synovitis of the metatarsalphalangeal (MTP) joints, and forefoot ulcerations.[12-15] Nonsurgical treatment such as stretching has been shown to be minimally effective.[18,19] Therefore, successful surgical management of these deformities should include assessment for ankle equinus as these patients are unlikely to experience full relief of symptoms unless this component is surgically addressed.

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40.3 Anatomy and Etiology

The muscles of the superficial group of the lower leg are the gastrocnemius, soleus, and plantaris. The gastrocnemius and soleus form the triceps surae and share the Achilles tendon. The gastrocnemius muscle crosses the knee joint and is superficial and posterior to the deeper soleus muscle, which lies anterior. The plantaris is much smaller and arises lateral and directs medial to the gastrocnemius muscle but may have to be addressed during surgical correction of equinus deformities via tenotomy.[18]

The Achilles tendon is the strongest tendon in the human body. The gastrocnemius portion makes up the entire lateral aspect of the posterior surface and part of the lateral aspect of the anterior surface of the Achilles tendon. On the other hand, the soleus portion of the Achilles tendon usually comprises the medial two-thirds of the anterior surface and a small part of the medial posterior surface. Overall, the soleus and gastrocnemius contributions to the Achilles tendon are not easily separable.[18-21]

Ankle equinus may be classified according to different etiologies. Decreased ankle dorsiflexion may be due to muscular deformity, osseous deformity, or a combination of the two. In addition, muscular equinus is subclassified as either spastic, as in cerebral palsy, or the more common non-spastic. Gastrocnemius-soleus and isolated gastrocnemius are the two forms of muscular equinus.[2]

Osseous forms of equinus may be caused by exostoses that limit ankle range of motion with the knee either extended or flexed. Pseudo-equinus is the term often used for the false perception of true ankle equinus such as may be seen with pes cavus.[22] Although less frequent than muscular forms and osseous forms, pseudo-equinus must be ruled out before embarking upon surgical correction of equinus due to soft-tissue contracture.

40.4 Procedures

Various surgical procedures have been described for the correction of ankle equinus. Tendo-Achilles lengthening (TAL) may be performed in an open or percutaneous fashion. The Z-plasty technique was first performed through two transverse incisions 8–10 cm apart.[23] The open frontal plane Z-plasty became quite popular over the years due to its consistency in correction compared to other tenotomies.[2,23-25] Percutaneous TAL in a triple hemi-section fashion has been performed for 60 years.[25,26] The authors utilize this approach with two lateral and one medial incision in a valgus foot and with two medial and one lateral incision in a varus foot. Hansen describes a two-incision percutaneous technique.[10]

Gastrocnemius recession has been described as an open distal recession and was initially performed with variations of a transverse lengthening.[27,28]

Later modifications took the form of distally or proximally oriented tongue and groove lengthening of the gastrocnemius.[29,30] EGR has been reported as a viable alternative to open technique.[31-34] Studies have revealed average correction of equinus deformity after surgery to be about 18° using either open[35] or endoscopic[31] technique.

40.4.1 Clinical Examination and Procedure Selection

The preoperative physical examination is paramount to proper patient selection for EGR. It is necessary to distinguish between flexible and osseous equinus while ruling out any spastic component. Once it is established with a diagnosis of non-spastic muscular equinus, proper evaluation of ankle joint dorsiflexion can take place. There is much disparity in the literature to the exact measurement of ankle joint dorsiflexion when evaluating ankle equinus. The measurements range from 0° to 25°.[13] Note must be taken as to the position of the foot when measuring ankle joint dorsiflexion. In past studies, the foot position has not been consistent. When considering surgical correction, the Silfverskiold test should be performed to distinguish between muscular forms of ankle equinus.[36] The exam is performed with the patient in a supine or sitting position. The assessor extends the patient's knee and passively dorsiflexes the ankle with the subtalar joint in neutral position and the midtarsal joint adducted. It is very critical that the examining physician ensures that the patient's anterior tibial tendon is not actively functioning, performing a passive range of motion. The sagittal plane relationship of the bisection of the leg to the rearfoot is measured. Because the gastrocnemius muscle crosses the knee joint and the soleus does not, the gastrocnemius is shortened when the knee is flexed. Gastrocnemius equinus is present if there is less than

10° of dorsiflexion with the knee extended and an increase in ankle joint range of motion with the knee flexed.[31]

While the Silfverskiold test may help determine whether to perform an Achilles tendon lengthening or a gastrocnemius recession, other preoperative criteria must be considered. A percutaneous TAL may be selected for a patient who suffers from gastrocsoleus equinus and peripheral arterial disease,[3] e.g., patients who had undergone peripheral bypass surgery or amputations. On the other hand, a patient with gastrocnemius equinus can benefit from an open or endoscopic procedure.

Gastrocnemius recession in general may be preferable to a TAL in the athletic patient since the former maintains the propulsive strength of the soleus. One must note, however, equinus has been found in asymptomatic adolescent athletes, and since posterior lengthening has not been critically studied in this patient population, more study is needed.[5,8] Lengthening may be needed for posttraumatic contracture for an athletic patient.

Recurrent resection for anterior ankle exostoses is a good indication for consideration of a gastrocnemius recession. This is to reduce the deforming posterior contracture that may aid in the pathological development of anterior talo-tibial exostoses and is analogous to soft-tissue re-balancing in bunion deformity. Achilles tendon lengthening could produce weakness and is essentially a controlled rupture. Since gastrocnemius tears (also known as "tennis leg") allow for full functionality after adequate healing time, one could infer that gastrocnemius lengthening would be "safer" on athletic patients.

In addition, gastrocnemius recession allows for earlier weight-bearing as opposed to TAL and may be beneficial if the patient has a history of Achilles injury.[3,32,37] Furthermore, even in the non-athlete, patients with isolated gastrocnemius tightness who have had a TAL have been shown to lose plantarflexory strength and may develop calcaneal gait.[38] Overcorrection and loss of strength can be avoided when isolated gastrocnemius contracture is properly treated with a gastrocnemius recession.

Mistakenly, it has been understood by numerous clinicians that isolated gastrocnemius recession will not provide adequate correction when compared to TAL. In fact, 1-cm gapping of the gastrocnemius yields approximately 10–15° of increased ankle flexibility while diminishing instability from the midtarsal joint due to excessive sagittal plane rotation.[39]

Endoscopic gastrocnemius recession (EGR) may be preferred to open procedures for a number of reasons. It provides enhanced cosmesis and a lower likelihood of hematoma formation due to its minimally invasive nature.[3,31,32] As a result, this decreases overall tissue trauma and allows for quicker healing postoperatively. An endoscopic procedure will necessitate only two small stab incisions (bi-portal) or a single (uni-portal) incision approach.[31,32] An open procedure may require the incision up to 10 cm in length.[8,33,40] Direct image through the endoscope allows for protection of vital structures such as the sural nerve and lesser saphenous vein. Also, EGR easily allows for supine or prone positioning of the patient and an associated decrease in operating room time.[12,31]

40.4.2 Technique

Following an appropriate time out and identification of the patient, the patient is placed in a supine position and anesthesia is induced. Typically, the patient is maintained in a supine position to allow ease of transition to additional procedures. A traditional prep and drape is performed to a level above the knee allowing the surgeon an entire view and function of the entire lower extremity. Normally, the endoscopic gastrocnemius recession is completed first and, in most cases, is performed in combination with other surgical procedures.

The incision landmarks are determined by the level of the inferior aspect of the muscle bellies of the medial and lateral head of gastrocnemius muscle. The gastrocnemius aponeurosis is typically identified at a level approximately 2–3 cm distal to the most inferior aspect of the medial head of the gastrocnemius muscle belly. (The medial head of the gastrocnemius muscle belly is more inferior than the lateral head of the gastrocnemius muscle belly.) The medial and lateral aspects of the lower leg (at the level of the gastrocnemius aponeurosis) are divided into thirds (Figs. 40.1 and 40.2). The small stab incisions are made longitudinally in line along the neurovascular structures in the posterior one-third of the lower leg at the gastrocnemius aponeurosis level. For a bi-portal technique, an incision is made at this level both medially and laterally. If utilizing a uni-portal technique, this incision is made medially at this level. The

Fig. 40.1 A lateral and medial clinical view with marks demonstrating the leg broken into anterior, middle and posterior 1/3 of the leg

Fig. 40.2 The Endoscopic Gastrocnemius Recession Surgical Procedure incisions should be made at approximately the posterior 1/3 of the leg

reason for the incisions being placed somewhat anteriorly is the gastrocnemius aponeurosis is shaped in a one-third tubular fashion. As the aponeurosis flares medially and laterally, it tends to advance anteriorly and by having the incisions placed in the posterior one-third of the lower leg, this allows for complete visualization of the gastrocnemius aponeurosis from medial to lateral.

The surgeon should then put the plantar aspect of the patient's foot against his or her chest (making sure the patient's knee is fully extended) and the surgeon should lean into the foot or have an assistant dorsiflex the ankle joint therefore applying tension to the posterior muscle group. A small stab incision is made medially, avoiding the greater saphenous vein and nerve (Fig. 40.3). The incision is deepened in the same plane to the deep fascia via blunt dissection. Any bleeders are identified and cauterized as necessary.

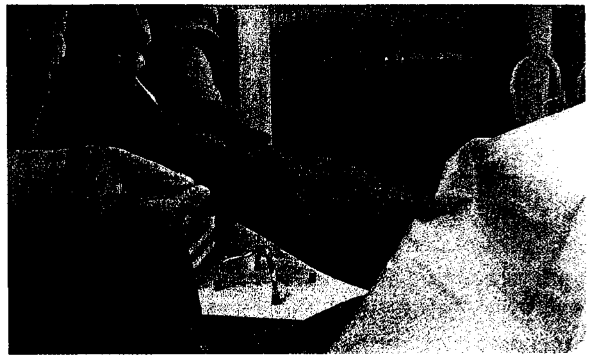

Fig. 40.3 A longitudinal stab incision is made in the posterior 1/3 compartment

Fig. 40.4 The obturator is inserted from medial - lateral tenting the skin

Attention is then carried down through the deep fascia to the gastrocnemius aponeurosis. A fascial elevator is slid along the posterior gastrocnemius aponeurosis from medial to lateral separating the deep fascia from the aponeurosis. Next, an obturator is inserted in the same plane and the obturator is inserted posterior to the gastrocnemius aponeurosis from medial to lateral (Fig. 40.4). For a bi-portal technique, the lateral skin is tented and a small stab incision is made laterally, parallel along the lines of the neurovascular structures (Fig. 40.5). Transillumination aids in avoiding these structures. A cannula is then inserted over the obturator (Figs. 40.6). The cannula is inserted all the way across, thereby staying posterior to the gastrocnemius aponeurosis. The cannula is cleaned for good visualization with a cotton tip applicator, and the slotted aspect of the cannula should be facing anteriorly to allow for visualization of the gastrocnemius aponeurosis. Figure 40.7 with the open end of the cannula facing anteriorly against the gastrocnemius aponeurosis, a 4.0-mm 30° angled scope

Fig. 40.5 A lateral view making a stab incision over the tented skin of the obturator

Fig. 40.6 The cannula fitted over the obturator going from lateral - medial

is inserted (Fig. 40.8). At this time, range of motion of the ankle joint is performed. This allows confirmation and visualization of the gastrocnemius aponeurosis only. If any other tissue is visualized, the equipment is exited and the blunt dissection separating the tissue planes is performed again in order to be posterior to the gastrocnemius aponeurosis and deep to the deep fascia and anteriorly to the sural nerve. Visualization of only the gastrocnemius aponeurosis fibers insures that the sural nerve and/or other neurovascular structures are not implicated. This also insures that the only tissue cut is the gastrocnemius aponeurosis. It is critical at this time that the gastrocnemius aponeurosis is the only anatomical structure visible in order to evade any possible neurovascular damage. The striations of the aponeurosis are very apparent and very distinct. It is also extremely important that the surgeon dorsiflexes and plantarflexes the ankle joint in order to allow for visibility of these specific fibers of the aponeurosis moving proximal and distal to the anteriorly facing cannula. It should be noted

Fig. 40.7 A lateral view demonstrating the slotted cannula facing up (anteriorly) prior to insertion of the scope

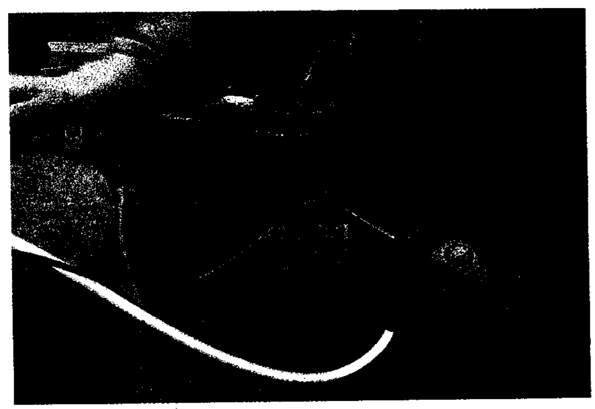

Fig. 40.8 Insertion of the endoscope from lateral to medial, please note that knee is extended and there is tension on gastrocnemius apenerosis by dorsiflexing the foot

that the surgeon performing EGR will often discover that the sural nerve may be located in the central posterior lower leg, and is not as laterally placed as many believe. It is possible in some patients to rotate the cannula posteriorly to view the sural nerve.

Once the cannula slot is facing anteriorly, a triangle blade, hook blade, or push blade can be used to incise along the gastrocnemius aponeurosis, performing a gastrocnemius recession (Fig. 40.9). This will allow a direct visualization of the soleus muscle belly and allow improved range of motion in the ankle joint. Many times there will be small portions of gastrocnemius aponeurosis septae in the soleus muscle belly. These fibers can be cut with the endoscope blade easily being careful not to cut the soleus muscle. The surgeon should be leaning into the foot prior to the release. As the cut is being performed and completed, the surgeon

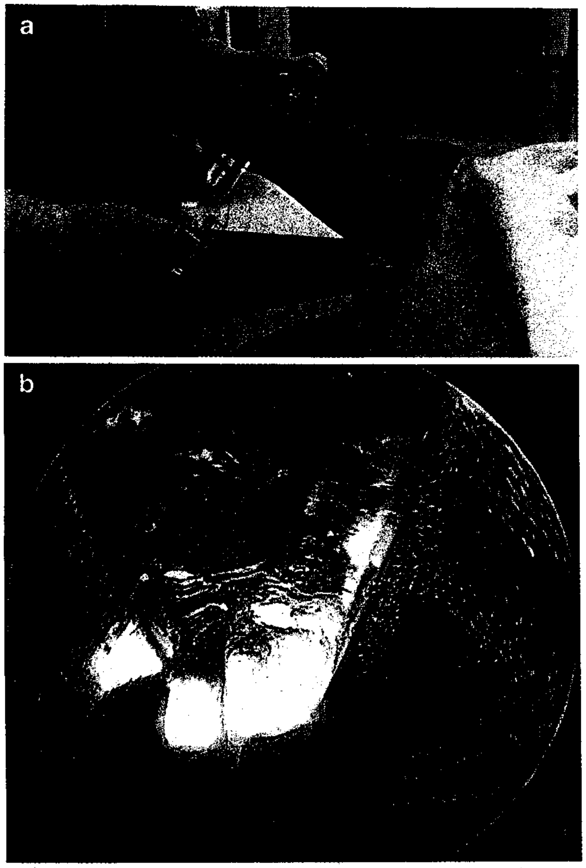

Fig. 40.9 Endoscopic insertion of a triangle blade from medial to incise the gastrocnemius aponeurosis (a) and endoscopic view (b)

should "fall in" (feel the release) as the gastrocnemius aponeurosis is lengthened and increase in range of motion of the ankle joint is distinguished. With increased range of motion identified, the equipment is removed. Often times, the plantaris tendon will maintain its integrity and can be palpated following removal of the equipment. This small tendon can often times be very strong and prevent a complete increase in range of motion. In this scenario, a small blade is used to complete a plantaris tenotomy, yielding a complete release and increased range of motion of the ankle joint. Closure should consist of one simple skin closure per incision site (Fig. 40.10).

The surgeon must be well versed with gastrocnemius recession prior to embarking on the EGR procedure. It is mandatory that the surgeon knows how to convert an attempted EGR into a medial open gastrocnemius recession. This technique employs removing all of the

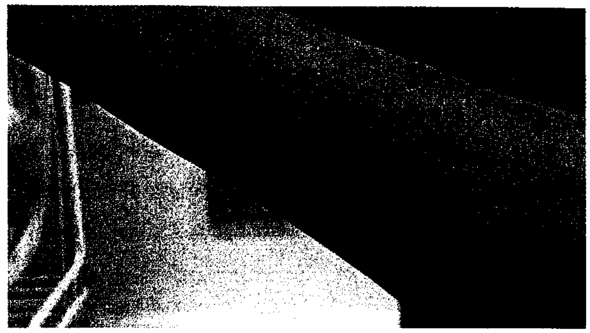

Fig. 40.10 Demonstrating the small, cosmetically pleasing incision site following the procedure

endoscopic equipment and extending the medial "stab incision" approximately 3–7 cm. The incision is then carried down to the level of the deep fascia. The deep fascia is incised and retracted protecting the sural nerve. At this time, the gastrocnemius aponeurosis is recognized and the lengthening is performed with a pair of scissors or blade. Again, attention to detail is mandated to be certain to incise any isolated septae within the soleus muscle belly and the plantaris tendon. Once a complete release is obtained, the deep closure followed by skin closure is performed.

40.5 Contraindications and Complications

Contraindications to equinus correction ultimately only include associated medical issues that would negate any surgery or the use of anesthesia. Many complications, such as nerve damage or entrapment of the sural nerve, infection, wound dehiscence, hematoma, under-lengthening, over-lengthening, weakness, cutting into the soleus muscle, and painful scar formation, can be attributed to surgical technique. Recurrence of the contracture is usually associated with incomplete release, incorrect procedure selection, and is especially associated with spastic forms.[6] Overcorrection is more of an issue with TAL as opposed to gastrocnemius recession and can be avoided by properly examining the patient's range of motion preoperatively as well as intraoperatively. EGR demonstrates minimal risk of over-lengthening, thereby decreasing the chance of calcaneal gait which is fraught with further complications.[8,38]

Caution should be exercised when performing EGR in patients with an increased body mass index, specifically those with an obese lower leg and ankle region. These patients are typically the most difficult on whom to accurately perform an EGR as there is a very small area in which to appropriately place the incision. Proper placement of the incision cannot always be confirmed if gastrocnemius and soleus anatomy are not easily palpable. In such patients, the aponeurosis distal to the muscle junction can be especially challenging to accurately identify.

40.6 Conclusion

Despite the learning curve for this procedure (as compared to open techniques), the authors believe that the endoscopic approach could be superior to any of the open techniques available to the foot and ankle surgeon. Decreased likelihood for postoperative complications, the ability to position the patient either supine or prone, decreased surgical time, and a more cosmetically appealing incision are all advantages of the EGR over the established open approach.

Patient positioning is best done supine as opposed to many older techniques, which require that the patient be prone. Since most additional foot and ankle procedures require the patient be supine, placing the patient and rotating from the prone position greatly increases surgical time and anesthesia risks.

EGR may allow for improved recovery with earlier ambulation. In most cases, the procedures performed in conjunction with EGR will dictate the patient's postoperative recovery period and weight-bearing status. Total surgical time for this procedure is typically no more than 4–8 min, and requires minimal additional surgical equipment. When this technique is appropriately applied it may enhance surgical outcomes and is therefore advocated by the authors for the correction of gastrocnemius equinus.

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