Understanding Equinus

This profound causal agent is commonly overlooked and under-treated.

BY PATRICK A. DEHEER, DPM

Goals and Objectives

After completing this CME, the reader should:

1) Understand the definition of equinus.

2) Understand the evaluation of equinus.

3) Understand the treatment of equinus based on evidence based medicine.

4) Become more aware of the role of equinus in foot and ankle pathology.

5) Include equinus treatment as part of a global treatment plan, when indicated.

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*Following this article, an answer sheet and full set of instructions are provided (pg. 150).—**Editor***

Equinus has been described as "the most profound causal agent in foot pathomechanics and is frequently linked to common foot pathology," and also has been described as "the greatest symptom producer of the human foot;" yet it is commonly overlooked and under-treated. The importance of equinus cannot be overstated, and its management is crucial to treating of the underlying pathology of all the following foot and ankle conditions as documented in the literature: Heel spur syndrome/plantar fasciitis, Achilles tendinopathy, posterior tibial tendon dysfunction, diabetic foot ulcers, Charcot neuropathy, metatarsalgia, Morton's neuroma, lesser MPJ pathologies—PDS, capsulitis, hallux valgus, hammer digit

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syndrome, ankle fracture/sprains, Sever's disease, pediatric flatfoot deformity, osteoarthritis forefoot/midfoot, 1st ray hypermobility, pes plano valgus, hallux limitus, sesamoiditis, lateral column syndrome, Freiberg's infarction, and forefoot callus. So, if equinus is so prevalent, how come there is often a failure in recognition, association to pathology, and treatment of this condition?

There are several factors at play that all lead to this under-appreciation and lack of treatment with equinus. It all starts with the definition of equines, as there is no standard definition. The next crucial factor is the lack of appreciation of the relationship between equinus and the above-listed pathologies. Finally, the lack of treatment is related directly to ineffectual conservative management of the condition. Let's take a journey through equinus to fully understand the condition, and hopefully therefore bring to it the respect it is due.

Anatomy

Most pathologies of the foot and ankle start with anatomy. The anatomy of the triceps surae consists of the gastrocnemius, soleus, and plantaris muscles. The gastrocnemius muscle originates on the posterior aspect of the femoral condyles and posterior knee capsule with the medial head being the larger of the two, and descending further distally. The gastrocnemius muscle crosses the knee, ankle, and subtalar joints. This is a very important factor; the multi-joint crossing is directly related to the most common form of equinus, gastrocnemius equinus. The aponeurosis of the gastrocnemius muscle is anterior to the muscle. Its primary blood supply is from the popliteal and sural arteries, and it is innervated by the tibial nerve. The gastrocnemius primary act to supply power for propulsion, knee flexion, and plantarflexion of the ankle joint (Figure 1).

The soleus originates on the posterior aspect of the head of the fibular, the middle one-third of the medial border of the tibia, the soleal line, and the interosseous membrane. The aponeurosis of the soleus is posterior to the muscle. The soleus only crosses the ankle and subtalar joints. The soleus is innervated by the tibial nerve and its arterial supply is that of the tibial, peroneal, and sural arteries. The primary function of the sural artery is to stabilize the leg onto the foot and plantarflex the ankle joint.

There is a well-documented zone of hypovascularity 4-5 cm proximal to the insertion of the Achilles tendon.

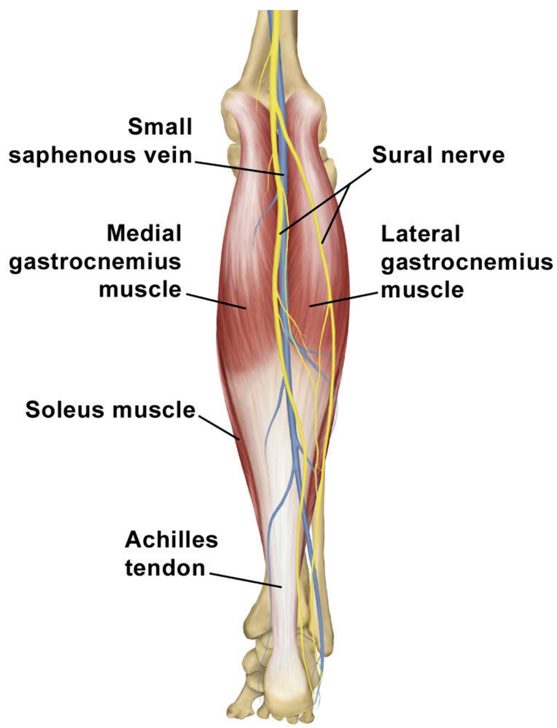

Figure 1: Posterior view of the GSC complex and related anatomical structures.

The gastrocnemius primary act to supply power for propulsion, knee flexion, and plantarflexion of the ankle joint

The plantaris tendon originates medial and superior to the lateral head of the gastrocnemius muscle at the lateral head of the femoral condyle, coursing lateral to the gastroc-soleal complex and medial to it. The plantaris tendon can be absent 7% of the time.

The Achilles tendon is the continuation of the aponeurosis of the gastrocnemius and soleus merging together. forming the largest, thickest, strongest tendon in the body, approximately 15 centimeters long. The tendon inserts into the middle one-third of the posterior aspect of the calcaneus with the plantaris tendon inserting medial to the Achilles tendon. There is a retrocalcaneal bursa between the Achilles tendon and the calcaneus. The fibers of the Achilles tendon rotate laterally approximately 90° so that the gastrocnemius fibers insert primarily laterally and the soleus fibers insert primarily medially. The tendon is surrounded by a tendon sheath which allows gliding of the tendon, and below this sheath is the paratenon, which protects and nourishes the tendon. The

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vascular supply of the Achilles tendon is from the myotendonous junction, the paratenon, and the calcaneal periosteum. There is a well-documented zone of hypovascularity 4-5 cm proximal to the insertion of the tendon.

Definition

After understanding the anatomy, the definition becomes the next most crucial factor and is surprisingly difficult, especially among different specialties. The definition of equinus ranges from -10° to + 22° in the literature, with +10° as a consensus of thirteen different studies. Sgarlato[36] in *The Journal of American Podiatric Medical Association* in 1975 first described the definition as +10° with the subtalar joint in neutral position and the midtarsal joint locked.

Pseudoequinus

There are two primary types of equinus—muscular and osseous, with subgroups of each kind. In the muscular group there can be either spastic or non-spastic equinus. Either of these subgroups of spastic or non-spastic equinus can further be broken down into gastrocnemius or gastro-soleus equinus. The osseous forms of equinus include: anterior tibiotalar exostosis (best seen on a lateral charger view on X-ray), distal tibial-fibular osseous bridging from prior trauma, pseudoequinus and combined equinus. Pseudoequinus occurs in the cavus foot structure where ankle joint dorsiflexion occurs to dorsiflex the forefoot, which is plantarflexed to the rearfoot. The ankle dorsiflexion used to do this then limits the amount available for normal ambulation, therefore the term pseudoequinus. The combined equinus is just a combination of one type of muscular and osseous equinus.

Figure 2: The Silfverskiold test is used to evaluate for equinus. This demonstrates evaluation of the dorsiflexion of the ankle joint with the knee extended.

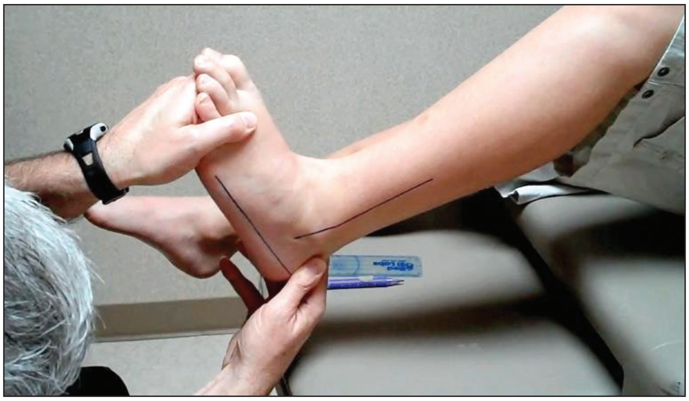

Figure 3: Evaluation of the ankle joint dorsiflexion with the knee bent removes the pull of the gastrocnemius muscle and allows the practitioner to determine whether equinus is gastrocnemius equinus or gastroc-soleal equinus.

Clinical Evaluation

Evaluation of equinus clinically is one of the primary stumbling blocks between professions that inhibit effective communication. The Silfverskoild test is what is used to determine the type of equinus. In this examination, the subtalar is placed in neutral position and the midtarsal joint is locked by supination of the forefoot. The ankle is dorsiflexed maximally with the knee in full extension and then checked with the knee in flexion (Figures 2 and 3). If the ankle joint dorsiflexes greater than 90° with both the knee extended and flexed, there is no equinus. If the ankle joint dorsiflexes greater than 90° with the knee flexed by less than 90° with the knee extended, the result is gastrocnemius equinus. If the ankle dorsiflexion is less than 90° with both the knee flexed and extended, then it can either be gastroc-soleus equinus or osseous equinus. This is determined by the quality of the end range-of-motion and with a charger dorsiflexion stress lateral ankle x-ray. A soft end range-of-motion is more likely a gastroc-soleus equinus, especially if no anterior ankle impingement is noted on the x-ray.

If the ankle joint dorsiflexes greater than 90° with the knee flexed by less than 90° with the knee extended, the result is gastrocnemius equinus.

Biomechanics of Equinus

Understanding the biomechanics of equinus is crucial to getting an appreciation of the devastation it has on the foot pathomechanics. The center of pressure is about 6 cm anterior to the ankle, roughly over the dorsal 2nd metatarsal-cuneiform joint. This would make us fall forward in normal standing, but that reaction is is negated by the pull of the plantarflexors. The triceps surae has been documented to be the pri-

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mary plantarflexor of the ankle joint and therefore offsets the anteriorly displaced center of pressure. It has further been demonstrated with equinus that the center of pressure moves about 3 cm distally and 3 mm laterally (Figures 4 and 5).

The important concept lies in the relation of the subtalar axis to the center of pressure and the subtalar axis to the insertion of the Achilles tendon. The Achilles tendon inserts medially to the subtalar axis and its distance from the axis is about the same as the laterally placed center of pressure to the subtalar axis in a foot with a normal subtalar axis and no equinus. The medial position of the Achilles creates a supinatory moment, while the lateral center of pressure due to ground reactive forces (GFR) creates a pronatory moment. These two cancel each other out, providing a rectus foot structure.

When equinus is present, the distal and lateral positioning of the center of pressure in relation to the subtalar axis creates an increased pronatory effect on the foot due to GRF, which is not offset by the supinatory effect of the Achilles tendon. When the subtalar joint axis is more medially deviated, such as in a pronated foot, this further distances the center of pressure from the subtalar axis, causing even more pronatory deformity due to GRF. The opposite occurs in the supinated foot, where the subtalar joint axis is more laterally deviated to the point where even the center of pressure is on the subtalar axis, medial to the subtalar axix or just lateral to the subtalar axis. This puts both the Achilles and center of pressure in supinatory moments (or at least is a lesser pronatory moment than the supinatory moment of the Achilles tendon) due to GRF—therefore making a cavus foot worse over a period of time due to increased rearfoot varus, peroneal pathology, and subtalar instability.

An important question that is often overlooked in the biomechanical discussion of equinus is the effect of pronation on the GSC.

Johnson and Christensen[17] examined the effects of equinus on first ray pathomechanics using cadaver weight-bearing models in their landmark series on first ray pathomechanics. Sensors were applied to each of the individual bones making up the medial column of the foot. Loading of the Achilles tendon was applied and then three-dimensional data were recorded for each segment of the medial column. The results showed plantarflexion of the talus and navicular, and dorsiflexion of the medial cuneiform and 1st metatarsal occurring through the naviculacuneiform joint. This occurs due to dampening of the effect of the peroneal longus tendon eversion of the medial cuneiform that leads to locking of the midtarsal joint. This lack of midtarsal joint locking leads to the above described medial column instability. This study showed that the effect of equinus is not a stretching of the plantar ligaments over a period of time that leads to first ray instability but, in fact, is a dampening of the peroneus longus function that leads to first ray hypermobility.

An important question that is often overlooked in the biomechanical discussion of equinus is the effect of pronation on the GSC. Kevin Kirby, DPM says via personal communication, "accommodative shortening of the GSC will occur with prolonged medial deviation of the STJ axis and flattening of the medial arch of the foot."

Sgarlato[36] described three types of compensation for equinus. The uncompensated equinus deformity manifests itself as a toe walker due to lack of ankle joint dorsiflexion and/or MTJ pronation to get the heel down to the ground. This accounts for about only 1% of equinus cases. In the partially compensated equinus deformity, the heel is on the ground but the tibia does not achieve 10 degrees of flexion to the ground. This results in an early heel-off gait pattern. When the equi-

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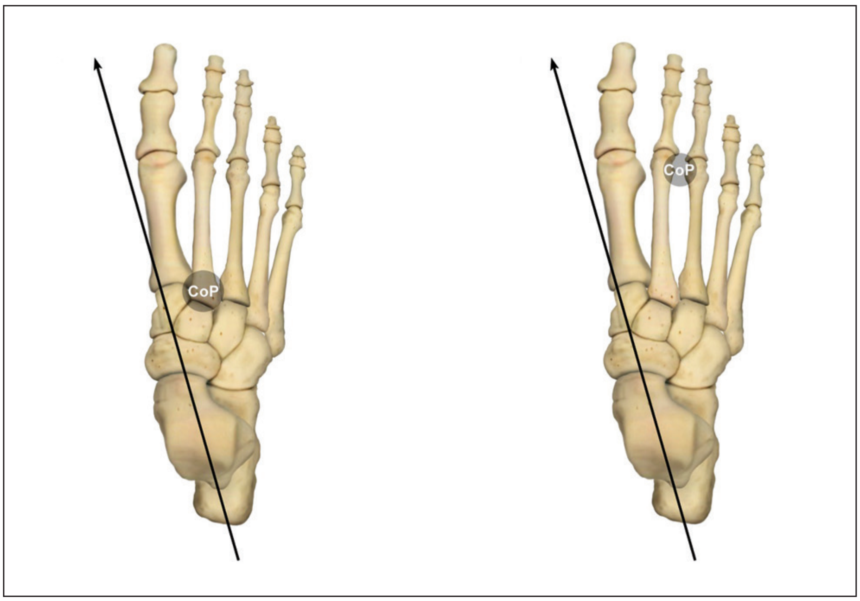

Figures 4 & 5: The center of pressure is located as shown on the left drawing approximately 6 cm distal to the ankle joint. With equinus deformity the center of pressure moves distal and lateral further away from the subtalar joint axis as shown on the right drawing.

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nus deformity is fully compensated, the result is the severely pronated, hypermobile foot with heel contact to ground and the tibia achieving more than 10 degrees of flexion to the ground. Heel-off in the fully compensated equinus deformity is normal.

The proximal pathologies associated with equinus are numerous and easily overlooked due to the profound distal pathologies that often overshadow these proximal deformities. Lumbar lordosis, hip flexion, knee flexion, genu recurvatum, and hamstring contractures have all been attributed to equinus. The more obvious distal pathologies that directly result from or have a relationship to equinus will be discussed with some of the well-documented literature.

In Hill's[15] article, the incidence of equinus with pathological conditions was studied by examining 209 new patient visits over a six week period of time. Twenty-nine patients were excluded from the study because they did not meet study criteria. Of the remaining 174 patients, six had normal ankle joint dorsiflexion, leaving 168 of the patients exhibiting equinus. Three of the patients had gastrocnemius equinus and 165 had GSC equinus. Their definition for equinus was less than 3-degrees dorsiflexion with knee extension. Their findings were that 96.5% of the patients with foot and ankle pathology exhibited equinus.

In Mueller's study, the forefoot pressures decreased 31% and the rearfoot pressures increased by 34%.

DiGiovanni[8] in the *Journal of Bone and Joint Surgery* (2002) examined ankle joint dorsiflexion in symptomatic patients and a control group, and the reliability of goniometer testing. The ankle joint dorsiflexion with the knee extended averaged 4.5 degrees in the symptomatic group and 13.1 degrees in the control group. The percentage of symptomatic patients with less than 5 degrees dorsiflexion was 65% and the control group was 24%, while the amount with less than 10 degrees dorsiflexion was 88% and 44%, respectively. The correct diagnosis via a goniometer, confirmed with an equinometer for the less than 5 degree group, was 76% for the symptomatic group and 94% for the control group, while the 10 degree group diagnosis was correct 88% and 79%, respectively.

Patel and DiGiovanni[25] found that 83% of plantar fasciitis cases were associated with equinus.

This study has helped to clarify the definition of equinus, which has a wide range of definitions in the literature, with the most common definition being 10 degrees of dorsiflexion with the knee extended and the subtalar joint in neutral position and the midtarsal joint locked. This was originally described by Sgarlato[36] in *JAPMA* 1975. According to DiGiovanni's[8] findings, with ankle joint dorsiflexion of less than 5 degrees, the correct diagnosis was made 76% of the time in the symptomatic group, and the incorrect diagnosis was avoided in 94% of the time in the control group. I believe the standard definition for equinus should therefore be 5 degrees of ankle joint dorsiflexion with the knee extended based on the findings of this study. Arriving at a standard definition is crucial for equinus and is the first step to standardized treatment protocols.

Aronow's[1] study was one of the first to not only explore the changes on forefoot and rearfoot pressures associated with equinus, but also to examine the midfoot changes as well. A load was applied to the GSC and then to just the gastrocnemius muscle, and then the changes in pressures were measured. In the GSC group, the rearfoot pressures decreased (18%) and the midfoot (38%) and forefoot (59%) increased. In the gastrocnemius group, the rearfoot pressures decreased (16%) and the midfoot (32%) and forefoot (50%) increased. These numbers were very consistent with other studies on the effect of equinus and forefoot pressure changes, such as Jones[18] in *The American Journal of Anatomy* in 1941 and Ward[43] in *The Journal of the American Podiatric Medical Association* in 1998. When the loads were removed, the pressures on the forefoot decreased 32% and the rearfoot pressures increased 32%. These additional findings were similar to those of Mueller[22] in *The Journal Bone and Joint Surgery* 2003, who measured the effect of a tendo-Achilles lengthening on pressure changes in the foot. In Mueller's study, the forefoot pressures decreased 31% and the rearfoot pressures increased by 34%.

Plantar Fasciitis and Equinus

The relationship with plantar fasciitis and equinus is well documented in the literature, with an estimated 2,000,000 cases of plantar fasciitis per year in the United States. Patel and DiGiovanni[25] found that 83% of plantar fasciitis cases were associated with equinus. Cheung, et al.[3] showed that equinus caused twice the amount of strain on the plantar fascia as body weight. This reaffirmed the close relationship between plantar fasciitis and equinus. Any treatment plan for plantar fasciitis must include

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equinus management.

Treatment of equinus can be broken down into either conservative care or surgical care. As with most pathologies, conservative care should be attempted initially. The two main forms of conservative care are manual stretching and bracing.

Radford, et al.[28] in a meta-analysis showed that calf muscle stretching provided a small but statistically significant increase in ankle joint dorsiflexion. Their analysis showed that 15 to 30 minutes per day provided the greatest amount of ankle joint dorsiflexion (3.03 degrees) for each of the three groups. Grady and Saxena[12] in their study had patients stretch once per day over a six-month period of time for 30 seconds, 2 minutes, or 5 minutes with the knee extended. The increase in ankle joint dorsiflexion for each group was 2.15, 2.3, and 2.7 degrees, respectively. These totals were not statistically significant, but when one takes into account the minimal amount of stretching done daily, the results are actually encouraging.

According to Hill, it is critical that the foot be adducted 10 degrees during the stretching to lock the subtalar-midtarsal joints for maximum benefit at the calf.

Hill[15] discussed the problems with manual stretching stating, "Active stretching requires detail in teaching the proper technique, and must be done at least four times a day at five-minute to eight-minute sessions. The most serious mistakes patients make during their previous attempts at stretching are inadequate stretch time and abducted foot position during the stretch. It is critical that the foot be adducted 10 degrees during the stretching to lock the subtalar-midtarsal joints for maximum benefit at the calf."

Night splints have long been the only mode of bracing for equinus treatment, but there are several flaws with them. First, they are designed to be used at night while sleeping and the most common sleeping position with these braces is on the side with knees bent. This means that the gastrocnemius muscle is not being stretched. Remembering that the gastrocnemius muscle crosses both the knee and ankle, it is most often the contracted structure. This accounts for the ineffective nature of night splints. Based on our personal experience, compliance with night splints is also very poor. These two factors led to the mediocre results attributed to night splints as described in the Evans[9] study, which showed only 6 of 20 patients achieving 10 degrees of dorsiflexion with the use of night splints.

A study by Evans showed only 6 of 20 patients achieving 10 degrees of dorsiflexion with the use of night splints.

Compliance Issues

The compliance issues associated with manual stretching (the daily stretching time, the length of therapy for complete resolution of deformity, and the technical difficulty performing the runner's stretch correctly) and the ineffectiveness of night splints (not extending above the knee, lack of dorsiflexion control, and sleep disturbance) make the conservative treatment of equinus seem tenuous. Ideally, bracing should produce more consistent results compared to manual stretching based solely on compliance, particularly if the bracing did not require the patient to sleep in the brace. The limitations of bracing have been addressed with a new bracing option that checks all the boxes of ideal equinus bracing. Ideal bracing concepts include all the following attributes.

1) The brace must extend above the knee—It is uncomfortable to dorsiflex the ankle while fully extending the knee. Expecting a patient to wear a traditional night splint while extending the knee is not reliable. The patient must be forced to dorsiflex the ankle while the knee is being held in full extension. This is mandatory for adequate stretching of the gastrocnemius muscle.

2) The brace must allow for controllable dorsiflexion of the ankle—The use of traditional night splints can lead to over-stretching of the gastroc-soleus complex (GSC) due to a lack of adjustable hinges at the ankle. These braces are, more often than not, based on tension applied by straps. It is difficult to gauge how much dorsiflexion is occurring in this situation. Over-stretching results in a different pathological paradigm.

3) Supination of the subtalar joint while dorsiflexing the ankle joint—If a dorsiflexion force is applied to the foot while the subtalar joint is pronated, the dorsiflexion occurs in the midfoot and hindfoot. Dorsiflexion through the midfoot is not desirable when treating equinus. The dorsiflexion must be isolated to the hindfoot. Supination of the subtalar joint eliminates midfoot dorsiflexion and isolates it to the hindfoot. The subtalar joint can be supinated by engaging the windlass mechanism via dorsiflexion of the hallux. A brace that incorporates a 60-70° wedge under the hallux can engage the windlass mechanism in

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such a manner. Full extension of the knee requires external rotation of the tibia, known as the screw home mechanism. External rotation of the tibia can only happen with supination of the subtalar joint. Based on these two factors, supination of the subtalar joint is critical for stretching of the GSC.

The surgical approach to equinus is well documented in the literature and focuses mainly on two different procedures, the tendo-Achilles lengthening (TAL) or gastrocnemius recession.

4) A compliant friendly treatment protocol—Based on the Radford, et al. study, I have utilized one hour per day of bracing to stretch the GSC.[28] The study showed that the longer the stretch, the greater the resultant increase in range-of-motion. The greater than 30-minute group in the study was underpowered according to the authors, but resulted in approximately a 3° increase in ankle joint dorsiflexion. Since the normative value is 5° of ankle joint dorsiflexion based on the study by DiGiovanni, et al., double the 30 minutes should result in the additional range-of-motion required to normalize ankle joint dorsiflexion.[8] Many studies utilize a six-week program of stretching; however, I believe it takes 8-12 weeks to fully stretch the GSC.

5) Maintenance program once the equinus deformity is fully corrected—Due to anatomy, aging, and factors related to the Law of Davis (over time soft tissue contracts to the shortest length possible) a maintenance program is required in most cases, particularly high functional demand patients (athletes) or pathological situations (diabetes) where there is a tendency for the GSC to tighten. Maintenance therapy must be individualized for each patient. Start by having the patient use the brace for one hour per day, one day per week. Check the patient after four weeks and measure the ankle joint dorsiflexion with the knee extended. If the measurement is greater than 5°, then the patient's maintenance therapy is stretching once per week for one hour. If the measurement is below 5°, then the patient stretches twice a week, and is re-evaluated after four more weeks. This process is utilized until the patient maintains 5° of ankle joint dorsiflexion with the knee extended.

Surgical Approaches to Equinus

The surgical approach to equinus is well documented in the literature and focuses on mainly two different procedures, the tendo-Achilles lengthening (TAL) or gastrocnemius recession. The TAL approach most commonly utilized is the Hoke triple hemisection. This procedure employs three stab incisions starting one centimeter proximal to the insertion of the GSC, with two medial incisions and one lateral incision between the two medial incisions. The tendon is sectioned through the central portion and incised in the respective direction of the stab incisions. The tendon then slides to a lengthened position. This procedure is not without potential complications, such as under-lengthening, or much worse, over-lengthening.

The gastrocnemius recession is one of our favorite procedures and is well documented in the literature. We prefer the Bauman intramuscular approach to lengthening of the gastrocnemius aponeurosis. This provides controlled, sequential lengthening. The incision is placed at the medial aspect of the calf, midway between the posterior calf and anterior border of the tibia. The incision is typically 3-4 cm long and is deepened to the level of the deep fascia. The fascia is incised, revealing the gastrocnemius and soleus muscle bellies. Using a finger to identify the natural separation between the aponeurosis of the two muscles, an anal speculum is inserted to spread them apart. The foot is dorsiflexed with the knee extended, and a long-handled #15 blade is used to cut the proximal portion of the gastrocnemius aponeurosis, including the intramuscular septum. This is a complete release from lateral to medial. The foot is dorsiflexed and the positioned examined. If inadequate dorsiflexion is noted, a second more distal (1 cm distal to the initial release) incision is recommended over a soleus recession (this is based on the study by Herzenberg and Lamm[14] in *Foot and Ankle International* 2007.) The pre-operative group had 1 degree of ankle joint dorsiflexion with the knee extended, and after gastrocnemius recession, single and double dorsiflexion increased significantly (9 and 15 degrees, respectively). Adding a soleus recession only increased dorsiflexion by one degree—thus it is more effective to perform a double gastrocnemius recession.

The treatment of equinus alone has shown to be effective for foot symptomatology without doing anything to the pathology within the foot.

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foot. Maskill, et al.[21] examined the effect of an isolated gastrocnemius recession on 29 patients (34 feet) that failed six months of conservative therapy. The measure was the visual analog scale (VAS) and there were three categories of patients (plantar fasciitis, midfoot pain, and arch pain). The VAS scores pre-operatively and post-operatively were as follows for each group: plantar fasciitis 8.1 to 1.9, midfoot pain 7.5 to 2.2, and arch pain 9.3 to 3.3. These drastic pain scale changes were the result of only a gastrocnemius recession without doing anything to the foot.

Equinus is an underlying factor in most of the pathologies associated with the foot and ankle and must be addressed either conservatively or surgically as part of the overall treatment plan for any condition associated with it.

Equinus is an underlying factor in most of the pathologies associated with the foot and ankle and must be addressed either conservatively or surgically as part of the overall treatment plan for any condition associated with it. If the equinus deformity is left untreated, the condition is never fully treated and outcomes are not as high as they should be. Education of patients to the importance of equinus treatment in their overall treatment plan must be discussed to ensure compliance and the highest overall outcomes. PM

References

[1] Aronow, MS; Diaz-Doran, V; Sullivan, RJ; Adams, DJ. The effect of triceps surae contracture force on plantar foot pressure distribution. Foot Ankle Int. 27:43-52, 2006.

[2] Charles, J; Scutter, SD; Buckley, J. Static ankle joint equinus. J Am Podiatr Med Assoc. 100:195-203, 2010.

[3] Cheung, JT; Zhang, M; An, KN. Effect of Achilles tendon loading on plantar fascia tension in the standing foot. Clin Biomech. 21:194-203, 2006.

[4] Chimera, NJ; Castro, M; Manal, K. Function and strength following gastrocnemius recession for isolated gastrocnemius contracture. Foot Ankle Int. 31:377-384, 2010.

[5] Dananberg, HJ; Shearstone, J; Guiliano, M. Manipulation method for the treatment of ankle equinus. J Am Podiatr Med Assoc. 90:385-389, 2000.

[6] Davis, PF; Severud, E; Baxter, DE. Painful heel syndrome: results of non-operative treatment. Foot Ankle Int. 15:531-535, 1994.

[7] Dietz, FR; Albright, JC; Dolan, L. Medium term follow up of Achilles tendon lengthening in the treatment of ankle equinus in cerebral palsy. Iowa Orthop J. 26:27-32, 2006.

[8] DiGiovanni, CW; Kuo, R; Tejwani, N; Price, R; Hansen Jr, ST; Cziernecki, J; Sangeorzan, BJ. Isolated gastrocnemius tightness. J Bone Joint Surg Am. 84:962-970, 2002.

[9] Evans, A. Podiatric medical applications of posterior night stretch splinting. J Am Podiatr Med Assoc. 91:356-360, 2001.

[10] Flanigan, RM; Nawoczenski, DA; Chen, L; Wu, H; DiGiovanni, BF. The influence of foot position on stretching of the plantar fascia. Foot Ankle Int. 28:815-822, 2007.

[11] Grady, JF; Kelly, C. Endoscopic gastrocnemius recession for treating equinus in pediatric patients. Clin Orthop Relat Res. 468:1033-1038, 2010.

[12] Grady, JF; Saxena, A. Effects of stretching the gastrocnemius muscle. J Foot Surg. 30:465-469, 1991.

[13] Grant, WP; Sullivan, R; Sonenshine, DE; Adam, M; Slusser, JH; Carson, KA; Vinik, AI. Electron microscopic investigation of the effects of diabetes mellitus on the Achilles tendon. J Foot Ankle Surg. 36:272-278, 1997.

[14] Herzenberg, JE; Lamm, BM; Corwin, C; Sekel, J. Isolated recession of the gastrocnemius muscle: the Baumann procedure. Foot Ankle Int. 28:1154-1159, 2007.

[15] Hill, RS. Prevalence and linkage to common foot pathology. J Am Podiatr Assoc. 85:295-300, 1995.

[16] Holstein, A. Hallux Valgus—an acquired deformity of the foot in cerebral palsy. Foot Ankle. 1:33-38, 1980.

[17] Johnson, CH; Christensen, JC. Biomechanics of the first ray part V: the effect of equinus deformity. J Foot Ankle Surg. 44:114-120, 2005.

[18] Jones, RL. The human foot. An experimental study of its mechanics, and the role of its muscles and ligaments in the support of the arch. Am J Anat. 68:1-38, 1941.

[19] Lamm, BM; Paley, D; Herzenberg, JE. Gastrocnemius soleus recession. A simpler, more limited approach. J Am Podiatr Med Assoc. 95:18-25, 2005.

[20] Lavery, LA; Armstrong, DG; Boulton, AJ. Ankle equinus deformity and its relationship to high plantar pressure in a large population with diabetes mellitus. J Am Podiatr Med Assoc. 92:479-482, 2002.

[21] Maskill, JD; Bohay, DR; Anderson, JG. Gastrocnemius recession to treat isolated foot pain. Foot Ankle Int. 31:19-23, 2010.

[22] Mueller, MJ; Sinacore, DR; Hastings, MK; Strube, MJ; Johnson, JE. Effect of Achilles tendon lengthening on neuropathic plantar ulcers. A randomized clinical trial. J Bone Joint Surg. 85-A:1436-1445, 2003.

[23] Myers, KA; Long, JT; Klein, JP; Wertsch, JJ; Janisse, D; Harris, GF. Biomechanical implications of the negative heel rocker sole shoe: Gait kinematics and kinetics. Gait Posture. 24:323-330, 2006.

[24] Nemec, SA; Habbu, RA; Anderson, JG; Bohay, DR. Outcomes following midfoot arthrodesis for primary arthritis. Foot Ankle Int. 32:355-361, 2011.

[25] Patel, A; DiGiovanni, B. Association between plantar fasciitis and isolated contracture of the gastrocnemius. Foot Ankle Int. 32:5-8, 2011.

[26] Pinney, SJ; Sangeorzan, BJ; Hansen Jr, ST. Surgical anatomy of the gastrocnemius recession (Strayer procedure). Foot Ankle Int. 25:247-250, 2004.

[27] Porter, D; Barrill, E; Oneacre, K; May, BD. The effects of duration and frequency of Achilles tendon stretching on dorsiflexion and outcome in painful heel syndrome: A randomized, blinded, control study. Foot Ankle Int. 23:619-624, 2002.

[28] Radford, JA; Burns, J; Buchbinder, R; Landorf, KB; Cook, C. Does stretching increase ankle dorsiflexion range of motion? A systematic review. Br J Sports Med. 40:870-875, 2006.

[29] Reimers, J; Pedersen, B; Broder-

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Equinus (from page 148)

sen, A. Foot deformity and the length of the triceps surae in Danish children between 3 and 17 years old. J Pediatr Orthop [B]. 4:71-73, 1995.

[30] Rompe, JD; Cacchio, A; Weil Jr, L; Furia, JP; Haist, J; Reiners, V; Schmitz, C; Maffulli, N. Plantar fascia-specific stretching versus radial shock-wave therapy as initial treatment of plantar fasciopathy. J Bone Joint Surg Am. 92:2514-2522, 2010.

[31] Roukis, TS; Schweinberger, MH. Complications associated with uni-portal endoscopic gastrocnemius recession in a diabetic patient population: An observational case series. J Foot Ankle Surg. 49:68-70, 2010.

[32] Rush, SM; Ford, LA; Hamilton, GA. Morbidity associated with high gastrocnemius recession: Retrospective review of 126 cases. J Foot Ankle Surg. 45:156-160, 2006.

[33] Saxena, A; Kim, W. Ankle dorsiflexion in adolescent athletes. J Am Podiatr Med Assoc. 93:312-314, 2003.

[34] Saxena, A; Ramdath, S; O'Halloran, P; Gerdesmeyer, L; Gollwitzer, H. Extra-corporeal pulsed-activated therapy for Achilles tendinopathy: A prospective study. J Foot Ankle Surg. 50:315-319, 2011.

[35] Scharfbillig, RW; Jones, S; Scutter, SD. Sever's disease: What does the literature really tell us? J Am Podiatr Med Assoc. 98:212-223, 2008.

[36] Sgarlato, TE; Morgan, J; Shane, HS; Frenkenberg, A. Tendo Achilles lengthening and its effect on foot disorders. J Am Podiatry Assoc. 65:849-871, 1975.

[37] Sheridan, L; Lopez, A; Perez, A; John, MM; Willis, FB; Shanmugam, R. Plantar fasciopathy treated with dynamic splinting. A randomized controlled trial. J Am Podiatr Med Assoc. 100:161-165, 2010.

[38] Stovitz, SD; Coetzee, C. Hyperpronation and foot pain. Phys Sportsmed. 32:19-26, 2004.

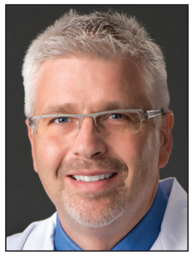
[39] Strayer, LM. Recession of the gastrocnemius: An operation to relieve spastic contracture of the calf muscles. J Bone Joint Surg Am. 32:671-676, 1950.

[40] Tabrizi, P; McIntyre, WMJ; Quesnel, MB; Howard, AW. Limited dorsiflexion predisposes to injuries of the ankle in children. J Bone Joint Surg Br. 82:1103-1106, 2000.

[41] Thordarson, DB; Schmotzer, H; Chon, J; Peters, J. Dynamic support of the human longitudinal arch. Clin Orthop Rel Res. 316:165-172, 1995.

[42] Vallejo, RB; Iglesias, ME; Sanz, DR; Frutos, JC; Fuentes, PS; Chicharro, JL. Plantar pressures in children with and without Sever's disease. J Am Podiatr Med Assoc. 101:17-24, 2011.

[43] Ward, ED; Phillips, RD; Patterson, PE; Werkhoven, GJ. The effects of extrinsic muscle forces on the forefoot-to-rearfoot loading relationship in vitro. J Am Podiatr Med Assoc. 88:471-482, 1998.



Dr. DeHeer is in private practice in Central Indiana. He is the team podiatrist for the Indiana Pacers and the Indiana Fever and is on the editorial Board of Podiatry Today. He is the inventor of the EQ/IQ brace, President and Founder of Wound Care Haiti, and a medical missionary. Dr. DeHeer is President of the Indiana Podiatric Medical Association and continuing education chairperson. He is recipient of the 2011 APMA Humanitarian of the Year Award.

CME EXAMINATION

SEE ANSWER SHEET ON PAGE 151.

1) Muscular equinus includes:
- A) Spastic equinus
- B) Non-spastic equinus
- C) Distal tibial-fibular osseous bridging
- D) A & B

2) Osseous equinus includes:
- A) Anterior spurring of the ankle joint
- B) Distal tibial-fibular osseous bridging
- C) Pseudoequinus
- D) All of the above

3) There is a gastrocnemius equinus when:
- A) The ankle joint dorsiflexes greater than 90 degrees with the knee extended
- B) The ankle joint dorsiflexes less than 90 degrees with the knee extended
- C) The ankle joint dorsiflexes greater than 90 degrees with the knee flexed
- D) B & C

4) The ____________ test is used to determine the type of equinus.
- A) Silfverskoild
- B) Coleman block
- C) Hubscher
- D) Jack's

5) The proximal pathology NOT associated with equinus is:
- A) Hamstring contractures
- B) Quadriceps contractures
- C) Genu recurvatum
- D) Lumbar lordosis

Continued on page 150

6) Which of the following is NOT seen in a partially compensated equinus?
A) Early heel-off gait pattern
B) The heel is on the ground
C) Toe walking
D) Tibia does not achieve 10 degrees of flexion to the ground

7) According to the study by Aronow, when a load was applied to the gastrocnemius muscle, which of the following did NOT happen?
A) Rearfoot pressures decreased
B) Midfoot pressures decreased
C) Midfoot pressures increased
D) Forefoot pressures increased

8) According to the study by Mueller, which occurred as an effect of a tendo-Achilles lengthening?
A) Forefoot pressures increased
B) Forefoot pressures decreased
C) Rearfoot pressures decreased
D) Rearfoot pressures remained the same

9) What percentage of plantar fasciitis cases was associated with equinus in the study by Patel and DiGiovanni?
A) 95%
B) 100%
C) 83%
D) 50%

10) Based on the study by Herzenberg and Lamm, which of the following is most effective?
A) A double gastrocnemius recession
B) A soleus recession
C) A single gastroc recession
D) A single gastroc with the addition of a single soleus recession

SEE ANSWER SHEET ON PAGE 151.

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EXAM #4/17
Understanding Equinus
(DeHeer)

Circle:

1.	A	B	C	D	6.	A	B	C	D
2.	A	B	C	D	7.	A	B	C	D
3.	A	B	C	D	8.	A	B	C	D
4.	A	B	C	D	9.	A	B	C	D
5.	A	B	C	D	10.	A	B	C	D

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Strongly agree [5]	Agree [4]	Neutral [3]	Disagree [2]	Strongly disagree [1]

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A B C D

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