IDIOPATHIC TOE WALKING

Toe walking is a common feature in immature gait and is considered normal up to 3 years of age. As walking ability improves, initial contact is made with the heel.

Toe walking gives rise to parental concern. Therefore, toe-walkers are often referred at the 3 years of age.

For children who persistently walk on their toes present, orthopedic surgeons must consider whether there is an underlying cause for the observed gait (ie, an abnormality of the musculoskeletal or neurologic system) or the toe walking is idiopathic.

Differential Diagnosis

1. Duchenne muscular dystrophy
2. Abnormal psychological profiles must be considered.
3. Mild cerebral palsy with diplegia (CP) and idiopathic
4. Toe walking (ITW).

Children who have ITW who present young and have no calf contracture are best considered as having overactive triceps surae. Whether persistent toe walking results in true shortening of the calf over time is uncertain.

Children who have ITW have normal hamstring length, and this is often used to distinguish these groups clinically. However, it is not reliable, and therefore gait analysis has been used to define the differences.

In the CP group, any abnormality observed at the ankle is not the primary deformity. Instead, the equinus is secondary to knee posture consequent on contracture of the hamstrings. A group of normal children, when

asked to walk on their toes, showed kinematics identical to the ITW subjects.

Management of Idiopathic Toe Walking

1. Management of children who have idiopathic toe walking is controversial.
2. Predicting whether an individual's gait will spontaneously improve to allow heel strike at initial contact is not possible currently.
3. Based on the assumption that ITW often improves without intervention, reassurance alone is one treatment option commonly used.
4. Recognition is increasing that a wide variety of pathologies are associated with longstanding calf contracture.

Treatment without surgery

a. **Always nonoperative**: Hirsch reported on the outcome of long-term follow-up in 14 children at 7 to 21 years.

Regime: Passive stretching regimen

5 underwent a period of casting (<4 weeks)

Physiotherapy with or without night splints.

The authors concluded that ITW is a condition that usually corrects spontaneously and that any surgical treatment should be reserved for cases showing calf contracture.

b. **Middle path**:

Patients treated with casting, followed by surgery in recalcitrant cases. Stott 13 patients, 7 required surgery. Calf strength was not significantly different between operatively and nonoperatively managed groups.

c. **Achilles lengthening:** Hemo reviewed 15 children treated with Achilles tendon lengthening at a mean of 1 year postoperatively. They

found that nonoperative measures failed to correct the problem in 12 patients. Surgery to lengthen the Achilles tendon was performed percutaneously in 3 patients and as an open procedure in the other 12.

Sagittal plane kinematics showed that dorsiflexion improved and overlengthening did not occur. Preoperatively, seven patients showed knee recurvatum during stance phase, and six of these improved postoperatively.

The authors concluded that careful Achilles lengthening is successful in idiopathic toe walkers when nonoperative management failed. They caution against surgery in patients who have no fixed ankle equinus deformity.

SUMMARY OF LITERATURE REVIEW

1. Does idiopathic toe walking matter when the number of patients presenting as adults with problems directly attributed to ITW is very small?
2. If ITW is untreated does a contracture develop over time?
3. Does the natural history vary according to the presence of a contracture?
4. If so, should there be a distinction between idiopathic toe-walkers (who have an unexplained contracture) and habitual toe-walkers (who have sufficient dorsiflexion of the ankle to achieve a plantigrade stance)?
5. When evidence of a contracture is present, does it matter whether it is occurs in the whole triceps surae or is confined to the gastrocnemius? Is the surgical outcome after gastrocnemius lengthening better than after (open or percutaneous) Achilles tendon lengthening?

Limited conclusions can be drawn:

The natural history of ITW suggests spontaneous improvement but not that the gait to become completely normal. The condition usually persists despite nonoperative treatments, including casting. Non-operative treatments offer no improvement in outcome over observation alone.

Surgery has a low complication rate but only produces an improved, rather than normal, gait. Surgery may be best reserved for cases with a demonstrable contracture. Where surgery is chosen, a gastrocnemius release may be preferable to Achilles lengthening.

CALF CONTRACTURE

Pathomechanics and Surgery

The exact amount of ankle dorsiflexion required for normal gait is controversial, but it is generally accepted that ankle dorsiflexion past neutral (<10°) is required.

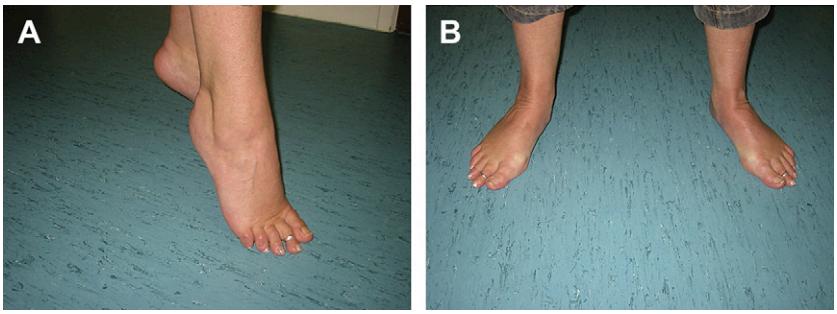
During terminal stance phase, maximal ankle dorsiflexion occurs just before the heel lifts from the ground. At this moment of maximal ankle dorsiflexion, the knee is extended (stretching the gastrocnemius) and the foot supinates to create a rigid structure for leverage.

In individuals who have a tight calf, several compensatory mechanisms can be observed: Early heel off, causing increased pressure under the forefoot. The resultant forefoot overload is implicated in many different problems that affect the adult foot. Shifting the center of mass forward relative to the foot, which can be accomplished by increasing lumbar lordosis, hip flexion, or knee recurvatum.

Subtalar joint pronation. With the transverse tarsal joint unlocked, dorsiflexion occurs through the talonavicular and calcaneocuboid joints. This mechanism increases strain in the tibialis posterior tendon and spring ligament. Gastrocne mius contracture has been implicated in tibialis posterior dysfunction. External rotation of the leg to shorten the lever arm of the foot.

The Silfverskiold test is used to distinguish between contractures that are predominantly in the gastrocnemius and those that affect both the gastrocnemius and soleus. The proximal attachment of the gastrocnemius to the posterior surface of the femoral condyles causes this muscle to be tight when the knee is extended. When the knee is flexed, the gastrocnemius relaxes. Therefore, a loss of ankle dorsiflexion that is evident when the knee is flexed must affect the soleus and gastrocnemius.

Compensating for calf contracture: with recurvatum or by Out toeing



contracture is present with the knee fully extended but improves with knee flexion, then the soleus is not contributing to the contracture, and the calf contracture is limited to the gastrocnemius (Fig 3).

Nonoperative Treatment

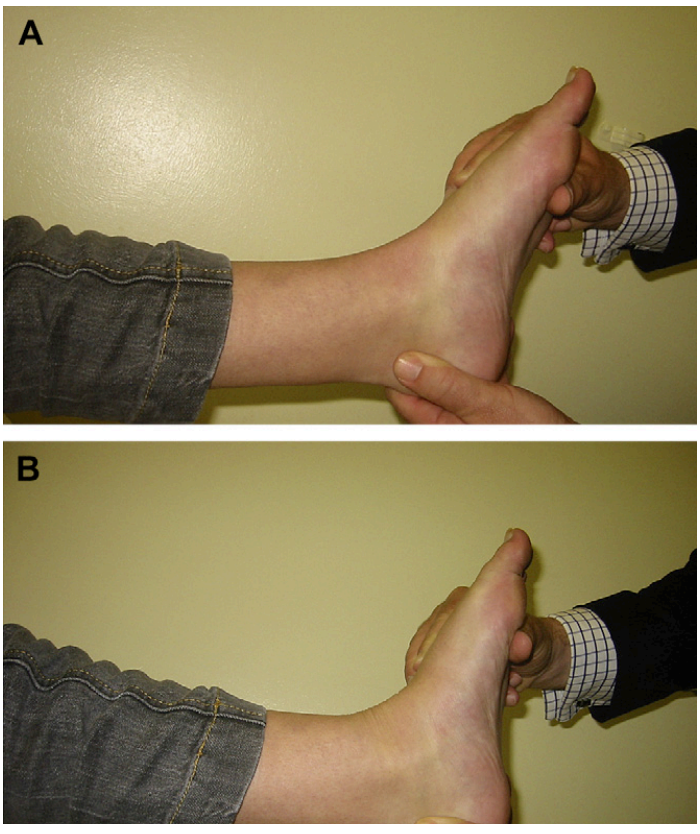
The role of physiotherapy and serial casting in the treatment of ITW is discussed earlier. Eastwood and colleagues, who published the largest review, found no difference between patients managed with serial casts for 6 weeks and those offered no treatment.

Operative Treatment

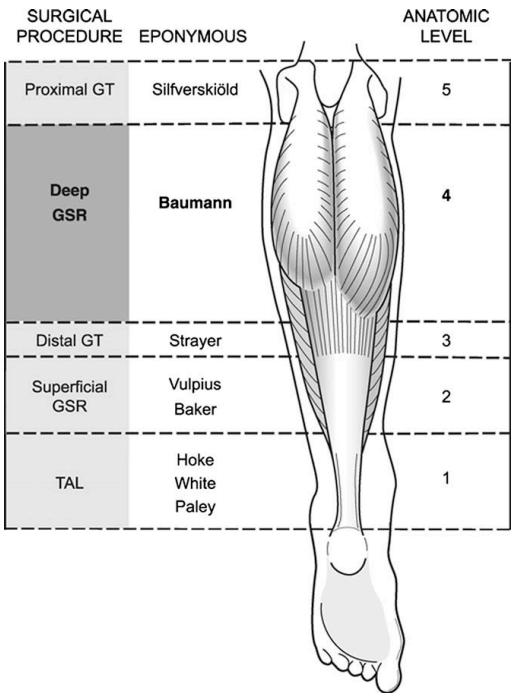
When surgery is considered for treating calf contracture, the technique must be appropriate for the type of contracture. The Silfverskiold test allows surgeons to determine whether the contracture is in the gastrocnemius and soleus or confined to the gastrocnemius portion of the triceps surae.

Surgical release of the Achilles tendon is associated with a risk for weakness from over lengthening. A lengthy rehabilitation period is also associated with casting. For these reasons, when the Silfverskiold test confirms that the contracture is confined to the gastrocnemius, release of just this portion of the calf should be preferred.

The Silfverskiold test, (A) knee extended and (B) knee flexed.



Surgical Release



Vulpius, Silfverskiold, and Strayer published the pioneering work on gastrocnemius release. Classifying the anatomic level of the gastrocnemius–soleus complex is useful when the release is performed.

Silfverskiold described an operation that releases the heads of the gastrocnemius from their origin on the femur. [Level 5]

The Bauman procedure divides the aponeurosis covering the deep (anterior) surface of the gastrocnemius (level four). The procedure is performed through a medial incision and places the saphenous nerve and greater saphenous vein at risk. The surgical dissection is deep, necessitating general anesthesia. An assistant is needed for retraction so the undersurface of the gastrocnemius muscle can be reached.

Strayer described an open release at the gastrocnemius insertion onto the tendoachilles (level three). Strayer allowed the gastrocnemius to retract and then he reattached the muscle more proximally. The course and formation of the sural nerve have five common variations, and operations at this level place it at risk. In addition, the sural nerve can be superficial, deep, or closely applied to the fascia at this level. After a Strayer release, the patient is immobilized for at least 2 weeks. This is another disadvantage of a surgical release at this level. Poor wound

cosmesis has also been reported. The Strayer release has been associated with a 6% overall rate of complication. Furthermore, 5% of patients complained of poor wound cosmesis and 3% had nerve damage.

The Vulpius procedure (level two) is often used for children who have spastic diplegia. In this procedure, the external aponeurosis of the gastrocnemius and the underlying superficial aponeurosis of soleus are sectioned transversely just distal to the gastrocnemius muscle belly. The Vulpius procedure therefore **must lengthen the gastrocnemius and soleus**.

Level one is the Achilles tendon itself. Z-lengthening or triple-cut techniques may be performed either open or percutaneously. Cadaver work has shown that percutaneous techniques are unreliable and risk damage to adjacent nerves. Open surgery is recommended. Wound healing and weakness are both potential complications with significant associated morbidity.

Level 3 is the ideal level to perform an isolated release of the gastrocnemius.

European authors have reported a simple and safe gastrocnemius release in level four. When the contracture is pronounced, both heads can be released through a single popliteal crease incision under general anesthesia. Because the medial head has been noted to be the source of most of the gastrocnemius tightness, less severe cases can be treated with a proximal release of the aponeurosis of the medial head in isolation.

Results and Complications of Gastrocnemius Lengthening

Short-term reports show that ankle dorsiflexion with the knee extended

improves to the same amount achieved with the knee flexed. No studies confirm that this correction is maintained over time, and limited literature has examined whether a change in muscle strength occurs with the various lengthening operations described.

With the Strayer release, the possibility of weakness is a concern.

Summary of Surgery

There is increasing recognition that adult foot pathologies are associated with gastrocnemius shortening. The Silfverskiold test determines whether the equinus deformity is confined to the gastrocnemius. When a stretching program, supervised by a physiotherapist, fails to produce sufficient improvement, surgical release may be considered.

Release of gastrocnemius alone is associated with less risk for complication and a shorter rehabilitation, and therefore should be preferred when the Silfverskiold test confirms an isolated contracture of the gastrocnemius. These principles are applicable to adult and pediatric populations.