CHAPTER **35**

DIGITAL EQUINUS

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DIGITAL CONTRACTURES

There are four main etiologies for digital contracture deformities: biomechanic, systemic disease, neurologic, and traumatic.[1-3] The most common biomechanical etiology is flexor stabilization, followed by extensor substitution and flexor substitution.[4] Systemic diseases include rheumatoid arthritis, diabetes, and ligamentous laxity. Neurologic etiologies include cerebral palsy and Charcot-Marie-Tooth disease. A trauma-induced contracture can result from either direct force to the digit, or indirect force to the soft tissues that control the digit.[5] There have been few descriptions of traumatic digital deformities in the literature.

ANKLE EQUINUS

Ankle equinus is characterized by decreased dorsiflexion motion available at the ankle with the knee fully extended. The classifications of ankle equinus are soft tissue contractures of the gastrocnemius muscle, soleus muscle, or anterior osseous impingement. The Silfverskiold test (knee flexion) is used to evaluate ankle equinus. The subtalar joint is held in a neutral position or supination during the evaluation to prevent pronation compensation and midtarsal joint dorsiflexion. The dorsiflexion motion available at the ankle joint is evaluated with the knee at both fully-extended and flexed positions. The classification is differentiated by extending the knee (gastrocnemius, soleus, and plantaris evaluated), flexing the knee to relax the gastrocnemius tendon (soleus evaluated), or with a stress dorsiflexion lateral ankle radiograph (osseous evaluated). Ankle equinus can be compensated for with dorsiflexion of the joints distal to the ankle such as the subtalar, Chopart, and Lisfranc joints. The compensation can often be illustrated during the evaluation. This systematic evaluation can also be used to determine the presence of digital equinus.

DIGITAL EQUINUS

Digital equinus is characterized by decreased dorsiflexion motion at the metatarsophalangeal joint with the proximal and distal interphalangeal joints fully extended, and the ankle in 10° of dorsiflexion. The etiologies of digital equinus are soft tissue contractures of the long or short flexor tendons, or dorsal osseous impingement. The push-up test is used in a similar manner as the Silfverskiold test to evaluate digital equinus. The subtalar and midtarsal joints are controlled and the proximal and distal interphalangeal joints are observed during the evaluation. The dorsiflexion available at the metatarsophalangeal joint, and the compensatory plantarflexion of the interphalangeal joints, is evaluated with the ankle in a plantarflexed, perpendicular, and 10° dorsiflexed position. The test is performed with passive and active motion of the metatarsophalangeal joint. Digital equinus is compensated for with plantarflexion of the proximal and distal interphalangeal joints. This relaxes the flexor tendons and allows the proximal phalanx to dorsiflex at the metatarsophalangeal joint.

Three cases will be presented to help illustrate the evaluation of digital equinus. Case 1 and Case 2 demonstrate the uncommon etiology of indirect trauma to the soft tissues controlling the digits. These two patients have specific soft tissue adhesions that help isolate and illustrate the concept of digital equinus. Case 3 illustrates the concept of digital equinus with osseous impingement.

CASE PRESENTATION 1

A 40-year-old male was seen with a chief complaint of painful contractures of the first three digits of his left foot. He was involved in a moped accident and subsequently hospitalized for eight months. His right leg was amputated above the knee due to a severe infection. While being treated for this infection, he developed a deep decubitus ulcer on the posterior aspect of his left calf. After a series of debridements, he received a split-thickness skin graft from his right hip to cover the ulcer. Over the next several months, he noticed the first three digits of this left foot contracting, and he developed pain on the dorsal and distal aspects of the digits (Fig. 1).

The patient had a rigid contracture of the interphalangeal joint of the hallux, and rigid contractures of both the proximal and distal interphalangeal joints of the second and third digits. During passive and active dorsiflexion of the ankle joint, when the foot approached a position perpendicular to the leg, the three digits simultaneously plantarflexed at the metatarsophalangeal joint. This metatarsophalangeal flexion deformity was fully reducible with ankle plantarflexion. Gait analysis showed that during the late midstance phase of the gait cycle, when the ankle began to dorsiflex, there was a rapid plantarflexion of the digits and an early heel-off.

These digital contractures were related to the scar tissue adhesions located in the posterior aspect of the leg. The muscle belly of the flexor hallucis longus and a portion of flexor digitorum longus were adhered directly to the posterior aspect of the tibia, interosseous membrane, and fibula (Fig. 2). This functionally shortened these tendons during passive motion, and resulted in a flexion contracture of the digits with ankle dorsiflexion. Manual muscle testing during active motion showed that the patient had a decreased ability to plantarflex the second and third digits, while digits four and five showed no limitation (Fig. 3). The other muscles had normal function and were not involved in the scar. This is an unusual presentation of soft tissue contractures proximal to the ankle joint influencing the function of the digits (Fig. 4).

CASE PRESENTATION 2

A 35-year-old female presented with a painful contracture of the hallux of her right foot. She sustained a puncture wound in the medial plantar aspect of her foot that resulted in a severe infection. After the infection was successfully treated with antibiotics and surgical debridements, she received a split-thickness skin graft to cover the tissue loss (Fig. 5). She then complained of limitation of dorsiflexion in her first metatarsophalangeal joint. She developed pain on the dorsal aspect of the interphalangeal joint and within the first metatarsophalangeal joint.

The proximal phalanx demonstrated decreased dorsiflexion on the metatarsal head, 15°

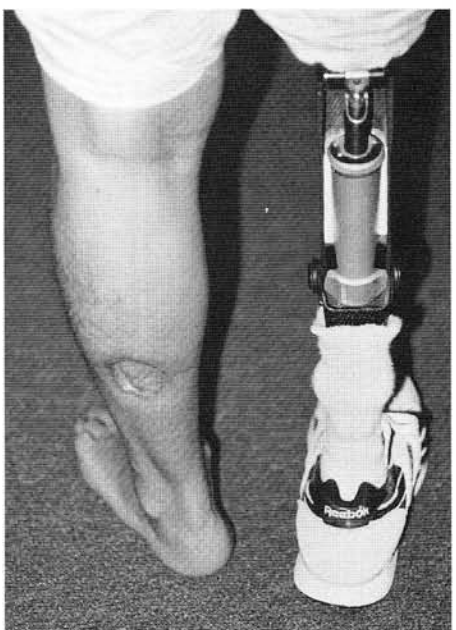

Figure 1. The patient has a full-thickness scar in the soft tissues posterior to the left tibia and fibula. The scar firmly attaches the skin and muscle to the underlying bone.

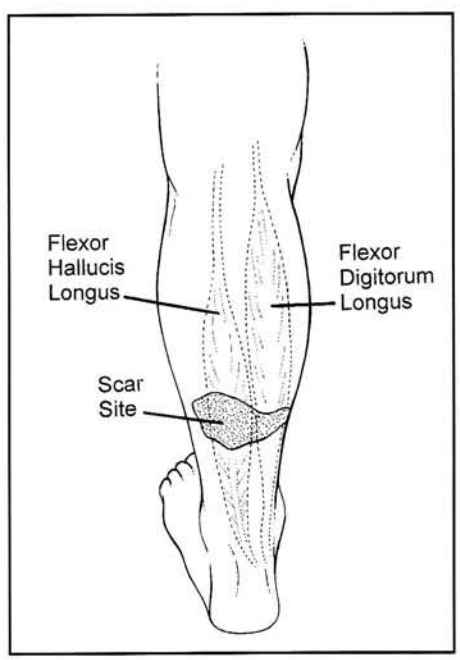

Figure 2. The flexor hallucis longus and flexor digitorum longus are adhered directly to the tibia, fibula and interosseous membrane.

Figure 3. The standard push-up test (dorsiflexion of the metatarsal and midtarsal joints) produces compensatory plantarflexion at the interphalangeal joints. The metatarsophalangeal joints remain in a dorsiflexed position.

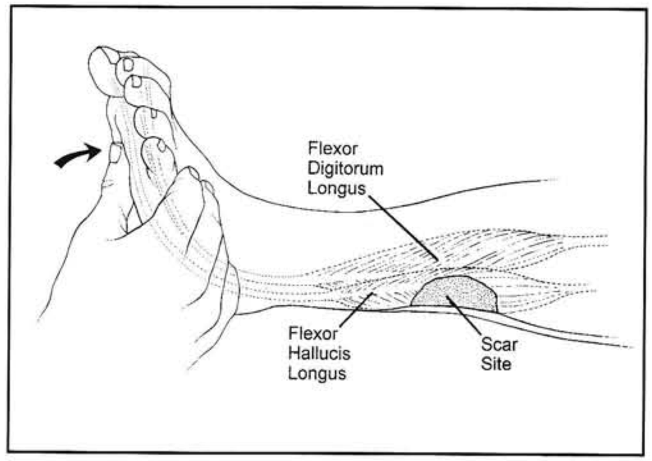

Figure 4. The adhesions prevent full extension of the digits during metatarsal dorsiflexion. The digits can compensate with plantarflexion at the metatarsophalangeal joints (cannot be done during weight bearing) or dorsiflexion of the metatarsophalangeal joints with plantarflexion at the interphalangeal joints (compensated digital equinus).

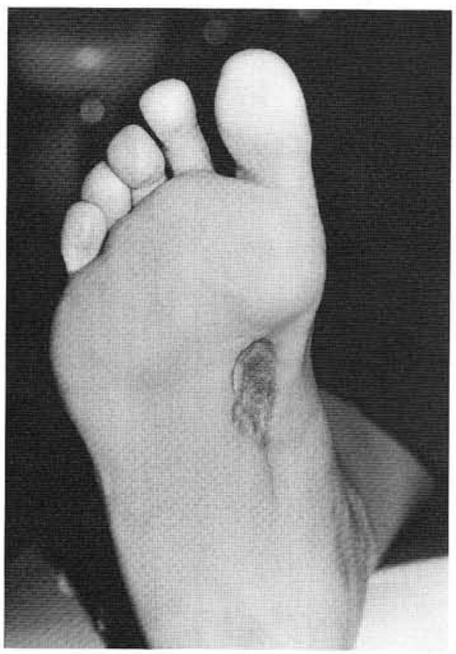

Figure 5. The patient has a full-thickness scar in the soft tissues plantar to the first metatarsal. The scar firmly attaches the skin and muscle to the underlying bone.

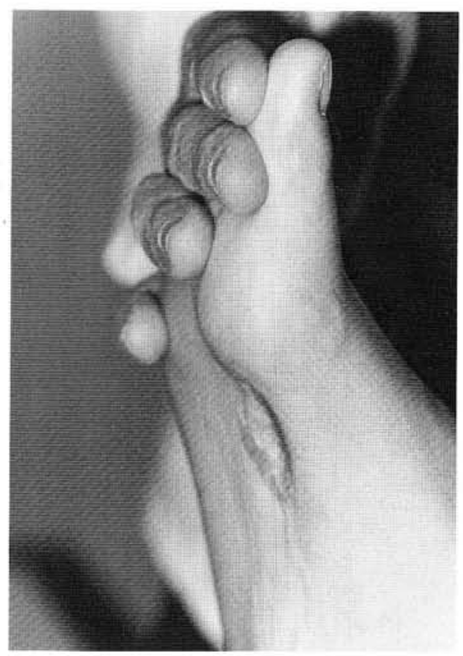

Figure 6. The standard push-up test (dorsiflexion of the first metatarsophalangeal joint) produces compensatory plantarflexion at the hallux interphalangeal joint. The interphalangeal joint can not extend due to the soft tissue digital equinus.

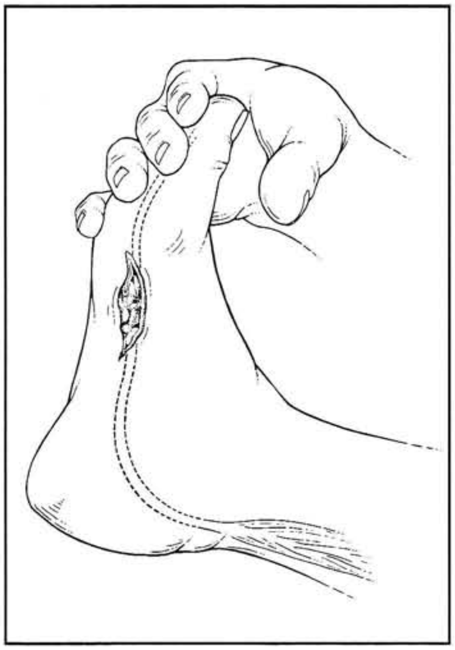

Figure 7. The adhesions prevent full extension of the digit during metatarsal plantarflexion. The digit can compensate with plantarflexion at the interphalangeal joint (compensated digital equinus).

Figure 8. The flexor hallucis longus soft tissue equinus is being compensated with dorsiflexion of the metatarsal base (first metatarsal elevatus) and plantar flexion of the first metatarsophalangeal joint and interphalangeal joint (hallux malleus). This first metatarsal dorsiflexion is only available with subtalar joint pronation. The compression force due to the soft tissue contracture can produce subchondral bone fracture and a secondary osseous impingement. Just as an anterior osseous impingement can limit ankle dorsiflexion, dorsal osseous impingement can limit first metatarsophalangeal joint dorsiflexion.

with the interphalangeal joint fully extended, and 20° with the interphalangeal joint flexed. The patient had a flexible contracture of the interphalangeal joint of the hallux (Fig. 6). During passive and active dorsiflexion of the metatarsophalangeal joint, the hallux plantarflexed at the interphalangeal joint. Gait analysis showed that during the late midstance phase of the gait cycle, when the heel began to come off the ground and the proximal phalanx began to dorsiflex, there was a rapid plantarflexion of the interphalangeal joint (Fig. 7).

These digital contractures were related to the scar tissue adhesions located in the plantar medial aspect of the foot. The flexor hallucis longus tendon and the flexor hallucis brevis muscle belly were adhered directly to the first metatarsal shaft. This functionally shortened these tendons during passive motion, and resulted in a flexion contracture of the interphalangeal joint with metatarsophalangeal joint dorsiflexion. The ankle dorsiflexion was normal, and all other muscle function was normal. Muscle testing during active motion showed that the patient had a decreased ability to plantarflex the metatarsophalangeal joint. This was an unusual presentation of soft tissue contractures proximal to the metatarsophalangeal joint influencing the function of the digit.

CASE PRESENTATION 3

A 47-year-old female was seen with a chief complaint of pain and limitation of motion in the first metatarsophalangeal joint. She gradually developed pain on the dorsal aspect of the first metatarsophalangeal joint over a four-year period.

The proximal phalanx had a limited dorsiflexion on the metatarsal head, 10° with the ankle plantarflexed or dorsiflexed. Gait analysis showed that during the late midstance phase of the gait cycle, when the heel began to come off the ground and the proximal phalanx began to dorsiflex, there was a slight adduction of the foot and an early heel-off. The patient had a rigid dorsiflexion deformity of the first metatarsal (Fig. 8). There was compression of the articular cartilage and osseous lipping on the medial, dorsal, and lateral aspects of the first metatarsal head, as well as the base of the proximal phalanx. This was an example of dorsal impingement digital equinus. The flexor hallucis longus soft tissue equinus was being compensated with dorsiflexion of the metatarsal base (first metatarsal elevatus) and plantarflexion of the first metatarsophalangeal joint and interphalangeal joint (mild hallux malleus). This compression force, due to the soft tissue contracture, could produce subchondral bone fracture and a secondary osseus impingement. In the same manner that an anterior osseous impingement could limit ankle dorsiflexion, dorsal osseous impingement can limit first metatarsophalangeal joint dorsiflexion. This patient had dorsiflexion available at the first metatarsal to compensate for the soft tissue equinus. This hallux limitus was an example of first metatarsal compensated soft tissue digital equinus.

Therefore, if a patient with a flexor hallucis longus soft tissue equinus does not have dorsiflexion available (supinated subtalar joint and stable midtarsal joint), the first metatarsal will remain on the ground, and a more severe hallux malleus will develop, as all of the equinus is compensated at the interphalangeal joint. This hallux malleus was an example of proximal phalanx compensated soft tissue digital equinus (Fig. 9).

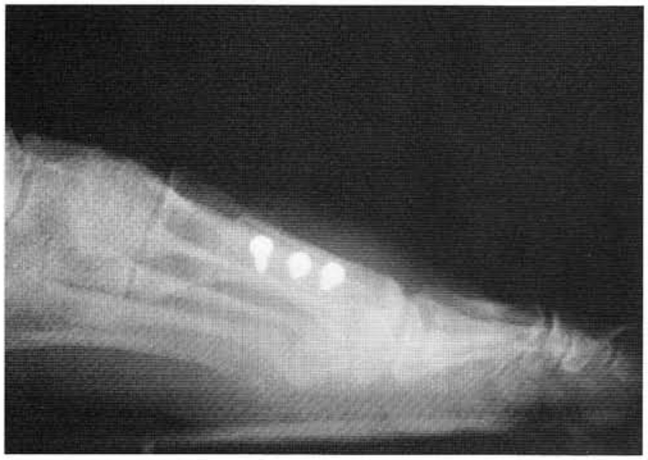

Figure 9. By plantarflexing the first metatarsal, the primary compensation available for the soft tissue equinus is removed. A plantarflexory osteotomy of the first metatarsal will only be successful if the soft tissue contracture is also released (shorten the first metatarsal) or the metatarsophalangeal joint has the motion available to take up the compensation.

DISCUSSION

The term digital equinus is not currently used to describe hammertoe and metatarsophalangeal joint deformities. It is a useful term to describe the structural and biomechanical etiology of these deformities. The same biomechanics that affect ankle equinus can also explain digital contractures. When a contracted tendon limits a joint movement, the body attempts to compensate at proximal and distal joints. This compensation is identified by releasing the soft tissue effect on the joint by flexing the joint proximal to the tendon contracture: the knee, ankle, midtarsal, and metatarsophalangeal joints. The Silfverskiold test is used specifically for the knee joint, but other joints can be released to identify a specific joint equinus. By describing the etiology of the joint limitation, a different perspective is used to help understand the biomechanics and treatment of the deformity.

These case presentations described the etiology and evaluation of digital equinus. The unusual etiology of soft tissue adhesions helped to illustrate the biomechanical concepts of digital equinus.

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