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CLINICAL EXPOSITION

Chiropractic management of painful Tarsal Tunnel Syndromes: The neurological channels in the human foot and manual Muscle Testing

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Narrative: At the inner rear portion of the foot is a tunnel through which a nerve, blood vessel, and several tendons pass. As long as the foot and ankle function in a balanced manner, this tunnel and its neurovascular bundle create no problems. If, however, the ankle and foot become imbalanced in a particular and measurable way, the fibrous band that covers the tunnel becomes stretched and interferes with both normal nerve function and circulation.

This area is known as the tarsal tunnel. A narrowing of the tunnel follows foot pronation, an extremely common human problem, which is an inward rolling of the ankle and foot. Unfortunately, when the problem first develops it usually does not cause symptoms. If symptoms such as pain or numbness developed immediately, the individual would recognise a problem and seek treatment. Manual muscle testing of the muscles that move the foot permits the earliest diagnosis of this oncoming problem to occur and saves many patients from enormous troubles. The muscular analysis offered by chiropractic manual muscle testing are the very muscles that help support the bones during activity to avoid narrowing of the tarsal tunnel.

Indexing Terms: Chiropractic; AK; Applied Kinesiology; Tarsal Tunnel Syndrome.

Introduction

The first description in the literature of the tarsal tunnel syndrome was in 1962, when two operative cases were reported. (1) In the early investigations of the carpal tunnel syndrome, advanced cases showed marked motor and sensory disturbances; at operation, pathological changes of the median nerve were evident. Tarsal tunnel syndrome is analogous to the carpal tunnel because the tunnel contains tendons and blood vessels together with the tibial nerve. Lam states, '*Nowadays the carpal tunnel syndrome is sufficiently well recognized to ensure that most cases are treated before this stage is reached. The same pattern of events may evolve in the case of the tarsal tunnel syndrome.*'

'... Tarsal Tunnel Syndrome is often compared to carpal tunnel syndrome in the wrist, but its consequences are far more widespread upon bipedal body function. Both involve nerve compression in a confined space. An essential, common chiropractic condition, essential to correct ...'

Unfortunately, there are a large number of people with unrecognised entrapment at the tarsal tunnel. Many physicians overlook the tarsal tunnel syndrome. Walther and Alshami et al. (1, 2) note that tarsal tunnel syndrome is frequently diagnosed as acute foot strain or plantar fasciitis. In applied kinesiology chiropractic experience, many patients who have previously been unsuccessfully treated for foot dysfunction are found to have functional tarsal tunnel syndromes. This allows the plantar intrinsic muscles to become weak and causes increased development of extended pronation affecting not only the foot but total body function.(3)

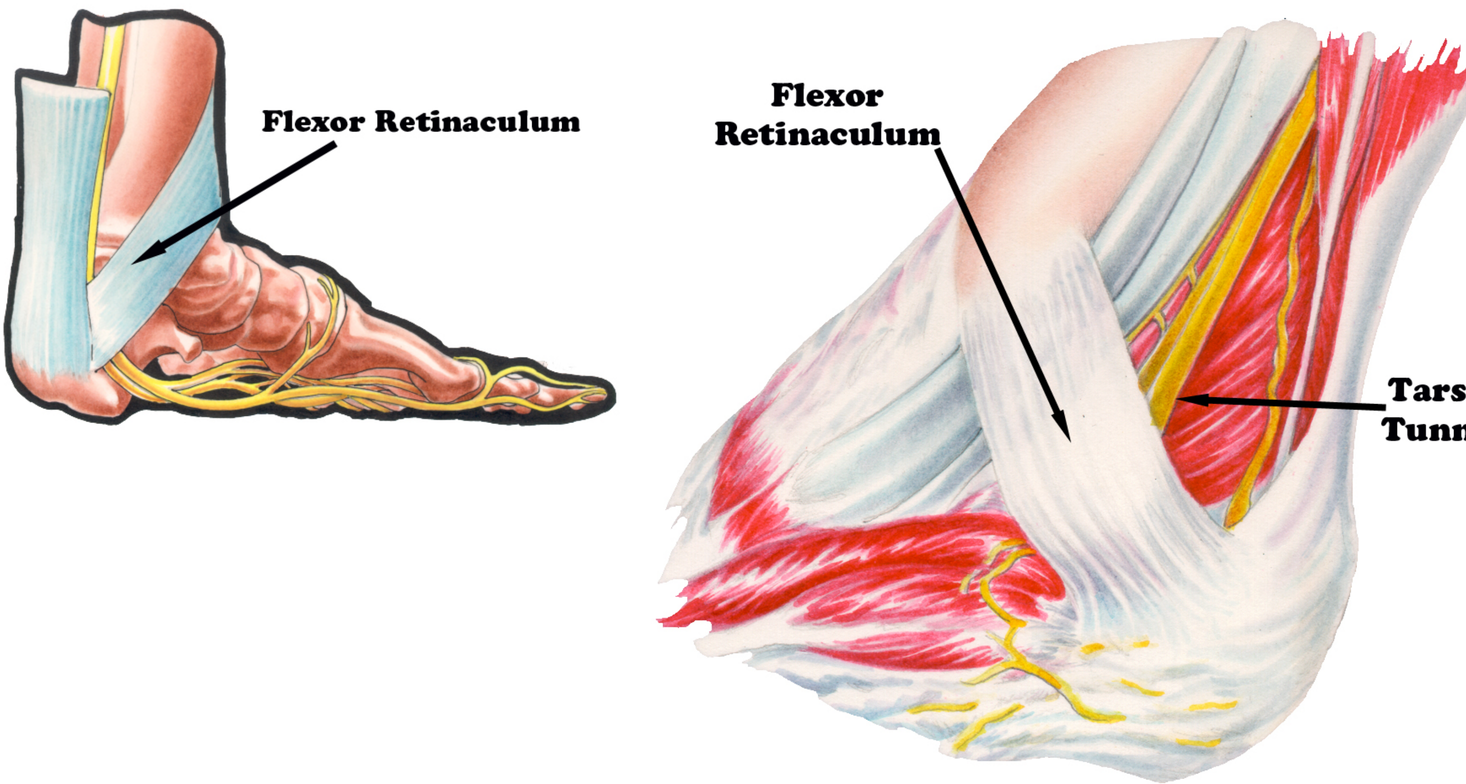
The term '*functional tarsal tunnel syndrome*' was used above to differentiate from frank pathological entrapment of the tibial nerve, which may require surgical decompression. The functional tarsal tunnel syndrome highlighted in this discussion is the type of nerve entrapment that causes dysfunction, yet will respond and return to normal with conservative chiropractic treatment. Since Goodheart's (4) introduction of tarsal tunnel treatment into applied kinesiology, many have been treating it successfully. (1, 5, 6, 7) With an increased awareness of this type of tarsal tunnel syndrome we may yet treat these conditions before marked motor and sensory disturbance with pathologic change develops in the feet of the patients we serve.

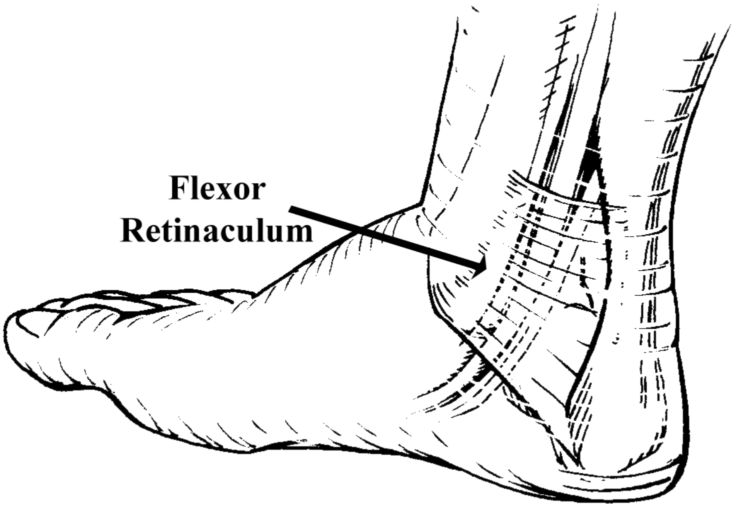
Peripheral nerve entrapment was introduced into chiropractic applied kinesiology in Goodheart's discussions of the carpal tunnel (1, 4) and tarsal tunnel syndromes. The tarsal tunnel syndrome needs more patient education than any other foot condition. The syndrome is a more advanced stage of foot pronation. If it has been present for any length of time, there is usually atrophy of the plantar muscles. This atrophy requires considerable foot which the chiropractor can uniquely provide. (1) Hammer toes and bunions and heel spurs and *extensor hallucis limitans* can also develop from the tarsal tunnel syndrome, and so its effective treatment is critical to the patient's future podiatric and ambulatory health.

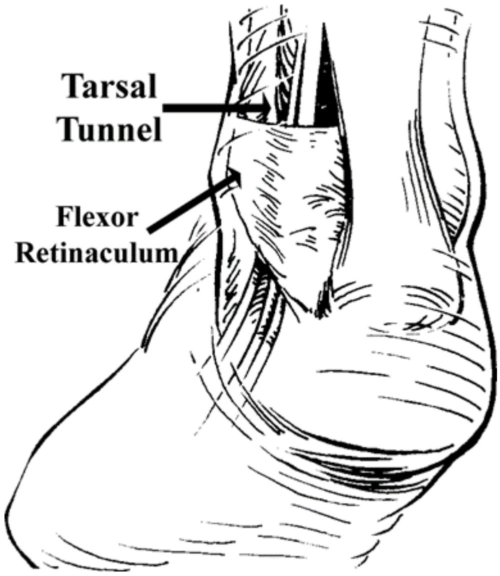
Anatomy

The tarsal tunnel is a superficially located osseous tunnel behind and below the medial malleolus and covered by the *flexor retinaculum* (*laciniate ligament*) with the bones making up the base of the tunnel. The *tibial nerve* passes through this osteofibrous passageway with the tendons of the *tibialis posterior*, *flexor digitorum longus,* and *flexor hallucis longus* muscles, each within its own synovial sheath. The other components of the neurovascular bundle are the posterior tibial artery and vein. (8)

Tarsal tunnel - medial & postero-medial views

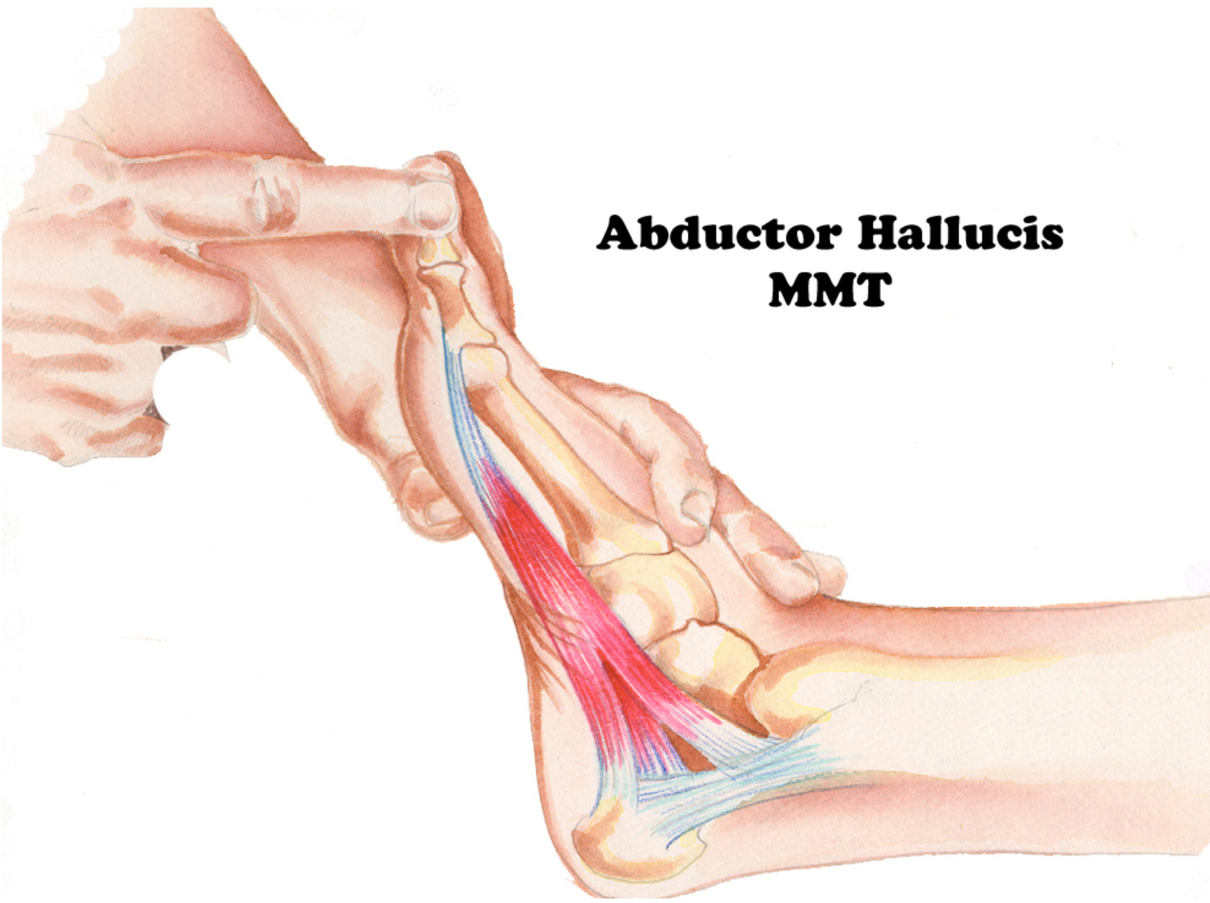


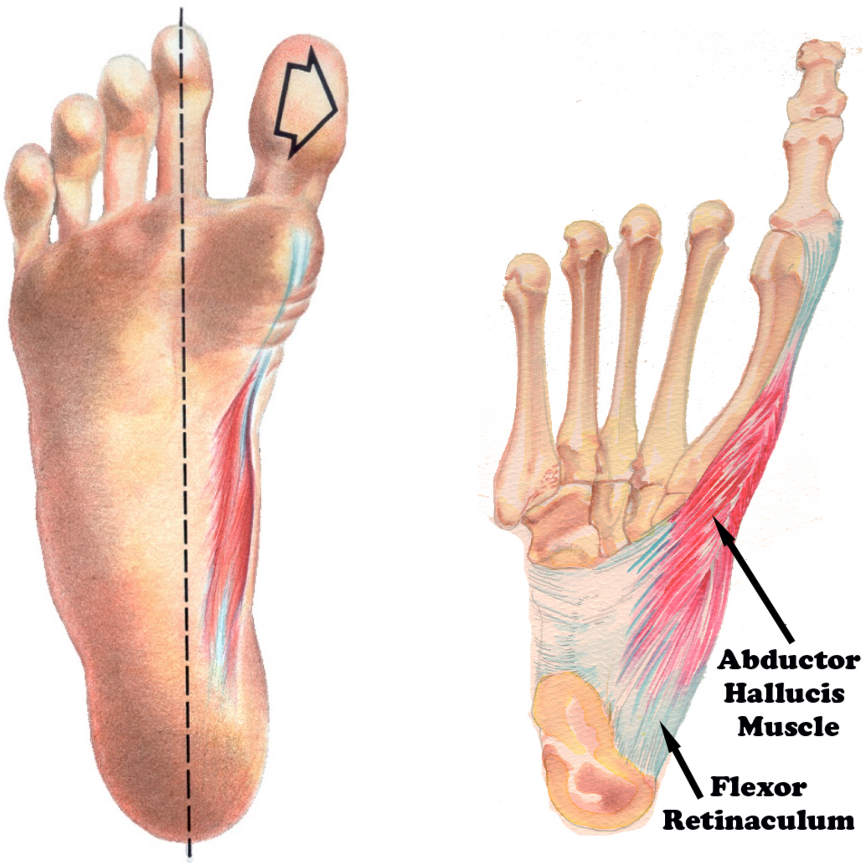




The *abductor hallucis* muscle crosses the passageway of the plantar vessels and nerves which serve the sole of the foot and it may entrap these nerves against the medial tarsal bones. (9) Trigger points in the *abductor hallucis* refer pain to the medial aspect of the heel and foot and the taut bands associated with trigger points in this muscle may be responsible for tarsal tunnel syndrome itself.

Abductor Hallucis MMT





The *flexor retinaculum* extends between the malleolus and the medial side of the *calcaneus* but has several deep fibrous septa that blend with the periosteum of the *calcaneus*. The neurovascular bundle in the tarsal tunnel is often attached to some of these septa, rendering itself more liable to minor degrees of traction on movement of the foot. (1)

Vascular supply to the nerve may have a bearing on its susceptibility to compression. As in the carpal tunnel syndrome, the *median nerve* in the wrist and the *posterior tibial nerves* have better arterial supply than the *ulnar* and *lateral tibial* nerves. The *ulnar* and *lateral tibial* nerves rarely have 'spontaneous' compression symptoms, though they run through osteofibrous tunnels.

The *median* and *tibial* nerves have a much more common incidence of 'spontaneous' compression. Their ample arterial blood supply may make them more susceptible to the effects of localised vascular insufficiency. Lam stated, '*When exploring the posterior tibial nerve one is struck by the density of the areolar tissue binding the structures under the retinaculum, and by their relative lack of mobility, compared with the extreme mobility and lack of adherence of the median nerve in the carpal tunnel. Hence even slight degrees of compression, possibly caused by oedema following minor strains, may produce vascular insufficiency locally and render a nerve lesion more likely*'. (1) It is suggested by Mense and Simons, as well as Butler (10, 11) that sensory symptoms in nerve compression syndromes are partially due to arterial insufficiency.

More slowly occurring motor paralysis is thought to be due to later structural changes produced within the nerve, and the paralysis is less likely to benefit from decompression. Manipulative treatment is known to have an effect on the diameter of arteries and veins. (12, 13) It is important therefore to make the diagnosis and treat the patient before the onset of demonstrable motor involvement resulting from ischæmia. Fluid flow through a blood vessel is strongly affected by small changes in the diameter of the vessel, demonstrating how even a small swelling or compression around the neural tissues will severely reduce the flow of blood and lymph in the area.

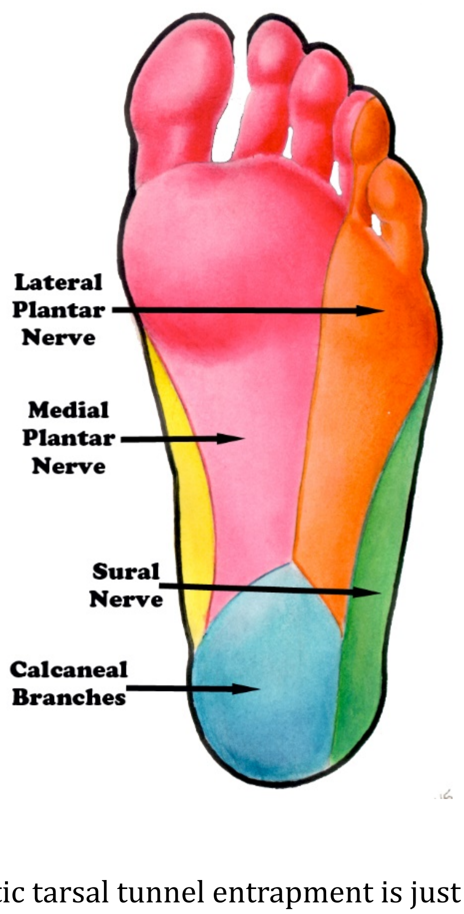
In Lam's (14) early series of ten cases surgically treated, one case had enlarged tortuous veins within the tarsal tunnel. There was no other demonstrable pathology in any of the cases. This points out the necessity in a Chiropractic examination of determining whether actual paralysis develops in the muscle from nerve impingement, or whether there is functional weakness as observed in the manual muscle test. This is readily determined by challenge and therapy localisation. If one is unable to return muscle function to normal, as observed by manual muscle testing, surgical intervention may be necessary. When peripheral nerve entrapment is treated in its early stages, it is reversible.

Extended pronation is a factor in nearly all cases of *tarsal tunnel syndrome* treated by chiropractors. (1, 4, 5, 6) Because of the posterior movement of the calcaneus on the talus during extended pronation, the flexor retinaculum is stretched. In extended pronation there is intermittent compression, then release, then compression, then release of the laciniate ligament on the posterior tibial nerve. (15)

Symptoms

Tarsal tunnel nerve entrapment can be discovered by an astute examiner when the patient has no complaint of foot or ankle dysfunction. As discussed extensively in the author's book on the subject, foot dysfunction plays a major role in total body health and function. (1)

Dermatomes of plantar surface of foot



Recognising an asymptomatic tarsal tunnel entrapment is just as important as examining and finding the cause of the painful foot.

Patients' complaints of tarsal tunnel syndrome include burning pain and paræsthesia in the toes and along the sole of the foot. This may cause '*burning feet*' or the '*restless legs syndrome*'. (16) One study reports that in 43% of cases the pain is more severe at night. (3) Moving the limb, getting out of bed, or hanging the limb over the edge of the bed may provide relief. (17) Transitory nerve ischæmia or compression may be relieved by massage or walking. (18)

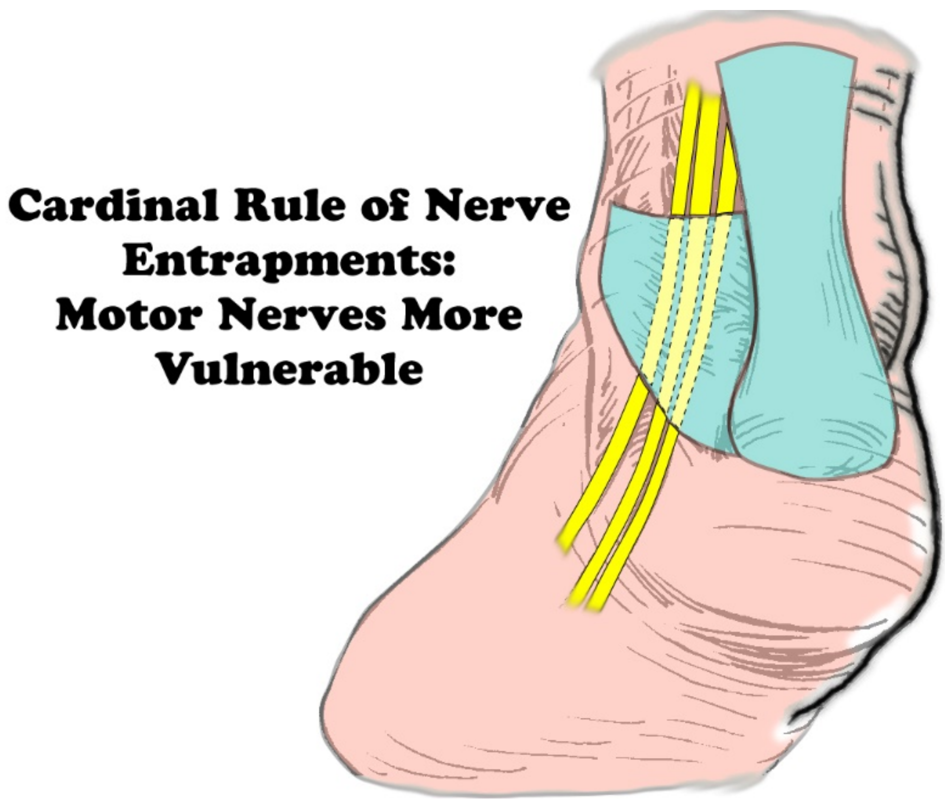
Proximal pain, tingling and numbness may radiate up the leg from a tarsal tunnel syndrome and is seen in approximately 30% of cases and is called the *Valleix phenomenon*. It may simulate a disc problem, peripheral vascular disease, or neuritis. Sometimes the pain is attributed to an existing condition, such as diabetes or peripheral vascular disease, when the problem is really an undiagnosed tarsal tunnel syndrome. This error frequently occurs with older patients. This is why tarsal tunnel syndrome may be under-diagnosed because it can be difficult to differentially diagnose from other conditions of the foot. For these reasons, specific as compared to group manual muscle tests are an important advantage in the diagnosis of specific articular-muscular impairments. (1, 4, 5)

Many aspects of an examination may appear normal when there is entrapment at the tarsal tunnel. There may be normal *dorsalis pedis* and *posterior tibial* pulses. Skin colour, hair distribution, and capillary circulation may also appear normal.

With chronicity the plantar muscles of the foot may be atrophied, giving an appearance of a high arch. There is indication in the literature that sensory deficit develops prior to motor deficit; this does not agree with applied kinesiology findings nor with more recent neurophysiological research. When muscles are painful, fatigued, or injured, there is an inhibition of muscle strength, timing, and a decrease in their endurance. (1, 10, 19) In any exercise inducing muscle damage, decreased neural drive to the muscles is thought to be an attempt of the neuromuscular system to protect the muscle-tendon unit from additional damage. (20)

For this reason muscular imbalance is thought to be a primary reflection of the functional state of the neuron; this is particularly true because of the extreme sensitivity of the muscle spindle cells, where a muscle spindle reacts to a pull of only 1 gram and a stretch of 1/1000th mm. (21, 22) This makes the muscular system and the manual muscle test an extremely sensitive organ and diagnostic tool.

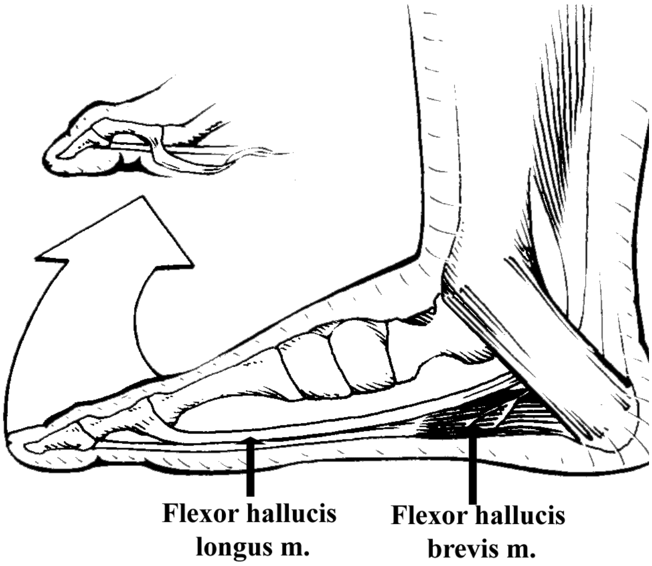
Motor nerves are more susceptible to injury

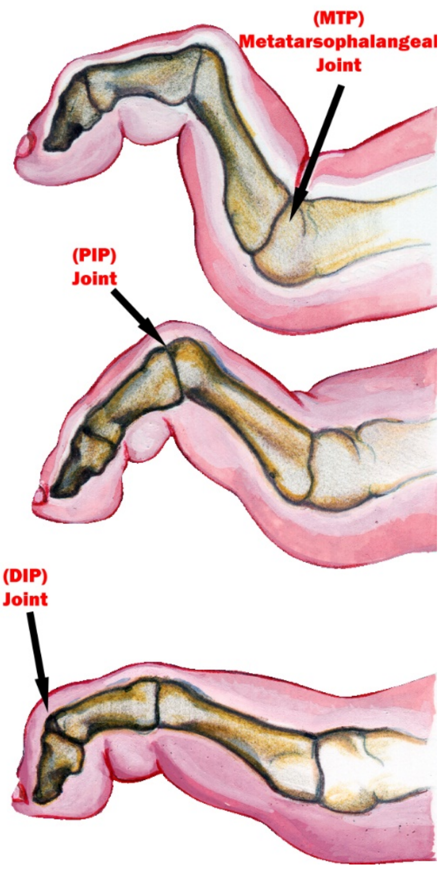


One often finds severe plantar muscle atrophy with no sensory deficit or hyperæsthesia. (3) The patient with tarsal tunnel entrapment will have weak plantar muscles, and the long toe flexors will probably be strong. This, of course, is because the long muscles receive their nerve supply prior to the tarsal tunnel, and the intrinsic muscles after the point of entrapment.

With this muscle imbalance, the patient will have hyperextension at the *metatarsophalangeal* articulations and hyperflexion at the *interphalangeal* articulations, giving a claw–like appearance to the toes, which is often called '*claw toes*'. This is because the long muscles insert into the distal phalanx, and the intrinsic muscles into the intermediate phalanx. When the individual stands or walks, one can see the distal phalanx gripping the substrate with elevation of the proximal phalanges. There will often be calluses on the distal ends of the toes.

Insertion of muscles to the toes





Claw toes

Ætiology

Often there is no known ætiology for functional tarsal tunnel syndrome. Space-occupying lesions such as ganglions or tumours are rare. Even in a surgical series of sixteen cases reviewed by Edwards et al (26) eight of the cases were 'spontaneous' entrapment, that is, no space-occupying lesion was found. Five were post–traumatic fibrosis due to fracture, three had accessory or hypertrophied abductor hallucis muscle, and one was due to tenosynovitis.

Tenosynovitis within the tarsal tunnel can develop in runners, from trauma, or from infectious processes. The latter, in effect, causes a space-occupying lesion to produce pressure on the nerve. There will be crepitation at the tunnel and severe pain on digital pressure over the tendons.

Circulation problems may be responsible for *tarsal tunnel syndrome*. Peripheral nerves in a diabetic are more easily affected by compression force than are normal nerves. Venous engorgement of the tunnel can develop as a result of proximal venous obstruction or valvular deficiency. Some of the pain present with an obvious venous stasis or thrombophlebitis may be caused by encroachment on the posterior tibial nerve rather than pressure from the vein distension alone. (2)

Any condition that creates fluid retention such as the *ileocecal valve syndrome* can be the final factor that causes entrapment at the tarsal tunnel. Helm et a. (27) studied 164 pregnant women to determine if there is an increased incidence of tarsal tunnel syndrome during pregnancy. They found 56.1% had abnormal nerve conduction through the tarsal tunnel. Twenty of the subjects were studied six weeks postpartum. Thirteen of these had abnormal conduction studies of the tibial nerve during the course of pregnancy, and twelve (92.4%) reverted to normal values at postpartum follow-up. Of the subjects with abnormal studies, 69.5% had some complaint of leg cramps, burning of feet, tingling, numbness or pain during the pregnancy.

Tarsal tunnel syndrome must be differentially diagnosed from *interdigital neuritis*, *dropped metatarsal heads*, *plantar calluses*, *arch strain*, various types of *arthritis*, *tenosynovitis*, *peripheral neuritis*, *peripheral vascular disease*, and various causes of *sciatic* pain. (28) Antidromic impulses can cause tenderness along the entire sciatic nerve. The pain may simulate root pain of spinal origin. (28, 29)

Moloney (30) reported on a case where three spinal surgeries were done without permanent improvement of pain until the tarsal tunnel was diagnosed and operated, which eliminated the painful condition. Patients who have a systemic propensity toward peripheral entrapment may have a history of problems in other areas such as a previous carpal tunnel or hyper-mobility syndrome. (3)

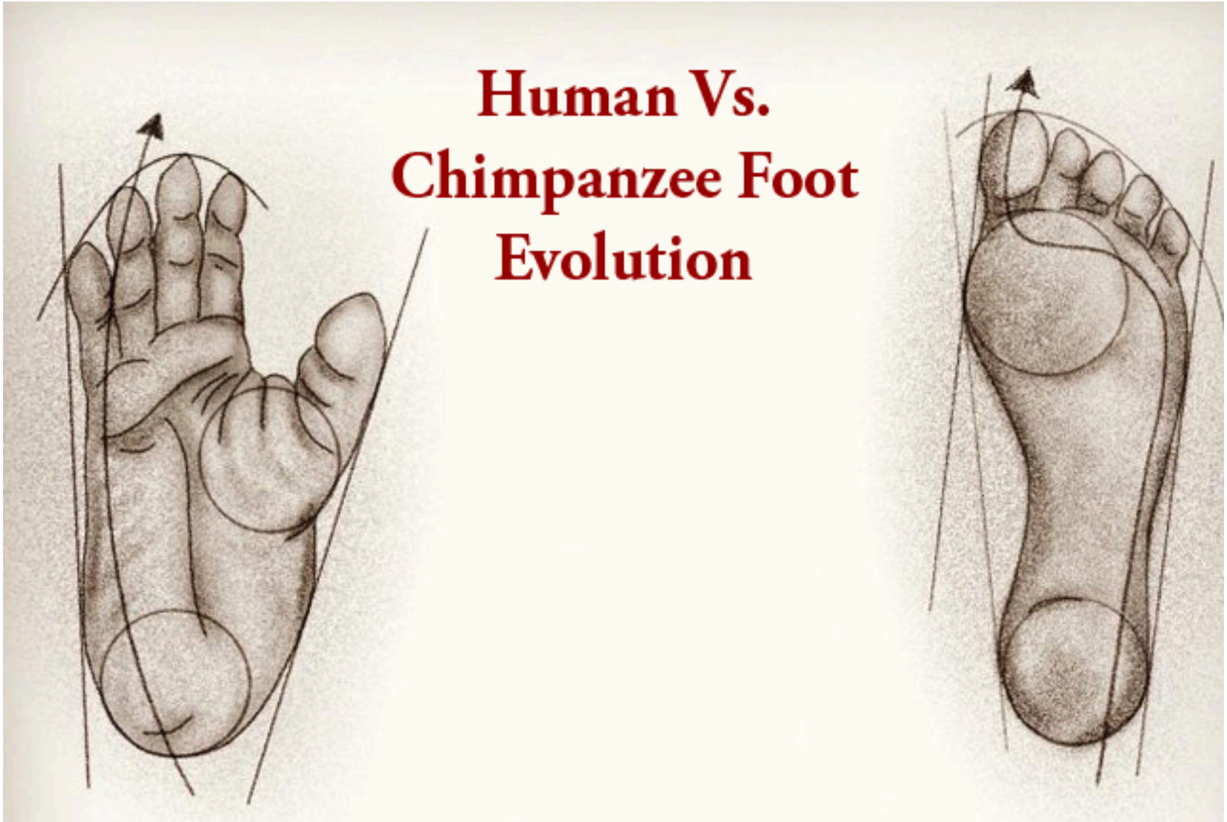
Examination

It's fascinating to realise that for Chiropractors who become involved in the treatment of their patients' feet, how the foot has so many homologues to the hand; yet often when they are compared, the foot comes out second-best because of the hand's ability to grip, its dexterity, and its apparent beauty in comparison to the foot. From an evolutionary point of view, several million years spent sitting in trees helped bipedalism emerge because it freed up the prehominoid hand, which allowed the gradual evolution of the opposable thumb. This led to a leap forward in hominoid survivability and versatility in every environment the hominoid lived.

The 26 bones of the foot and its soft tissue comprise a marvel of engineering design. With 200,000 nerve endings, 19 major muscles, 33 joint centres and 17 ligaments, it may be that 6 million years of evolution created the perfect foot. When one considers the stress of walking, running, and jumping that must be accommodated and dissipated by the foot, it's a wonder that anyone has healthy feet and that *tarsal tunnel syndrome* isn't even more prevalent. The normal stresses the foot must adapt to are compounded by poor quality or improperly designed and fitted shoes.

The foot has gone through many changes to adapt to human bipedal posture. There are three basic ways the human foot differs from that of other primates:

1. In man the 1st ray is not markedly divergent thus it is normally not useful as a grasping appendage, as is the hand;
2. The human foot has both longitudinal and transverse arches; and
3. In certain functions the foot is a rigid structure with strong ligamentous support, yet it can become supple to adapt to the contour of the ground.

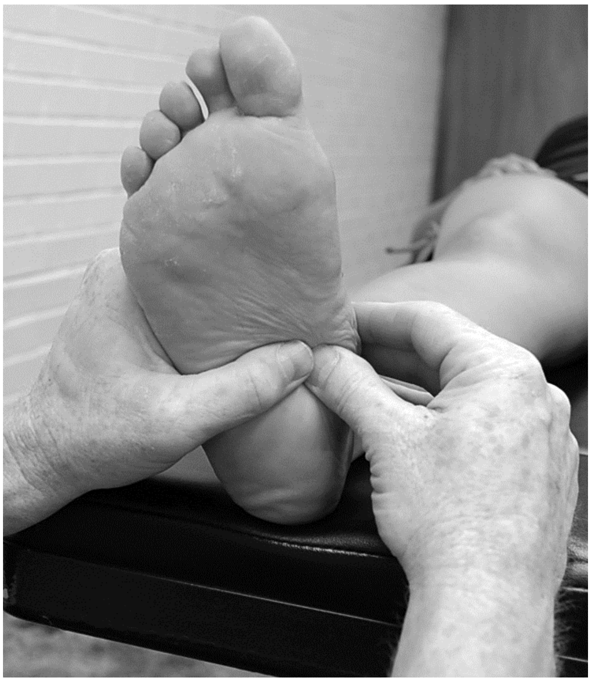


These factors are true of the normal foot, which is best adapted to weight bearing. Many poorly functioning feet revert back to the simian or prehensile foot, with pronation, loss of the arches, hyper-mobility, and medial deviation and flexibility of the 1st ray.

When there is frank entrapment of the *tibial* nerve in the tarsal tunnel, the *Tinel Sign* is sometimes present over the tunnel or the medial arch. One study reports that *Tinel's Sign* is positive in only 67% of cases. (3) The *Valleix phenomenon* or nerve trunk tenderness may be present proximal or distal to the area of entrapment.

Palpation over the *retinaculum* may reveal tenderness or a small fusiform swelling of the nerve. (18) Hypo- or hyperæsthesia may develop in the tibial nerve branches (medial and lateral plantar nerves), or the *calcaneal* branches. Sensory disturbance should only be in this distribution, and it should not affect the dorsum of the foot except over the distal phalanges of the toes. There may also be loss of two-point discrimination. Pressure on the calf of the leg created by inflating a sphygmomanometer cuff may reproduce symptoms on the affected side more quickly than in a normal foot. (11)

Abductor hallucis muscle palpation



The neurodynamic test places the entire neuraxis under tension. The tibial & peroneal nerves' tension is felt at the head of the fibula.

There must be careful differentiation in cases of leg pain. In a series of thirteen patients, seven of whom were operated and four being treated conservatively but expected to go to operation, Mann (32) found over half the patients had pain radiating up the medial side of the calf but not past the knee. In one patient the sharp pain in the plantar aspect of the foot could be reproduced by straight leg raising and dorsiflexion of the patient's foot.

Manoeuvring the heel into a valgus position narrows the tarsal tunnel and may increase pain; on the other hand, manoeuvring the heel into a varus position may reduce pain. (11, 28) Neurodynamic testing (11) employs this type of nerve tension testing. When a neurodynamic tension test is positive (i.e., pain or other sensations result from one or another element of the test, for example, the initial position alone, or with 'sensitising' additions) it indicates that there exists abnormal mechanical tension (AMT) somewhere in the continuous nervous system, but not that this is necessarily at the site of reported pain. For more detail of this assessment and treatment approach, the books by Butler (11) are recommended.

Patients may not complain of muscle weakness in a tarsal tunnel syndrome; (31) however, muscle deficiency will be found if carefully examined for by inspection, palpation, and specific muscle testing and AK sensorimotor challenges. The *abductor hallucis* located along the medial longitudinal arch is inspected and palpated for atrophy, along with the other intrinsic muscles of the foot. The ability to flex the toes at the *metatarsophalangeal* articulation is evaluated by muscle testing. There is no weakness of toe extensor muscles.

The *flexor digitorum longus* and *brevis* and the *flexor hallucis longus* and *brevis* should be evaluated. These long muscles will have improved function over the short ones. Challenge, usually directed to the calcaneus, may improve the function of the intrinsic muscles. There will be positive therapy localisation over the tarsal tunnel at the area of entrapment, and probably at the subtalar articulation, making an immediate and non-invasive diagnosis of this disorder readily available to the clinician.

Electrodiagnosis should be done to determine nerve conduction in cases that are unresponsive to conservative care; however, there may be false–positive findings from these studies. Gatens and Saeed (33) studied the *adductor hallucis*, *extensor digitorum brevis*, *1st dorsal interossei*, and *abductor digiti minimi* in seventy individuals with asymptomatic feet. They found that 38.6% had at least one of the four muscles examined showing abnormal potentials. They concluded that using abnormalities in intrinsic foot muscles by needle EMG as a diagnostic criterion could be misleading.

An interesting question regarding studies like these is what an applied kinesiology examination would have found in the individuals with positive tests. Functional problems are often found in asymptomatic feet. 34-35 It is possible in studies like these that the positive findings were in feet that were functionally inadequate but asymptomatic. If the muscles of the foot and ankle are dysfunctional, the lower legs, knees, thighs, hips, lower back, shoulders, neck and head are also disturbed. (1, 9)

Treatment

Most cases of tarsal tunnel syndrome respond well to the conservative approach of applied kinesiology chiropractic. (1, 4, 5, 6, 23, 35) If there are neoplasms or other space-occupying lesions that are irreversible with conservative care, surgical intervention will be necessary.

There are numerous orthopædic provocative tests that are used in evaluating peripheral nerve entrapment in the lower body. Most of these can be used in conjunction with manual muscle testing. An example is *Adson's Test* for *scalenus anticus* syndrome. In this condition, the *ulnar* nerve is usually involved. A previously strong triceps muscle may test weak in this position, indicating entrapment by the *scalene* muscle(s), 1st rib, cervical rib, or anomalous fibrous bands. Conversely, when the *triceps* muscle tests weak, positions that relax the *scalene* muscles or otherwise change the position of the thoracic outlet may cause the *triceps* to become strong, providing evidence of entrapment at the thoracic outlet.

Cross–stimulation of the nerve from entrapment or stimulation to the joint receptors often accompanies peripheral nerve entrapment. The improper afferent signals could go to any muscle associated with the agonist or joint. This neurologic model appears to explain many clinical observations from the evaluation and correction of peripheral nerve entrapment. A common example is *neck flexor weakness* associated with a *tarsal tunnel syndrome*.

> Proprioceptive information from the articulations and intrinsic muscles of the foot, mediated through the central nervous system, provides control for facilitation and inhibition of the neck flexor muscles when walking.

This model proposes that the afferent supply from the ligaments, tendons, muscles, fascia, and skin of the foot can be disturbed by entrapment in the tarsal tunnel, creating information to be sent to the central nervous system that is not in keeping with the current actions of the foot. For this reason, the neck flexors, or any other associated muscle in the gait system for that matter, may be inappropriately inhibited; they immediately regain normal function when the tarsal tunnel entrapment is corrected.

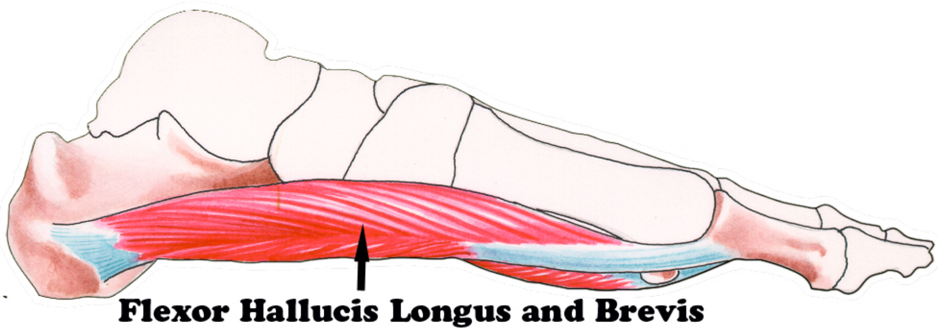
Challenge is usually mechanically moving a bone or other structure to a position that temporarily improves the nerve entrapment or irritation. For example, in the tarsal tunnel syndrome the *calcaneus* is usually subluxated posteriorly. An anterior challenge of the *calcaneus* will often strengthen the intrinsic muscles innervated by the *posterior tibial* nerve past the point of entrapment. This gives positive indication not only of the entrapment but also of the direction of subluxation correction. As with other extra-spinal subluxations, the bone is adjusted in a direction that causes the weak muscle(s) to strengthen.

In the *anterior tarsal tunnel syndrome*, the most common motor weakness is in the *extensor digitorum brevis* muscle; the foot should be placed into full plantar flexion in some cases to find this inhibition pattern. Frequently in this syndrome, an anterior *talus* subluxation will be pressing the *deep peroneal* nerve into the *extensor retinaculum* of the foot. Additionally, inhibition in this muscle is an important clinical parameter for L5-S1 radiculopathy, with associated sensory and motor impairments as well as atrophy in this muscle. (36)

Extensor digitorum longus and brevis tested together

The tendon of the 5th digit is congenitally absent in 23% of cases. (8) This muscle frequently requires treatment to the neuromuscular spindle cell, Golgi tendon organ, origin/insertion technique, or percussion. Attempts to exercise this muscle are clinically ineffective if there is a tarsal tunnel syndrome present. Atrophy of the *flexor digitorum brevis* muscle indicates the probability of a *tarsal tunnel syndrome*.

Flexor Hallucis Longus and Brevis MMT

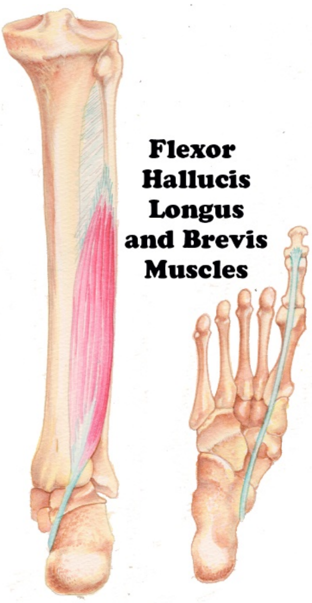


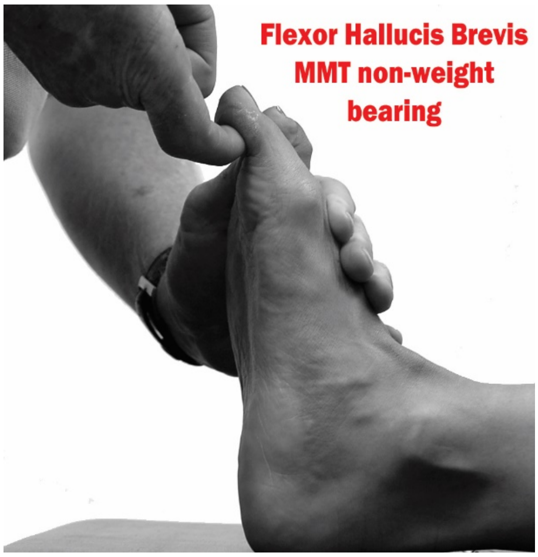
The *flexor hallucis longus* and *brevis* are most frequently tested in relation to the *tarsal tunnel syndrome*. The difference in strength of the *flexor hallucis longus* and *brevis* in the *tarsal tunnel syndrome* is realistic, because the *longus* is in the upper leg and is not innervated by the nerves going through the tarsal tunnel.

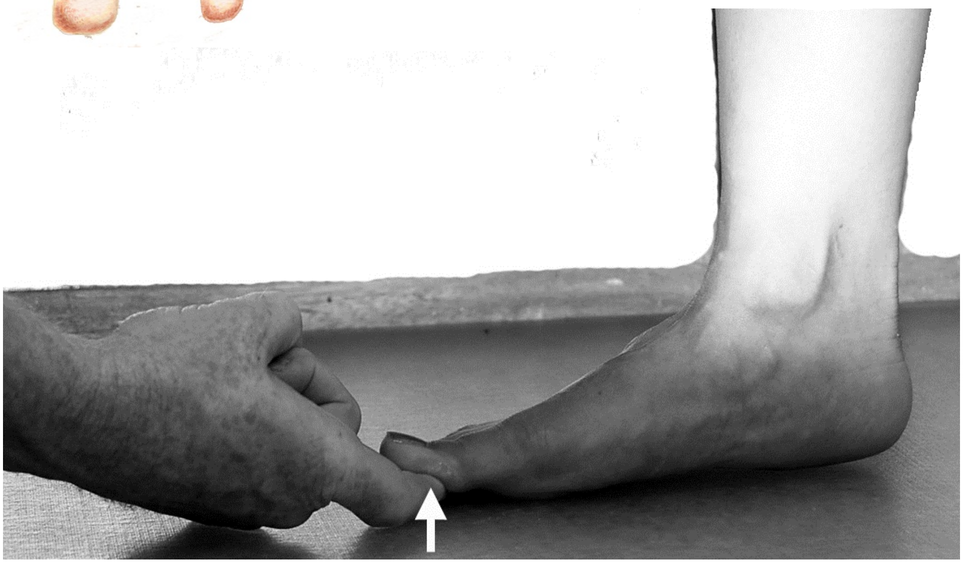
Weakness in this muscle can be associated with the weakness of the *tibialis posterior* due to an inferior displacement of the *navicular* bone. Ramsak and Gerz (24) recommend shifting the body weight onto the forefoot when testing these muscles in the standing position in order to uncover these problems. This method of testing will increase the stress on the tarsal tunnel during the MMT.

Trigger points in the *flexor hallucis longus* referred pain and tenderness into the plantar surface of the first metatarsal and great toe. Overactivity of the toe flexor muscles contributes to the development of hammer toes, claw toes and other deforming foot conditions as they attempt to stabilise the foot during weight bearing. (9)

Flexor Hallucis Brevis MMT, non-weight bearing and standing





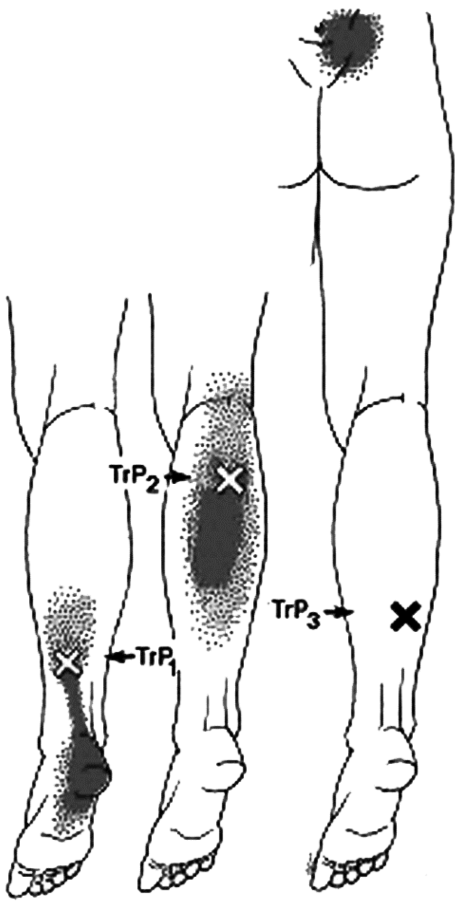


The *flexor hallucis longus* and *brevis* are the most frequently tested in relation to the tarsal tunnel syndrome. Beardall (23) made an improvement in the methods of testing these two muscles. When testing the *flexor hallucis longus*, stabilisation of the proximal phalanx should be made by the doctor as he or she tests the plantar flexion ability on the distal phalanx. It was once thought that, in the *tarsal tunnel syndrome*, both the *flexor hallucis longus* and *brevis* were weak; however, with the improved testing methods it became obvious that the *flexor hallucis* usually remains strong while the *brevis* shows weakness.

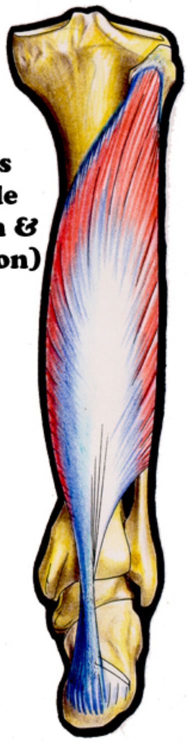
The *gastrocnemius* and *soleus* have typically been known as the *triceps surae* because the two heads of the *gastrocnemius* and the *soleus* insert into a common tendon. It is the strongest plantarflexor of the foot. Campbell et al (37) demonstrated electromyographically that these muscles, in reality, act as a *quadriceps surae* since the medial and lateral aspects of the *soleus* are capable of acting independently. O'Connell, (38) using surface and needle electrodes, also found that the medial and lateral aspects of the *soleus* act independently.

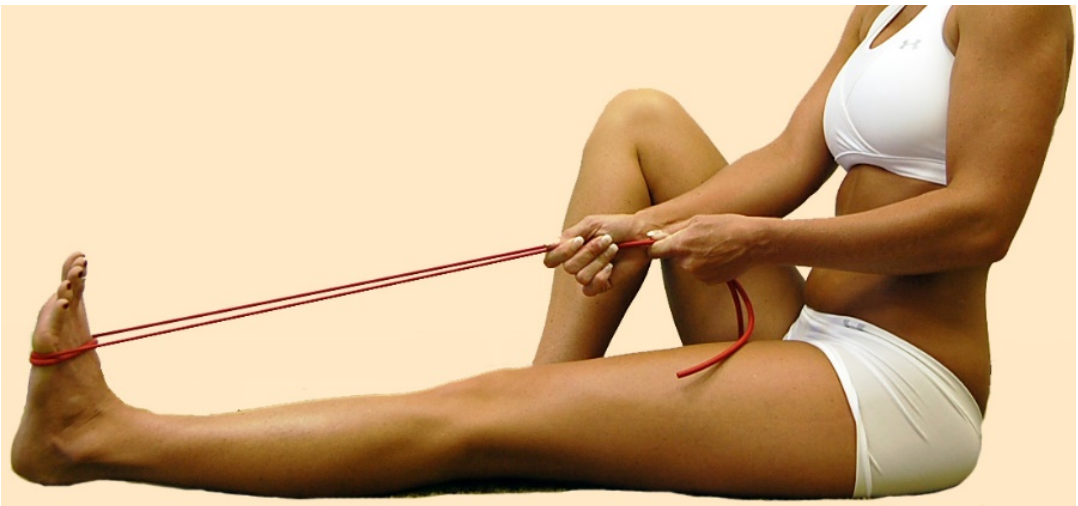
This medial and lateral action of the *gastrocnemius* and *soleus* correlates with a medial or lateral *calcaneus* subluxation, which is found in applied kinesiology by using the sensorimotor challenge mechanism. Usually, the subluxation correlates with a *tarsal tunnel syndrome*, where the *calcaneus* is also posterior. The *calcaneus* will usually be lateral, and there will be weakness on the medial head of the *gastrocnemius* and the medial aspect of the *soleus*. This gives poor medial support to the *calcaneus*, allowing it to deviate laterally. As with other structural distortions, it is necessary to return the muscles to normal balance to obtain maximum correction. Since the *gastrocnemius* and *soleus* are very difficult to evaluate by standard MMT, it is best to evaluate the medial and lateral aspects by therapy localisation directly to the muscle. The most common disturbance is dysfunction of the neuromuscular spindle cell or Golgi tendon organ, uncovered with 'pincer palpation' followed by MMT. (1) There may also be a muscle stretch response on the tight side of the muscles, indicating the presence of myofascial trigger points.

Soleus MMT and trps



Soleus Muscle (Origin & Insertion)





Most often accompanying and frequently the precipitating factor for *tarsal tunnel syndrome* is extended foot pronation. The first effort toward correction is to examine for and correct extended pronation, which includes any subluxations of the foot and other foot dysfunction. Intrinsic muscles of the foot may not be corrected until specific adjustments are made for the tarsal tunnel because their nerve supply is being interfered with due to foot and ankle subluxations.

One of the most common forms of muscle inhibition comes from joint subluxations, commonly called *arthrogenic weakness*. Even non-noxious stimulation of the joints of the foot and ankle can elicit strong inhibition of the muscles of the foot and ankle. (39) There are few better options for patients with joint subluxations of the foot and ankle affecting the tarsal tunnel than specific manipulative joint correction. Non-manipulative treatments for the arthrogenic weakness of muscles will be less effective and more time-consuming when joint disturbances are present.

After correcting pronation, challenge the *calcaneus* in its relationship to the *talus*. The *calcaneus* will usually be subluxated posterolaterally, with its posterior surface somewhat superior. There are several methods for adjusting the *calcaneus*; it can be done with the patient supine or prone. With the patient supine, the physician stands at the patient's feet facing the foot to be corrected.

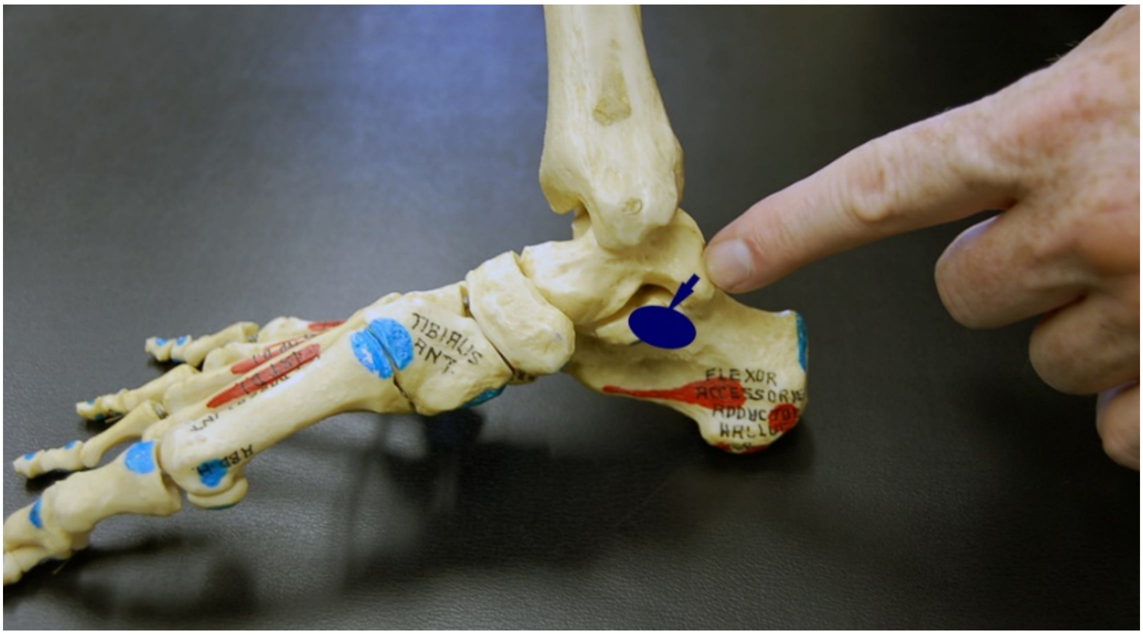
Calcaneus adjustment

To adjust the *calcaneus*, the physician grasps the posterior superior surface of the bone solidly with his or her hand. The left hand makes a broad contact across the dorsal surface of the foot. A broad contact is important to avoid creating a subluxation with this stabilising and controlling hand.

The correction is an extension thrust directed toward moving the posterior surface of the *calcaneus* in a generally inferior anterior direction. The vector of force is determined by challenge. It usually requires moving the inferior portion of the calcaneus medially. It is often necessary to have the patient hold the side of the examination table to prevent slipping, especially if the table is covered with tissue paper. There is often an audible release of the *calcaneus*; however, it is not necessary for an adequate correction.

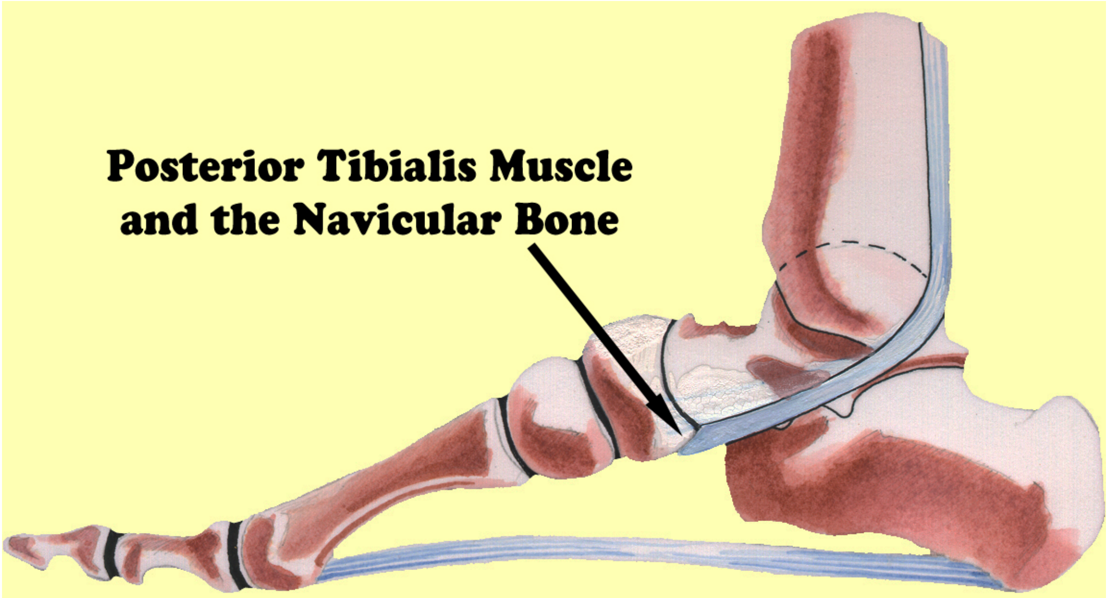
Another method is to flex the prone patient's knee to 45°. The physician stands on the side to be corrected. To correct the right *calcaneus*, the physician's right hand cradles the superior posterior aspect of the *calcaneus* between his thumb and forefinger. The other hand cradles the dorsum of the foot. The thrust is directed to the *calcaneus* as previously determined by challenge. Usually, the thrust is directed to move the posterior inferior aspect of the *calcaneus* in an anterior, inferior, and medial direction.

Pain location from calcaneus malposition & foot pronation

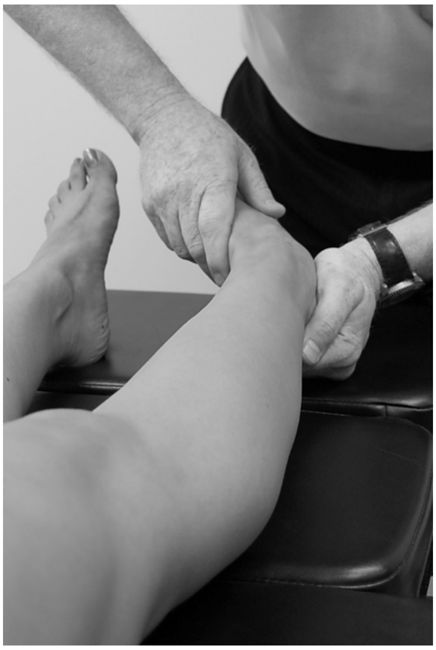


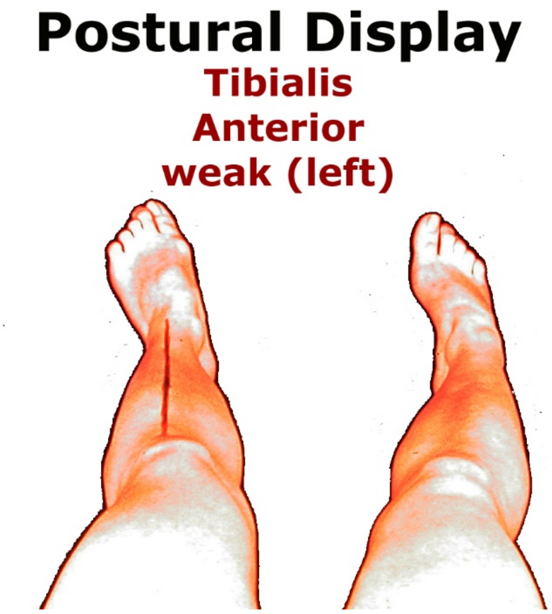
Successful adjustment of the *calcaneus* and pronation correction are indicated by relief in the painful area inferior to the *medial malleolus*. Goodheart states that the disappearance of this diagnostic feature is essential. It may be necessary to adjust the *calcaneus* several times to completely eliminate this pain.

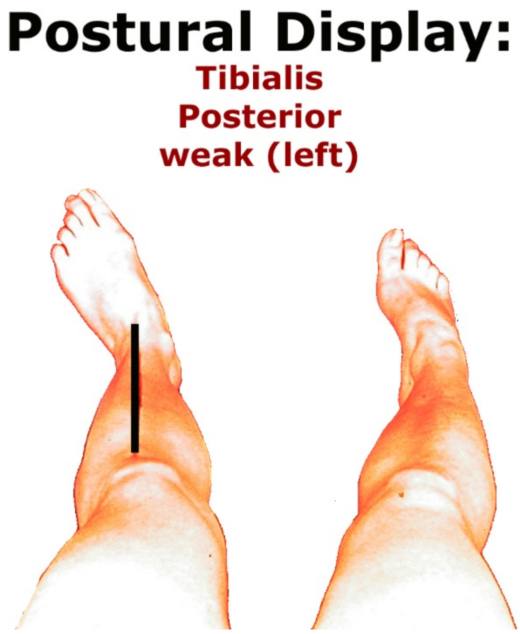
Leaf (40) points out that the *navicular* bone is another key in the correction of *tarsal tunnel syndrome* and other disorders of the foot. The *navicular* is controlled by the *tibialis posterior* and when the *navicular* drops inferiorly from *tibialis posterior* inhibition, the alignment and dynamics of the rest of the foot are disturbed. As the *navicular* descends it fails to support the *talus* and thereby causes the *calcaneus* to shift posteriorly. The posterior *calcaneus* that results produces increased pressure on the *flexor retinaculum*. The initiating disturbance in this sequence is the inferior *navicular* and it must be corrected. When *tarsal tunnel syndrome* is associated with tendinitis, as from jogging, it is treated with ice.


Posterior Tibialis Muscle
and the Navicular Bone

Posterior Tibialis Accurate MMT



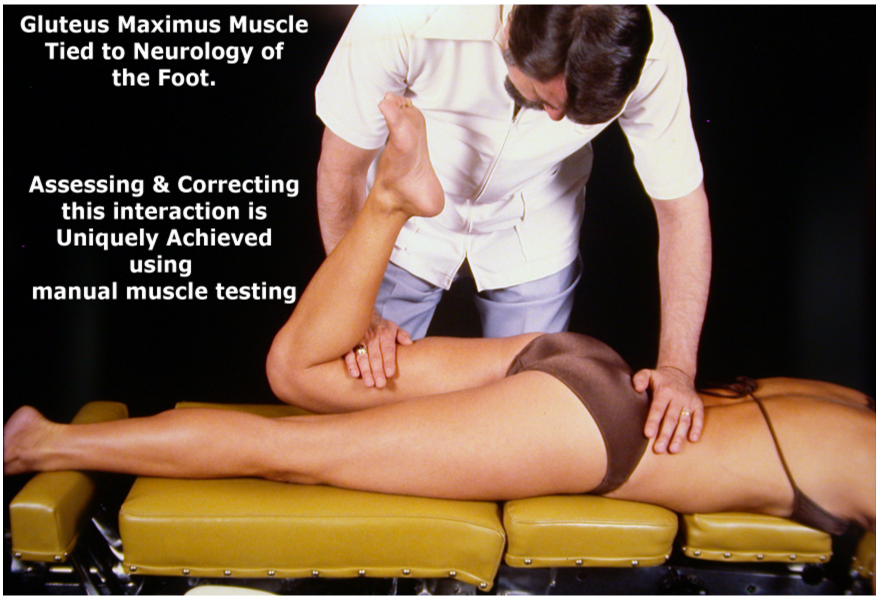




The *posterior tibialis* muscle is tested by placing the patient's ankle in complete planar flexion and adduction. The toes should be in a neutral position and not active in this test. The examiner stabilises above the ankle on the lateral aspect. The testing pressure is against the medial distal foot in a direction of abduction. Care must be taken that the patient does not dorsiflex the foot, thus recruiting other muscles into the test. The toes also should not dorsiflex, as this adds the digital muscles to the test. The testing motion is very limited. It may be necessary to do the test several times before the patient understands the movement and avoids recruitment of other muscles. The testing motion is very limited.

Correction of any foot, leg or other problems associated with the running pattern should be done to prevent recurrence. The intrinsic plantar muscles should be individually evaluated. They often require treatment to the muscle proprioceptors, or need origin–insertion technique, or fascial release. The muscles are often exquisitely tender in the area requiring treatment. It may be of value to use a percussor or Laser unit for treatment.

Foot Pronation Rehabilitation



It is very important to follow up with proper treatment of the extended pronation. Failure to adequately stretch the *triceps surae* if necessary, adjust subluxations or fixations in the feet, or to provide proper footwear will result in failure to permanently correct the *tarsal tunnel syndrome.* Ask the patient to do these steadily for several weeks.

Soleus Muscle self-stretch

When conservative treatment fails, surgical release can be effective (1) if proper diagnosis has been made. Surgical release may find a small tag or tags of tissue often secondary to trauma. At the point of entrapment there may be enlargement of the *tibial* nerve, with poor nerve conduction with electrical stimulation past the point of constriction.

In a group of sixteen patients who required surgical decompression, Edwards et al (26) found that '*Local injection of cortisone produced only transient, if any, improvement. Shoe modifications provided no improvement and arch supports always increased the severity of symptoms*'.

Burning feet from *tarsal tunnel entrapment* do not improve with vitamin treatment. When there is a sensation of burning feet without the nerve entrapment, they often respond to vitamin B–complex. (1, 16, 41) Goodheart recommends vitamin B complex for burning feet; and burning feet accompanied by swelling in hot water needs thiamine.(4)

Conclusion

The foot is a marvel of structural design. When functioning normally, it endures a tremendous amount of shock throughout the day and still smiles at day's end, with no evidence of fatigue.

Unfortunately, this is not true for a large number of chiropractic patients with spinal pain. Foot problems are very common. Interestingly, when the foot is involved, the entire body usually becomes involved as a result.

The most common foot problem is that of pronation and its associated *tarsal tunnel entrapment* syndrome. Tarsal tunnel syndrome means that some of the bones of the foot have rolled inward and displaced, causing the foot to lose its structural integrity and placing strain in the foot and ankle as they function.

The Chiropractic approach to this problem is effective, non-invasive, inexpensive and worth the clinical trial.

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