Chapter 5

Physiological effects

CHAPTER CONTENTS

To achieve successful clinical outcomes in orthopedic massage the practitioner should understand the physiological effects of different treatment methods. There are physiological differences among the various massage techniques, for example the effects of deep transverse friction and effleurage differ in key ways. With such a wide array of techniques, it is impractical to describe the effects of every procedure individually. In fact, despite advances in massage research, the full range of effects for most treatment methods has not been adequately identified. The current understanding is based on clinical experience and established physiological concepts. Consequently, this area is in need of further investigation.

Even with the limited understanding of massage physiology, there must be some awareness of physiological effects for safe and effective massage treatment. This chapter focuses on what is currently known about the physiological effects of massage. As research develops, new techniques and approaches will arise from this improved understanding and established treatment strategies may be revised.

The primary physiological effects of massage can be broken down into several categories. These are classified as fluid mechanics, neuromuscular responses, connective tissue responses, psychological effects, and reflex effects. This chapter looks at each of these categories, and some of the primary treatment techniques used to achieve these effects.

EFFECTS ON FLUID MECHANICS

One of the most commonly described effects of massage is the enhancement of tissue fluid movement. Blood and lymph are the primary tissue fluids affected by massage. These fluids are carried through vessels in the body and their passage is governed by hydraulic movement principles. The application of mechanical pressure on these vessels can either enhance or impede fluid movement. Treatment methods performed in the same direction as the primary flow of fluid enhances fluid movement. Treatments performed in a direction opposing that of fluid movement in the vessels may slow this movement.

There is particular concern about treatments applied to the extremities that move opposite the direction of venous blood return, particularly in the lower extremities. Dangerous levels of fluid pressure can build up in the veins from pushing the blood against the venous valves that keep blood moving proximally. The pressure build-up can dislodge a thrombus and cause serious complications such as an embolism, thereby leading to cardiovascular or cerebral damage.[1]

Tissue fluid movement is primarily encouraged by a pumping action of the vessels, since they have soft and pliable walls. The pumping action results from muscular contraction and movement. The absence of appropriate muscle activity leads to circulatory impairment. The increase of venous pooling and thrombosis from immobilization is an example of circulatory compromise resulting from insufficient movement and fluid pumping.[2–5]

Massage can enhance this process of tissue circulation. The mechanical compression of tissue along with gliding movements encourages the movement of blood and lymph fluid.[6,7] Massage also dilates superficial blood vessels to encourage greater circulation.[8–11] Increased circulation plays an important role in the healing of soft-tissue injury. The body's injury repair processes are reliant on good circulation to remove unwanted tissue debris and replenish nutrient-deprived regions for proper healing.

There is debate in the scientific literature about the role of massage in increasing circulation. Some studies have called into question the idea that massage enhances circulation as much as is frequently reported.[12,13] There is some indication that enhanced circulation may be directly related to the size of the muscle being treated. Yet, in these studies the measurement of blood flow change was by mean blood velocity through large arteries. These studies did not evaluate the contribution of massage to increasing blood flow in small capillaries.

One of the most significant effects of massage is the encouragement of blood flow in smaller capillaries that are restricted due to muscle tightness.[14] This effect is often immediately apparent with the superficial hyperemia and warmth of the skin in the area that has been treated with massage. With this direct indication of an increase in local blood flow, it is difficult to argue that there has not been an increase in local tissue circulation due to the effect of the massage treatment.

Edema can occur in the tissues as a result of an injury such as a sprain or a strain. Excess amounts of fluid can impede the proper healing process, so a reduction in edema is a fundamental goal of most soft-tissue treatments following an injury.[15] Edema can also occur in the tissue because of diseases or pathological processes that impair proper lymphatic drainage.[16] Movement of fluid out of these tissues is enhanced with the application of pressure and gliding movements, and is an essential part of the healing process.[17–20] Massage is an effective treatment for edema reduction. Techniques such as manual lymph drainage have been designed specifically for their effects on

Figure 5.1 Gliding techniques, especially those such as effleurage and sweeping cross fiber, have beneficial effects on enhancing tissue fluid enhancement.

encouraging better flow of lymph fluid and reduction of edema.[16,21,22]

Delayed onset muscle soreness (DOMS) is a common occurrence following bouts of unaccustomed exercise, especially if the exercise involves significant eccentric muscle actions. A primary component of DOMS appears to be an inflammatory reaction in the tissues that results from minor connective tissue tearing.[23,24] The inflammatory reaction creates excess tissue edema. Pressure from edema on local nociceptors is a likely cause of the pain in DOMS. Because of its ability to encourage circulation and remove edema, massage can be helpful in reducing DOMS.[25–27,28–31] However, these findings are still somewhat controversial, as other studies have questioned the role that massage may play in reducing DOMS.[13,32,33]

The most successful means to affect fluid mechanics with massage comes from techniques that involve gliding with pressure. Because of significant circulation effects, most of these gliding techniques are performed in the direction of the heart to prevent backflow pressure against venous valves. Effleurage, which involves long gliding strokes, is the most effective technique for encouraging tissue fluid movement. Sweeping cross fiber techniques that move in a longitudinal/diagonal direction across the muscular fibers also help enhance tissue fluid movement.

Compression broadening techniques, while not moving in a longitudinal direction with most blood and lymph vessels, still enhances tissue fluid movement. The broad pressure application on the tissues during the stroke helps flush the tissues and encourage fluid movement. Deep longitudinal stripping techniques performed with a broad base of pressure, such as the palm, also help improve tissue fluid movement. Because there is a greater degree of pressure with longitudinal stripping, caution is advised if any structures of the circulatory or lymphatic systems appear weakened or compromised. The same will be true of any active engagement methods performed with a broad base of pressure application.

NEUROMUSCULAR EFFECTS

One of the primary reasons for using massage for soft-tissue pain and injury treatment is the reduction of muscle tightness. Muscles become hypertonic because of excess neuromuscular stimulation. Massage reduces this excessive stimulation.[34–37] A variety of conservative treatments are used to address excess muscular tension, and of those procedures massage is one of the most effective.[38]

When muscle tissue is in a heightened state of contraction, the individual muscle fibers are shortened and there is an overlapping of sarcomeres, which makes the muscle feel denser during palpation. The body can maintain this level of contraction in a perpetual state if no other stimulus is introduced. Excess muscle tension produces ischemia, resistance to stretch, and irritation of nociceptors, which bombard the nervous system with sensory information. In turn, this heightened sensory information causes a reactive tightening of muscles and development of the well known pain–spasm–pain cycle.[14,39] Massage breaks the cycle of pain and spasm to reduce the overall neuromuscular tension.

Additional problems with excess neuromuscular activity arise from the muscle spindle cells, one of the primary proprioceptors in the body. The muscle spindle cells are unique among proprioceptors, in that they receive motor signals from the central nervous system through the gamma efferent (motor signal) system. The gamma efferent system is designed to help regulate the proper amount of tension in the muscle tissues.[40] If this system is overactive it causes an increase in muscle tension, as in hypertonic muscles. Excess gamma activity is another aspect of the dysfunctional neuromuscular feedback loop.

Massage can make a beneficial intervention in this dysfunctional process by mechanically stretching the sarcomeres with pressure.[41] When pressure is applied to muscle tissue, the entire fiber is put under a greater tensile load, and this mechanically stretches the muscle tissue. If pressure is held for more than just a few seconds, there is a resetting of the level of resting tension in the muscle by the muscle spindle cells.[42] This change in spindle setting is perceived by both the client and practitioner as a relaxation or softening of the muscle.

Proprioceptors, such as the muscle spindle cells, play another crucial role in the treatment process. The neurological principle of facilitation suggests that when an impulse has traveled along

Figure 5.2 Massage techniques, such as deep stripping, greatly enhance elongation of sarcomeres and thereby provide a reduction in neuromuscular tension.

a particular nerve pathway, future impulses are more likely to take that same path.[43] This is the concept behind the learning and improvement of any motor skill. There is a gradual refinement of neuromuscular patterns as the individual practices the complex coordination of motor signals. Likewise, the body may adapt to dysfunctional patterns of motor activity, such as poor posture, simply because it is continually reinforced (facilitated). One of the most powerful effects of soft-tissue manipulation is the ability to re-train the patterns of motor signals in the body, and establish new pathways for facilitation that involve far less chronic tension.[44] Continual reinforcement of reduced muscle tension improves overall muscular patterns, enhances posture and movement, and has beneficial systemic effects as well.[32]

There are many descriptions of the benefits of massage in reducing muscle tension and improving athletic performance. Massage reduces post-activity muscle tension through some of the mechanisms mentioned earlier.[45,46] However, the question of whether or how this tension reduction actually improves sports performance is still controversial. Subjectively, the popularity of massage among athletes suggests that its effects do benefit sports performance.[47,48] More research needs to be performed in this area to understand the complex factors of athletic performance, and how massage may influence those factors.

Massage also produces neuromuscular effects that influence the pain-gate mechanism. Chapter 3 included a discussion of the gate theory of pain, which outlines much of our current understanding of pain sensations in the body.[49] This theory suggests that pain can be reduced or alleviated by pressure or thermal sensations, because the fibers from pressure and thermal receptors transmit signals faster than those from pain receptors. These other sensory signals arrive at the central nervous system before the pain sensations, and in essence 'close the gate' on certain pain signals being reported. Pressure and movement in massage activate proprioceptors in this pain-gate mechanism and reduce painful sensations in the muscle tissue.[50] Massage intervention thereby aids in breaking the pain–spasm–pain cycle.

All of the techniques mentioned in the previous chapter are likely to have a beneficial effect on reducing neuromuscular tension. If the increased neuromuscular tension occurs throughout the muscle, the various gliding techniques, such as effleurage, sweeping cross fiber, and compression broadening, are particularly helpful. Pressure applied to the muscle to reduce tension is magnified with active engagement methods. The increase in pressure level helps stretch a greater number of muscle fibers and their surrounding connective tissue. In many cases, there is greater reduction of neuromuscular tension with active engagement methods than from passive techniques.

If the neuromuscular tension is in a small area, such as a myofascial trigger point, an effective means of addressing that tension is with static compression methods. Broad contact pressure static compression is helpful to reduce overall muscle tension. Following the application of broad contact static compression, more specific compression techniques like those performed with the thumbs, knuckles, elbow, or pressure tools are more appropriate to neutralize the excess neuromuscular activity of myofascial trigger points.[39,51,52]

Because of the active neuromuscular component in various active-engagement stretching methods, these approaches are highly effective in reducing neuromuscular tension. Muscle energy technique (MET), for example, is used frequently for this purpose. MET is highly effective in reducing excess neurological activity because of using the muscle's own neurological energy to aid the relaxation.[53] Neuromuscular tension is also effectively reduced when various methods are combined. An example of combining various approaches to effectively address neuromuscular tension is a combination of static compression, positional release, and muscle energy technique described as integrated neuromuscular inhibition technique, or INIT.[54]

CONNECTIVE TISSUE EFFECTS

Massage affects the connective tissues of the body in numerous ways. Fascia, which is the most prevalent connective tissue in the body, envelops every anatomical structure. This complex fascial network creates a web of connection between every region of the body so that tensile or compressive forces in one area influence those in remote areas.[55] The well-known 'fascial sweater' concept that is described by Ida Rolf illustrates how fascial restriction in one area affects many others.[56] Recent research indicates that tendon is not the only tissue to transmit muscle contraction force. Connective tissue transmits a muscle's contraction force to bones and other adjacent structures.[57,58] Therefore, when massage affects connective tissue tension it also affects tensile loads on muscle and other adjacent structures.

Restriction in free mobility of connective tissues is the origin of many musculoskeletal problems. Tensile loads applied to fascial tissues help elongate and stretch them, and, therefore, reduce the symptoms of many complaints. This is best accomplished with a low force load that is held for a longer period of time to take advantage of the mechanical property of creep – a slow, gradual tissue elongation when a steady tensile load is applied.[59,60] Connective tissues such as fascia are richly innervated with mechanoreceptors and capable of active contraction.[61,62] Low-level tangential or transverse forces applied to fascia reduce neural excitability and decrease excess muscle tension as well.[41,63]

Figure 5.3 While many myofascial techniques apply only superficial pressure, the tensile force applied to the connective tissue can help to release muscle tension even in deeper muscles.

Connective tissues such as tendons and ligaments also benefit from massage treatments. The most common pathology affecting tendons is tendinosis (commonly called tendinitis). Originally thought to involve an inflammatory reaction in the tendon fibers, research now points to the primary problem as one of collagen degeneration in the tendon tissue.[64–67] Massage is helpful for tendinosis by encouraging fibroblast proliferation, which are essential in the rebuilding of damaged tissue.[68–70] Massage is also beneficial for tendon disorders such as tenosynovitis, which is an inflammation and irritation between the tendon and its surrounding synovial sheath. Adhesions commonly develop between the tendon and its sheath in tenosynovitis. Techniques such as deep transverse friction (DTF) help break dysfunctional adhesions and mobilize the tendon within its sheath, creating less restriction for the tendon.[71]

In some injury conditions, such as muscle strains or ligament sprains, excessive scar tissue impedes the proper healing process when it binds to adjacent fibers during healing. Motion loss in ligament tissue may occur when the ligament is bound to adjacent structures such as bone or joint capsule. Immobilization and lack of movement during the healing process is the usual cause of scar tissue binding in ligament injuries. Massage techniques, especially those such as DTF, can help reduce this scar tissue.[72,73] Scar tissue from soft-tissue injury can also bind nerves and reduce their ability to glide freely beside adjacent tissue.[74,75] When the nerves lose mobility because of soft-tissue binding, neurological symptoms such as pain, paresthesia, numbness, or motor impairment follow. Stretching and massage techniques are valuable in mobilizing the connective tissue that has bound nerves to adjacent structures.[76,77]

Treatment techniques such as the myofascial approaches described in Chapter 4 have the greatest ability to elongate superficial connective tissues throughout the body. However, in many instances the fascial restrictions are in the deeper tissues. The connective tissue surrounding deep muscles may be difficult to access with applications of light pressure used in many myofascial techniques. In those situations, techniques such as the active engagement methods are more effective. The active contraction in the muscle makes the tissue denser, and the pressure is able to penetrate more effectively through the muscle. The result is a greater degree of tensile load applied to the deeper connective tissue layers.

PSYCHOLOGICAL EFFECTS

One of the most commonly reported effects of massage treatment is the overall sense of relaxation felt after the treatment session. The feeling of relaxation is much more than just a reduction in muscle tension. It is a comprehensive psychological response characterized by an overall improved sense of well-being. Numerous factors in massage treatment play a role in enhancing the client's psychological state. However, the effects discussed below are general. There is no established connection between specific massage techniques and their ability to generate or enhance a specific psychological effect.

The massage treatment is a close interaction involving touch between two individuals. The power of touch with therapeutic intent has positive outcomes in a variety of client populations.[78–82] There are other therapeutic interventions that involve touch between a practitioner and the client, but the sense of psychological well-being produced is not as strong. If an individual were receiving an ultrasound treatment, the benefit of the treatment is not likely to be dependent on the person who administers the treatment. This is not true with massage. The interaction between the client and practitioner in the massage environment is of paramount importance and arguably one of the most important therapeutic elements.[83] Unfortunately, this is also one of the most difficult elements to quantify and study through proper research methods.

Our society is currently plagued by stress-induced illnesses. A large majority of the stressors that are manifesting in people's lives have a strong psychological component. Massage is an effective intervention for many stress-induced illnesses such as anxiety or depression.[84–88] One does not need to be experiencing clinically diagnosed anxiety or depression for those beneficial effects to take place. The same mechanisms are at work in each therapeutic session and help enhance various positive psychological states.

While reducing depression and anxiety may not seem to be a primary role of treating orthopedic disorders, attention to the psychological component of soft-tissue disorders is too often an overlooked element in rehabilitation practice. A client is not a machine with a broken part like some current technological health care models espouse. Each individual and their pain complaint exists within a unique psychosocial environment and that environment plays a crucial role in the healing process.[89] Recent developments in psychoneuroimmunology and the study of mind-body medicine emphasize that the psychological and physical components of health cannot be separated when considering optimum health.[90–93] Consequently, anxiety reduction and greater psychological well-being resulting from massage treatment have an important role in the treatment of any orthopedic disorder.

The lack of personalization in the mainstream health care setting can have a detrimental effect on the individual's trust and communication with their health care provider. Health care interventions are not as successful when there is a decreased trust between the client/patient and the practitioner.[94] Massage therapy clients have repeatedly reported high levels of satisfaction in the client/practitioner relationship that contribute significantly to positive therapeutic outcomes.[95,96]

Any soft-tissue manipulation method can have beneficial or detrimental psychological effects based on the way in which it is administered. A roughly administered technique by a disinterested or irritable practitioner does not produce the same benefits as the identical technique administered in a caring and therapeutic manner by a fully engaged and compassionate practitioner. The client must feel trust and safety in the therapeutic environment for beneficial psychological effects to occur. Because the client is usually in some stage of undress during the treatment, there can be increased feelings of vulnerability or power differential between the client and practitioner. The effectiveness of any treatment technique is dependent on the practitioner's ability to gain the client's trust in the treatment process. Massage practitioners tend to spend a greater amount of time with their client's than most other health care providers. Consequently, there is a greater chance of developing a deeper connection and trust between the practitioner and the client. Do not underestimate the power of this relationship as well as the benefits and advantages of this improved trust and connection in a rehabilitative context.

REFLEX EFFECTS

Some of the beneficial effects of massage are not direct physiological responses and are therefore harder to categorize and measure. In a massage treatment sensory signals relating information on touch, pressure, and temperature cause a variety of responses that are regulated by autonomic nervous system (ANS) activity. These ANS mediated responses are called reflex effects.

One of the most powerful reflex effects is massage's influence on the immune system. While more research is clearly needed in this area, numerous studies have demonstrated a positive effect on immune system function.[97–102] Healing from any soft-tissue pain or injury condition is a complex process that requires action from the immune system. With enhanced immune system function there is a greater chance of early and beneficial tissue healing. In addition, massage appears to reduce stress hormone levels, and this effect is connected with the improved immune system function.[43,103] A related reflex effect of massage is its lowering of blood pressure.[32,104] There are both chemical and psychological factors in the massage treatment that appear responsible for decreasing blood pressure. The increase in local tissue circulation discussed earlier may be partially responsible for the blood pressure effects.

A treatment method called connective tissue massage demonstrates one way in which blood pressure changes may occur. Connective tissue massage is a technique that focuses on mobilization of the superficial connective tissue (fascia) throughout the body and is similar to some of the techniques described above in the section on myofascial approaches. Connective tissue treatments increase blood flow to deeply seated organs by triggering cutaneo-visceral reflexes.[105,106] These reflexes cause an increase in blood flow to the affected region, together with suppression of pain sensations.[107] There is also a beta-endorphin release that is linked with the sensation of pain relief.[108] While many of these effects have been studied specifically with the techniques of connective tissue massage, they are likely with many other massage techniques as well. In addition, the practitioner should bear in mind that it is difficult to predict exactly how massage may produce some of these reflex effects.

Any discussion of reflex effects of massage treatment would not be complete without mention of the many different treatment systems that use specific reflex points in precise locations on the body. The Asian bodywork systems such as acupressure, shiatsu, and tui-na are examples of these systems that use specific reflex points. The physiological models these systems use are entirely different from Western anatomy and physiology. The considerable differences in theoretical models pose difficulty for many Western-trained clinicians in understanding the reflex processes in how these systems work.[109] According to these systems, a number of maladies that are remote from the site of treatment can be affected by compression on these points.[110–112] Most of the treatment procedures in these systems use static compression techniques on precise locations (usually corresponding to acupuncture points) to achieve a therapeutic response.

Several other treatment systems are based on reflex points. These include Chapman's neurolymphatic reflex points, Bennett's neurovascular reflex points, and the various autonomic nervous system effects from myofascial trigger points.[113] There is some common ground in the physiological effects that these different systems produce. For example, there appears to be a relationship between acupuncture points and myofascial trigger points.[114] When many of these systems of 'points' are mapped onto the body, a considerable overlap is evident.

Figure 5.4 Static compression techniques are used in many reflex systems such as acupressure, tui-na or shiatsu.

Another reflex effect from soft-tissue manipulation is the viscerosomatic reflex. A viscerosomatic reflex is one that involves reflex actions through the central nervous system between visceral (organ) and somatic (usually muscular) tissues. These reflexes occur because nerve fibers to and from abdominal viscera come off the spinal cord at the same level as sensory or motor fibers for back and abdominal muscles. Because of their close proximity, reflex arcs develop between visceral and somatic fibers so there can be interactions between the two. In a viscerosomatic reflex, excessive sensory stimuli from a dysfunctional abdominal organ may travel to the spinal cord and spill over in a reflex arc to muscular tissues whose motor fibers originate at the same level. The excessive sensory stimuli from the dysfunctional organ create increased motor signals and subsequent increases in muscle tension.

The reverse process is also a viscerosomatic reflex (although some call this a somatic-visceral reflex). Sensory signals from exceedingly tight muscles may spill over in the spinal cord to afferents associated with organ function. The spillover creates a dysfunctional level of neural stimulation to the organ resulting in an eventual organ disorder. Massage can have a positive outcome in reducing viscerosomatic reflex activity. A reduction in sensory stimulation can occur in this area if the muscles are treated and their overall neuromuscular activity is reduced. Massage can interrupt viscerosomatic reflexes and reduce excessive input to the central nervous system.[115]

Choosing specific treatment techniques to maximize reflex effects can be challenging because these effects are difficult to predict. It is more valuable for the clinician to bear in mind that all of the above effects are possible results from therapeutic procedures (the exception is if the individual is using a system that is specific for particular reflex effects, such as shiatsu). In this way, the practitioner should have a better understanding of what reflex processes might occur as a result of treatment.

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SECTION 2

A regional approach to pathology and treatment

SECTION CONTENTS

The next section examines the most commonly occurring soft-tissue pathologies the orthopedic massage practitioner is likely to see. Each of these disorders is presented as a separate condition that has unique clinical signs and symptoms. However, in many cases the client's condition is not limited to a single discrete pathology. Several problems can co-exist and they may involve a complex interaction of clinical factors. Biomechanics, nutrition, chemical exposure, and psychosocial stress are just a few of the additional factors that should be considered when evaluating and treating any orthopedic disorder. For that reason, the client must be viewed in a multi-dimensional manner, and not simply as a body with a condition.

The soft-tissue massage treatment methods described in the following chapters have been developed through years of research and clinical practice. Numerous practitioners were consulted in developing these treatment guidelines. Methods are suggested that have demonstrated positive results and are based on sound physiological principles. At the present time the field of orthopedic massage is limited on research literature that has evaluated these therapeutic procedures. Hopefully in years to come, research scientists and funding sources will be attracted to this therapeutic approach and can help validate the clinical efficacy of these methods.

It is difficult to teach a complex psychomotor skill such as massage through a book. Quality massage treatment requires a wide variety of skills. Proper training in basic and advanced skills of soft-tissue manipulation is essential to be a safe and effective orthopedic massage practitioner. There are numerous ways to learn and develop these skills including traditional schooling, continuing education courses, and multimedia options such as DVDs. However, a word of caution is necessary for those unfamiliar with massage training. Do not dismiss these skills as easy or too simple to warrant the time devoted to practice and mastery. High-quality massage treatment is a lot harder to perform than it looks.

Under each of the conditions described in the following chapters, a variety of treatment methods are presented. There are important considerations regarding when to use the techniques most effectively and when they should be modified. These concepts are discussed in the treatment subsections *Rehabilitation protocol considerations*. As you consider different treatment options keep in mind the legal scope of practice in your jurisdiction. Depending on your professional training and licensure status, some of the treatments recommended in this section may fall outside your legal scope of practice. You should not attempt to perform any technique or method that is out of your scope of practice, simply because it is included in the suggestion of treatments.

In presenting treatment suggestions a deliberate attempt is made to provide effective guidelines, but steer clear of giving a rigid treatment routine for these conditions. Massage techniques are frequently taught in a routine because it is an easy way to convey a set of movement skills. Yet, overemphasis on a specific treatment routine can cause the practitioner to look for overly simplistic solutions at the expense of greater clinical versatility.

Chapter 6

Foot, ankle, and lower leg

CHAPTER CONTENTS

The foot and ankle provide the fundamental base of support for bipedal locomotion. As a result this region is built for the challenges of movement, stability, and transmission of high force loads from body weight. The skeletal structure of the foot, ankle, and leg handle the majority of compressive loads during locomotion, which can amount to several times the body weight.[1] Soft tissues of the foot also handle considerable force loads. Consider the role of the lateral ankle ligaments in maintaining ankle stability or the plantar fascia in upholding the longitudinal arch. Other tissues, such as the tibialis posterior have a primary role in preventing overpronation of the foot. All these tissues are subjected to chronic overuse in our daily activities and numerous soft-tissue pathologies can result.

There are particularly high demands placed on this region of the body during athletics or other activities that require high force loads or long periods of locomotion, which can lead to numerous overuse soft-tissue disorders. However, it does not take excessive overuse or athletic activity to develop significant problems in this region. Something as simple as improper shoes can play a role in many lower extremity soft-tissue pathologies.[2–4] For many of these conditions, massage is one of the very best interventions to restore normal and healthy tissue function.

INJURY CONDITIONS

ANKLE SPRAINS

Description

There are three separate joints to consider when looking at ankle sprains. Technically, the ankle is the joint between the talus and the distal articulation of the tibia and fibula. This articulation is also called the talocrural joint (Fig. 6.1). The distal articulation between the tibia and fibula is also part of the ankle and can be involved in ankle sprains. The joint below the talocrural joint where the talus articulates with the calcaneus is the sub-talar joint. Sprains may occur to the ligaments that span any of these joints.

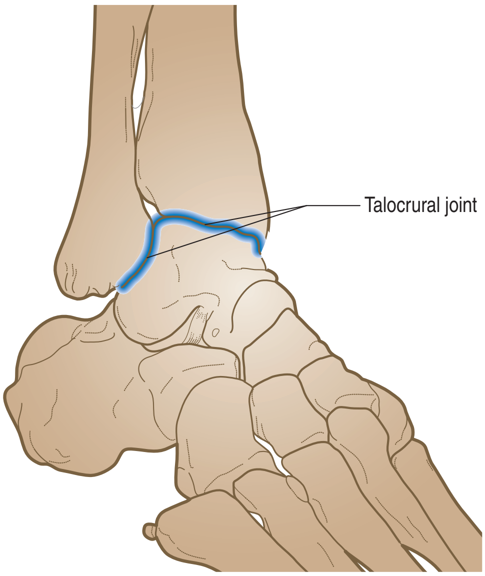

Figure 6.1 The talocrural joint of the ankle.

The ankle (talocrural) joint is a simple hinge joint. It relies strongly on the congruence of bones for its stability. However, there is a complex webbing of ligamentous structures that aids in stability of the ankle. There are three primary ligaments on the lateral side of the ankle that aid stability and prevent excessive inversion and rotational stresses at the ankle. They are the anterior talofibular, calcaneofibular, and posterior talofibular (Fig. 6.2).

On the medial side of the ankle the ligaments are designed to prevent excessive eversion as well as rotational stresses. There are four ligaments that aid in stability on the medial side of the ankle. They are the posterior tibiotalar, tibiocalcaneal, tibionavicular, and the anterior tibiotalar. These four ligaments create a strong triangular-shaped ligamentous restraint. Their fibers are blended together, and therefore they are often referred to simply as the deltoid ligament – referring to the Greek letter Delta that is shaped like a triangle.

The distal tibiofibular joint is called a syndesmosis. A syndesmosis joint is one that is tightly bound by ligaments and permits very little movement. It is crucial that the tibia and fibula stay tightly bound together at this joint to create the proper articular surface for the talus. The ligaments of this syndesmosis joint are not often sprained, but they should be considered as a possible source of injury with ankle sprains.

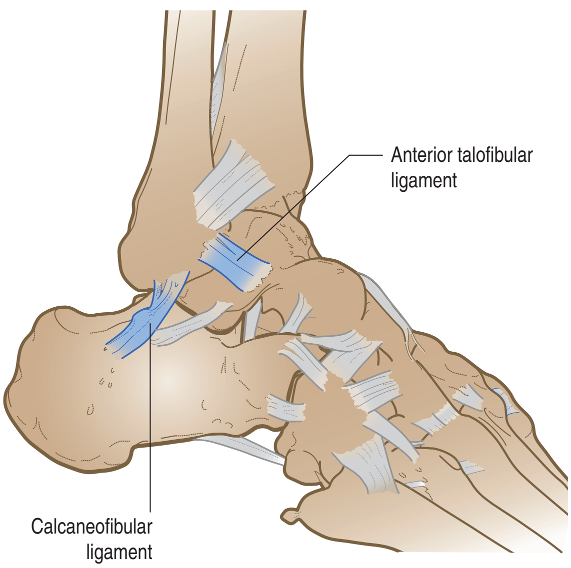

Figure 6.2 The lateral ankle ligaments.

The ankle has different degrees of stability on each side. This stability is determined by the structural integrity of the ligaments that span the joint. The weaker the ligaments are, the more likely they are to be injured from an ankle sprain. Ligaments are weaker on the lateral side of the ankle than on the medial side.[5] The deltoid ligament group is particularly strong and this is one reason why medial ankle sprains are so much less common than lateral ankle sprains.

Lateral ankle sprains

Sprains to the lateral ligaments of the ankle are the most common lower-extremity injury seen by health care providers.[6] It is estimated that 85% of all ankle injuries involve ligament sprains.[7] The anterior talofibular ligament is the most frequently injured, and the calcaneofibular is the second. The posterior talofibular ligament is rarely injured.[6,7]

A typical cause for this injury involves a twisting motion of the foot where the foot is excessively inverted. Inversion occurs at the sub-talar joint, and the lateral ankle ligaments are quite vulnerable as they cross that joint. Injuries are likely to be worse if the foot is both inverted and plantar flexed simultaneously. The severity of this condition is graded at three levels: grade one sprain is mild, grade two is moderate, and grade three is severe.

Swelling and pain usually accompany the onset of a lateral ankle sprain. Ecchymosis (bruising) is common after the initial injury as well. The bruising may settle into the lateral or medial aspect of the heel. Depending upon the severity of the injury, the client may have a difficult time bearing weight on the affected side. Swelling routinely stays in the region for long periods (sometimes weeks) after the initial injury.

Medial ankle sprains

Medial ankle sprains are far less common than lateral ankle sprains. The strength of the deltoid ligament group is one of the primary reasons for fewer sprains to the medial side of the ankle. The deltoid ligament complex is designed to prevent excessive eversion. However, this ligament group is assisted by the fibula.

The fibula extends farther distally than the tibia and, as a result, prevents excessive eversion of the foot. When a sprain does occur to the deltoid ligament group, it is usually a severe injury, and could involve fractures or ligament avulsions as well. An avulsion is an injury in which the ligament tears away from its attachment site. It can also take a small chunk of bone with it and if so this is called an avulsion fracture.

Syndesmosis sprains

Sprains to the distal tibiofibular syndesmosis are not very common. However, when they do occur they are generally slower to heal than sprains to the ligaments on either side of the ankle.[8] As the syndesmosis is superior to the other ligaments of the ankle, a sprain to the ligaments at this joint may be referred to as a high ankle sprain. These injuries ordinarily occur when the foot is exposed to a rotational stress or extremes of dorsiflexion.[9,10] During rotational stress or extreme dorsiflexion, the distal tibia and fibula are forced apart, causing a sprain to the ligaments.

Treatment

Traditional approaches

Ankle sprains are generally treated conservatively. A frequent guideline applied to acute injuries such as an ankle sprain is the acronym PRICE (Protection, Rest, Ice, Compression and Elevation).[11] In this instance, protection should mean preventing excessive movements in the direction of ligamentous weakness and instability. Ankle sprains used to be treated with immobilization, such as casting. However, recent studies supported by clinical experience conclude that early mobilization is more effective for helping ligament injuries heal because it stimulates collagen production.[12–14]

In the beginning of rehabilitation, the primary goals are to decrease pain, increase pain-free active range of motion, and protect the injured site from further damage. As the condition improves, greater effort is made to increase range of motion, improve flexibility, and enhance proprioceptive awareness in the area. Once the injured ligament has significantly improved, rehabilitative exercises are begun that strengthen the area to prevent injury recurrence.[14] These procedures should follow the rehabilitation protocol described in Chapter 1.

While some advocate that it is best not to perform significant exercise with the ligament until it has fully healed, lack of exercise can decrease the client's ability to achieve the best functional recovery. Experts argue that waiting until a ligament is fully healed would require waiting months for an athlete to return to their sport.[15] The majority of people are back to activity long before complete healing of the ligament. Active movement exercises, such as attempting to draw the letters of the alphabet in the air with the foot, are commonly used. Because this movement activity is performed in a non-weight-bearing position, it can be used without much pain for many ankle sprains relatively soon.[16]

Sprains usually heal within several weeks, depending upon their severity. The more severe the sprain, the longer is the period of recovery. However, if pain from an ankle sprain appears to linger long after the sprain should have healed, there is cause for concern, and the practitioner should consider the possibility of other complications. Persistent pain after injury can be the result of tissue impingement, insufficient rehabilitation, osteochondral injury, peroneal tendon damage, or chronic instability.[17]

Soft-tissue manipulation

General guidelines Massage can be a valuable part of the treatment approach for ankle sprains. The practitioner should thoroughly assess the problem and first determine no other serious pathology that may need medical attention. In the early stages of injury, the primary interventions focus on relieving pain and restoring pain-free range of motion. Often this involves active movements performed within the client's pain tolerance. With regard to massage treatment of a ligament sprain, the appropriate time period after which treatment can commence has yet to be determined. Physical-assessment procedures help establish the severity of the injury. Practitioners should avoid treating the region if it is still in an acute inflammatory stage.

The acute injury stage covers the first 48–72 hours after injury. As the swelling begins to subside (and this may be helped with ice or other anti-inflammatory methods), light stroking in a proximal direction aids the lymphatic drainage in the area. Lymphatic drainage reduces excess tissue fluid, and contributes to a decrease in pain. Discomfort following a sprain is often a result of excess fluid in the area that presses on nerve endings and fills the interstitial spaces.

It is common for swelling to stay in the region of an ankle sprain for several weeks post injury. Waiting until all the visible swelling is gone misses the ideal window of opportunity for the best contribution to injury rehabilitation. The techniques described below can be delivered in moderation even if some chronic swelling persists.

Once the initial swelling has subsided, more vigorous treatments may be incorporated. Deep friction massage specifically to the site of the injury is beneficial for repairing the ligament tissue damage. Deep transverse friction (DTF) massage is used to realign scar tissue in the damaged ligament (or tendon). In addition, DTF plays a role in mobilizing the ligament and preventing it from adhering to adjacent tissues. Deep friction also has a fundamental role in collagen synthesis in repairing the damaged tissue.[18] DTF is normally performed in a direction that is perpendicular to the direction of the ligament's fibers.

In addition to the foot, the lower leg muscles are treated, especially if they are in some degree of protective spasm following the injury. For example, after an inversion sprain there is usually tightness in the peroneal muscles, as they are likely to become hypertonic. Not everyone experiences the same rate of injury healing. A severe injury that is several years old can be bound down with a great amount of scar tissue. It could take this individual a longer time to regain proper functional movement than someone who has a very recent sprain.

Stretching is incorporated along with soft-tissue manipulation. After an inversion ankle sprain, it is helpful to stretch the peroneal muscles (moving the foot into inversion). Too much passive stretching, especially at the early stages of the injury, can over-stretch the ligaments. Stretching in the later stages is an important part of developing a healthy and functional repair of the injury site.

Following a ligament injury, it is important to achieve early mobilization of the area for the most beneficial healing to occur. Because passive movement runs the risk of overstretching the damaged tissue, active movement is preferable, especially in the early stages. The client is unlikely to perform any movement that hurts too much, so active movement is self-limiting and not likely to cause further damage.

Suggested techniques and methods

A. Deep friction Collagen synthesis and ligament repair is enhanced with deep friction. Apply friction directly to affected ankle ligaments if it is a medial or lateral ankle sprain (Fig. 6.3). A cycle of friction along with other techniques is used. Apply friction for several minutes and then use joint range-of-motion movements along with treatment of nearby and associated tendons and muscles. Repeat this sequence 3 or 4 times. The location of syndesmosis sprains are difficult to reach with DTF, but the technique can be applied to the anterior ankle region because pressure on structures in this area can also press on the affected syndesmosis tissues.

B. Deep longitudinal stripping Muscles often become hypertonic in reaction to the injury. This technique helps reduce overall muscle tension in the region. Apply deep longitudinal stripping to muscles in the region. For lateral ligament injuries, treat the peroneal muscles (Fig. 6.4). For medial sprains the muscles of the deep posterior compartment, tibialis posterior, flexor hallucis longus and flexor digitorum longus are addressed.

C. Superficial myofascial and lymphatic drainage techniques Reducing local edema is helpful,

Figure 6.3 Deep transverse friction to medial and lateral ankle ligaments.

Figure 6.4 Deep stripping to the peroneal muscles.

especially prior to some of the other treatments. Use the back side of the fingers to apply very light pressure with strokes moving in a proximal direction (Fig. 6.5). This technique is effective both before and after some of the other applications such as DTF.

D. Stretching and mobilization Enhancing joint mobility as the ligaments heal is a primary goal of treatment. Only gentle stretches or joint movements should be applied so no further tissue damage is caused. Gently stretching the damaged ligament in the direction of its primary tensile loads will help the ligament remodel; for lateral ankle sprains, the direction of stretch is inversion, for medial sprains it is eversion, and dorsiflexion is best for syndesmosis sprains. Because ligaments are the primary tissues being stretched, long (at least 20 seconds) static stretches are more effective than short duration stretches.

Figure 6.5 Light lymphatic drainage strokes around the ankle for ankle sprain.

Rehabilitation protocol considerations

- The primary focus in treating sprains is to assist in modeling an effective tissue repair.
- Another important goal is to decrease the onset of dysfunctional biomechanical muscular patterns.
- The more severe the ankle injury, the less intense the DTF applications should be. The severity of the sprain is determined with physical assessment.
- If the sprain is old (more than 6 months), excessive scar tissue may have accumulated in the area causing a thick degree of fibrosis. In this situation DTF applications can last considerably longer and be more aggressive. Instability should not be an issue in the joint because the ligament injury has healed. However, excessive scar tissue will need to be mobilized. The longer excessive scar tissue and adhesion build-up has been present in the tissues, the longer its resolution is going to take.
- As the injury progresses, greater degrees of movement and weight-bearing are incorporated with the soft-tissue treatment. It is also valuable to work on all the other lower extremity tissues (especially the lower leg) as they may have developed altered biomechanics as compensation for the injured joint.
- Proper movement and proprioception are important factors for preventing re-injury.

Cautions and contraindications Before treating an ankle sprain, identify the severity of the injury and make sure a more serious complication is not present. If the sprain is severe, a fracture or ligament avulsion can exist. These conditions should be ruled out before beginning massage treatment; referring the client may be necessary. If there is tenderness over the posterior distal portion of the medial or lateral malleolus, and the client is unable to bear weight, they should be referred for evaluation for a fracture or avulsion injury.[15] Swelling can exist with an ankle sprain for a long period, but if there is excessive swelling in the region, deep or vigorous treatments should not be attempted.

Pain reported by the client is a good guide for intensity of the treatment. Treatment approaches, whether they are specific massage applications or movement of the injured area, should be performed within the client's pain tolerance. As the condition improves, friction massage can become more vigorous and greater range of motion can be attempted.

MORTON'S NEUROMA

Description

Morton's neuroma, also called an interdigital neuroma or Morton's metatarsalgia, is a nerve injury in the distal region of the foot. A neuroma is an enlarged and irritated section of nerve tissue.[19] Morton's neuroma affects the medial and lateral plantar nerves or their terminal branches, the plantar digital nerves. This neuroma is most likely to develop between the heads of the third and fourth metatarsals, although it can occur between other metatarsals. Neuromas result from pressure on the nerve. In Morton's neuroma the nerve pressure can come from several different factors.

The medial and lateral plantar nerves are branches of the tibial nerve. They divide from the tibial nerve as they are exiting the tarsal tunnel on the medial side of the ankle. However, there is a communicating branch that converges between the medial and lateral plantar nerves near the heads of the third and fourth metatarsals (Fig. 6.6). This connecting branch is not present in everyone.[20] Lack of this connecting branch reduces the risk of developing Morton's neuroma.

Because the nerves converge between the metatarsal heads, the nerve diameter is greater here.[21] With a greater nerve diameter, there is an increased chance of pressure on the nerve by other structures, such as the metatarsal heads. There is less space between the third and fourth metatarsal heads than between the others, and the smaller space plays a role in the onset of Morton's neuroma as well.[20]

Another factor leading to neuroma development is the lack of mobility of the nerves in this region. The affected nerves are on the underside of the foot and they pass underneath (on the plantar side of) the transverse metatarsal ligaments that span between heads of the metatarsals.[22] The nerves can be irritated by tension against the transverse metatarsal ligaments. This would happen in a situation where the distal end of the nerve was being stretched. The distal region of the medial and lateral plantar nerves is stretched most during dorsiflexion with toe extension. Examples of this

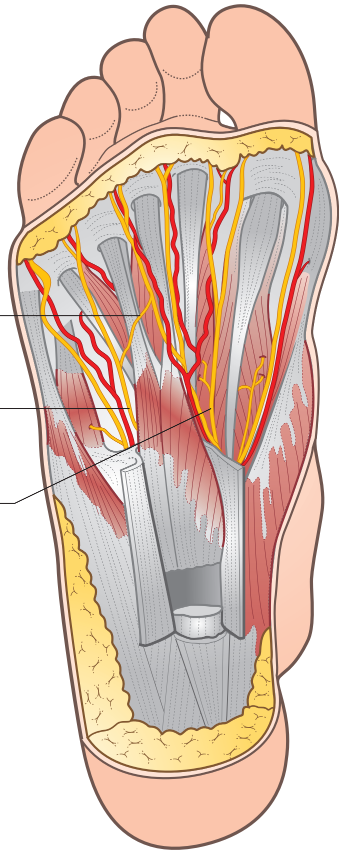

Figure 6.6 The communicating branch of the medial and lateral plantar nerves.

movement are the end of the push-off phase during normal gait, or squatting down while keeping the heels lifted off the ground and the weight on the forefoot (Fig. 6.7).[23]

Nerve injuries commonly occur as a result of excess neural tension (exaggerated pulling forces on the nerve in various positions).[24–27] Irritation of nerve tissues is exaggerated in areas where the nerves either branch or converge because there is less mobility at that location.[25,28] That is the case with Morton's neuroma, and it can play a role in the onset of the problem.

A person with Morton's neuroma usually feels sharp, shooting pain sensations in the forefoot or into the toes. The pain is likely to be aggravated by wearing narrow toe box shoes that force the metatarsal heads together. This condition is more common in women than in men.[21] A primary reason may be the wearing of high heel shoes. Not only do these shoes have a

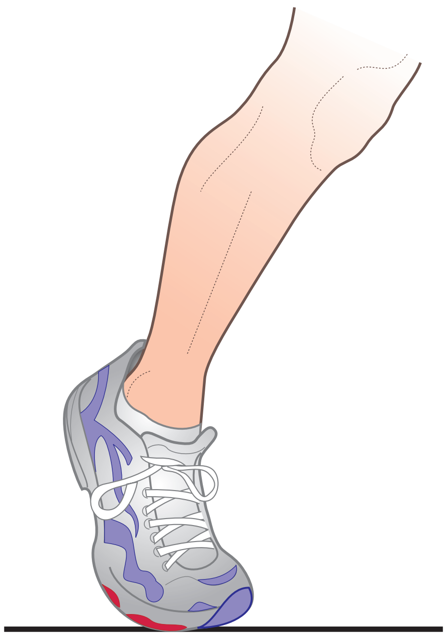

Figure 6.7 Bowstringing of the plantar nerves during push-off.

narrow toe box, but the elevation of the heel shoves the foot into the front of the shoe increasing compression of the metatarsal heads even further.[3]

Treatment

Traditional approaches

Morton's neuroma is usually treated with conservative methods. A primary aspect of treatment is to reduce nerve compression by the metatarsal heads. Changing to a shoe with a wider toe box may be the simplest means of treating this problem, and often all that is needed.

In addition to changing shoes, orthotics are sometimes advocated for Morton's neuroma. Rigid orthotics that limit dorsiflexion may be helpful if the primary problem is aggravated by positions of toe hyperextension with dorsiflexion. A typical orthotic device is a domed pad that sits under the heads of the metatarsals. This pad spreads the metatarsal heads apart inside the shoe and relieves pressure on the irritated nerve.

Anesthetic or corticosteroid injections may be used in the area to reduce pain or inflammation of the nerve. However, repeated corticosteroid injections can cause additional problems such as fat pad atrophy.[23,29] As a result these approaches are being used less. Surgical removal of the neuroma (neurectomy) is an option if conservative measures fail.

Soft-tissue manipulation

General guidelines Morton's neuroma will sometimes develop as a result of previous injury that has left scar tissue in the area. If this is the case, massage may be beneficial in breaking up fibrous scar tissue that is binding the nerve.[23] Other forms of massage are useful for treating Morton's neuroma, but techniques that put direct pressure on the region near the metatarsal heads should be avoided.

The neuroma is aggravated from pressure by the metatarsal heads, so it is best to use approaches that separate the metatarsal heads. These massage techniques are most effective when they are performed in conjunction with the other therapies, such as changing footwear.

It is important to address neural tension as excess tension in the nervous system can contribute to this problem. The practitioner should treat the tissues adjacent to sciatic nerve, along its length and branches in the lower extremity where additional restrictions might occur. Areas of potential nerve binding or restriction include the ankle, calf, hamstring, and gluteal regions. Valuable mobilization techniques are those that encourage flexibility and pliability as they enhance neural mobility. Metatarsal spreading and mobilization is relatively simple, and is something the client can do at home.

Suggested techniques and methods

A. Metatarsal spreading techniques Tightness in the intrinsic muscles in the foot can further aggravate the nerve compression. Metatarsal spreading techniques reduce soft-tissue binding and stretch the intrinsic foot muscles. Use the thumbs on the plantar surface of the foot in sweeping arcs across the metatarsal heads to encourage separation (Fig. 6.8).

B. Metatarsal mobilization Individual metatarsal mobilization techniques help flexibility and movement between metatarsals so they are less likely to squeeze nerve tissue. Grasp the forefoot with both hands. Begin with four metatarsals in one hand and one in the other. Pull and stretch the metatarsals in each hand away from each other in multiple directions. Then perform the same movements on the gap between the next two metatarsals so that

Figure 6.8 Metatarsal spreading.

Figure 6.10 Deep stripping to plantar surface of the foot.

two are in one hand and three in the other (Fig. 6.9). Continue the process of stretching the tissues between metatarsals until spaces between all of them have been treated.

C. Deep stripping techniques Mobility of the medial and lateral plantar nerve branches are enhanced with stripping techniques performed to the plantar surface of the foot. These stripping techniques can be performed from the toes toward the heel or vice versa (Fig. 6.10).

D. Neural stretching Neural movement that focuses on dorsiflexion and toe extension helps encourage full nerve mobility of the sciatic nerve and its distal branches. After performing some of the other mobilization techniques described above, pull the foot into simultaneous dorsiflexion with toe extension. This movement is performed at a moderate pace without stopping to hold the stretch at the end of the movement. The neural stretching movement can be repeated 5–10 times in one set and then repeated for several sets with a short period of rest between sets (Fig. 6.11). Knee extension and hip flexion can be added into each stretch to enhance sciatic nerve mobilization.

Rehabilitation protocol considerations

- If the Morton's neuroma is severe, use caution because the neural tissue may be sensitive to tension or compression.
- As the condition improves, more vigorous stretching or mobilization can be applied.
- These techniques are most effective when combined with changes in footwear that alleviate nerve compression by the metatarsal heads.
- In the early stages the client may be encouraged to avoid movements of dorsiflexion with toe extension (as in the push-off stage of gait), especially if it aggravates symptoms. In the later

Figure 6.9 Metatarsal mobilization.

Figure 6.11 Neural stretching of the plantar nerves for Morton's neuroma.

stages of the condition as it improves, these movements and positions are encouraged to further help with nerve mobilization.

- Nerves are notoriously slow in healing so the client may be improving, although the symptoms are still prevalent. Encourage the client to pay close attention to the levels of irritability of neural structures. A visual analog scale or some other measure for pain sensation may be valuable.

Cautions and contraindications A neuroma is an enlarged and irritated section of nerve. Avoid treatments that aggravate the client's symptoms as this could put unnecessary force on the irritated nerve. There can be a palpable mass of the nerve tissue just adjacent to the metatarsal heads so palpate this region carefully. Exercise caution with techniques that increase pressure on the metatarsal heads from the side of the foot. These methods can also aggravate the neuroma and increase the client's symptomatic complaints.

Box 6.1 Clinical Tip

Assessment techniques for peripheral nerve disorders use a number of neurodynamic tests to evaluate mobility in the nervous system. The same techniques that are used for the evaluation of neural tension can be used in treatment as neural mobilization (stretching) techniques. For example, the neural stretching technique mentioned in D under Morton's neuroma describes a position of dorsiflexion and toe extension to stretch the distal end of the sciatic nerve. Neural mobility can be enhanced even farther by using additional components of the neurodynamic evaluation procedure called the straight-leg raise test.
In this procedure the hip is flexed with the knee in extension to give the greatest amount of tensile stretch to the sciatic nerve.

PLANTAR FASCIITIS

Description

Plantar fasciitis is the most common cause of painful feet encountered in clinical practice and occurs more in women than in men.[30] The primary cause of this condition is excessive tension on the attachment of the plantar fascia into the anterior calcaneus. The plantar fascia plays a crucial role in maintaining stability and contributing to shock absorption in the foot. As a result, high tensile forces on the tissue can cause an irritation at its attachment sites.

The foot is composed of many joints, but becomes a stiff spring when the muscles acting on it become taut. The plantar fascia is an important part of this spring mechanism, because it is essentially a tension cable between the heel and toes. It acts like a mechanical pulley device called a Spanish windlass (Fig. 6.12).[31]

In the windlass mechanism tension on the 'cable', which in this case is the plantar fascia, is increased as the second segment (the phalanges) are extended. At the end of the push-off phase of gait there is increased tension generated in the foot to propel the body forward.[32] Because of the windlass design in the foot, the tension is greatest when the toes are in hyperextension. There is also increased tension on the plantar fascia from normal weight bearing. Downward-directed pressure on the longitudinal arch from weight bearing increases tension along the plantar fascia.[33] The increased tension pulls on each end of the plantar fascia.

The plantar fascia attaches distally into the fascia that crosses the metatarsal heads and extends

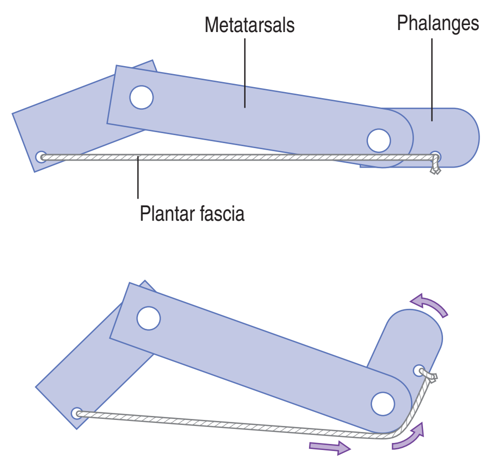

Figure 6.12 The plantar fascia seen as a Spanish windlass.

into the toes. Proximally its attachment is on the anterior calcaneus. Because the attachment site on the anterior calcaneus is so much smaller than the attachment region across the metatarsal heads, there is more force per square millimeter applied to the attachment site at the calcaneus. This concentrated force leads to the development of plantar fasciitis.

When a tendon or connective tissue such as the plantar fascia inserts into a bone it does not stop right at the bone. It has fibrous continuity with the bony matrix.[34] Therefore, excessive tensile stress on that site also affects the bone. As a result of the tensile stress placed on the bony attachment site, an exostosis (bone spur) can develop.[35] Therefore, plantar fasciitis is usually painful at the calcaneal attachment site. The planta fascia pulls on the periosteum, which is one of the most pain sensitive tissues in the body.

A frequent cause of plantar fasciitis is biomechanical dysfunction in the foot. While improper footwear can contribute, overpronation appears to be a major cause.[36,37] When the individual overpronates, the plantar fascia must take on greater shock absorption in the lower extremity. The increased tensile stress on the plantar fascia leads to fiber breakdown with resultant stress on the calcaneal attachment site. Overpronation often accompanies a flat foot (pes planus), so the presence of pes planus in the client is a good indicator that plantar fasciitis could occur. A pes cavus (high arch) foot is also a common factor in plantar fasciitis.[38] In pes cavus there is increased tension in the toe flexor muscles, and the higher arch may generate greater tensile stresses on the plantar fascia.

The plantar fascia has fascial connections with the gastrocnemius and soleus muscles. Keeping these muscles, the plantar fascia, and the corresponding connective tissues in a shortened position for long periods commonly aggravates the symptoms. Tissue shortening is most evident when the client first gets up in the morning and walks across the floor. The pain sensations are intense at that time. At night the client sleeps with their feet in a plantar flexed position. The soft tissues adapt to this shortened position, and then vertical weight bearing puts a strong tensile load on them when first standing and exaggerates the pain.

Treatment

Traditional approaches

The primary goal of plantar fasciitis treatment is to reduce tensile stress at the calcaneal attachment site of the plantar fascia. Reducing tensile stress gives the irritation site a chance to heal. Rest from further offending activities is also a crucial part of the rehabilitation strategy. Orthotics are used to change faulty biomechanical patterns in the foot, and take pressure off the plantar fascia. Orthotics are also useful if the client has either pes cavus or pes planus that is contributing to the plantar fascia overload.

Corticosteroid injections into the plantar fascia have been used to address inflammatory effects. However, these injections can have detrimental effects. Injections can leak into the fat pad causing fat pad degeneration and rupture of the plantar fascia.[39–41]

The tension night splint is used to treat plantar fasciitis with very good results.[42–44] This is a brace worn on the foot to maintain the foot in a position of dorsiflexion during the night (Fig. 6.13). The long period of dorsiflexion stretches the gastrocnemius and soleus muscles as well as some of the flexor muscles on the bottom surface of the foot. Prolonged dorsiflexion also conditions the plantar fascia to tensile stress and prevents the aggravation of tensile forces on the attachment site at the calcaneus.

Ice applications are routinely used to treat plantar fasciitis. Ice is used to reduce inflammatory activity associated with the chronic irritation of the fascia's attachment site. However, there is some question as to how much inflammation is actually occurring in this condition. Plantar fasciitis may result more from collagen degeneration (as in tendinosis) as opposed to inflammatory activity.[45]

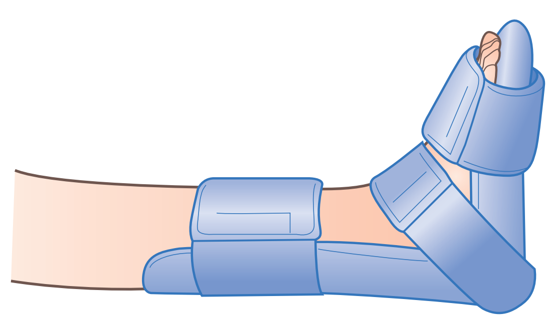

Figure 6.13 The tension night splint.

Extracorporeal shock wave therapy is a new treatment that is being used to treat plantar fasciitis. The focus of shock wave therapy is on bone spurs that develop at the fascial attachment site. However, several reviews of shock wave therapy indicate that this treatment does not have consistent effectiveness.[46,47]

Soft-tissue manipulation

General guidelines Massage techniques are valuable in treatment of plantar fasciitis as long as they are performed within proper rehabilitation protocol guidelines. Treatment focuses on the dysfunctional plantar fascia as well as other supporting soft tissues that biomechanically support it. The primary treatment goal is to reduce the chronic tensile load on the attachment site. Reducing the tensile load at the attachment site reduces stress on both the soft tissues and the bones to which they attach.

Muscles such as the tibialis posterior, which play a prominent role in dynamic foot stability, should be treated to reduce hypertonicity. Fatigue from eccentric overload of the tibialis posterior can cause overpronation and subsequent plantar fasciitis overload.[31] Massage assists the effectiveness of a tension night splint by reducing tightness in the connective tissues and muscles of the plantar surface of the foot and posterior calf.

Practitioners should also treat the muscles of the entire lower extremity when addressing plantar fasciitis. Biomechanical compensations as a result of the foot pain have effects on other areas as well. The effects of these compensations may not be limited to the lower extremity, so watch for bony or soft-tissue changes throughout the body.

Stretching the gastrocnemius and soleus muscles is very important in plantar fasciitis treatment. Stretching several times during the day is best if possible. Wearing a tension night splint will stretch these tissues during the night, and reduce accumulated tension on the plantar fascia attachment. Stretching that emphasizes elongating the plantar surface tissues is helpful as well. To stretch these tissues, pull the foot into dorsiflexion and the toes into hyperextension.

Suggested techniques and methods

A. Longitudinal stripping Stripping techniques encourage tissue elongation in the plantar fascia and the flexor muscles on the bottom surface of the foot. Perform a stripping technique with the thumbs, fingers, or other smaller contact surface from one end of the plantar fascia to the other (Fig. 6.14). Performing longitudinal stripping methods toward the calcaneus reduces additional tensile stress on the plantar fascia and is less painful for the client.

Figure 6.14 Deep stripping on plantar surface of the foot (toward the calcaneus).

B. Deep transverse friction Fibroblast activity can be increased in the plantar fascia with friction techniques. Apply friction with the thumb or fingers near the calcaneal attachment of the plantar fascia, but not right on the insertion (Fig. 6.15). Do not press directly on the anterior calcaneus when performing the deep-friction treatments because there is potential for a bone spur. Because it is not known whether a bone spur is present or not without an X-ray, assume that one is present and avoid treatments that would aggravate the tissues there.

Figure 6.15 Friction treatment to plantar fascia (away from calcaneus).

C. Compression broadening and deep longitudinal stripping The triceps surae are an integral part of the kinetic chain of tightness in plantar fasciitis, and reducing tightness in them is an important part of treatment. Apply compression broadening and deep stripping methods to the triceps surae group (gastrocnemius and soleus) to reduce tightness (Figs 6.16 & 6.17). Perform deep stripping techniques with a broad contact surface first for more general applications and then follow up with a small contact surface for more specific applications. Stretching can follow these techniques.

D. Deep stripping techniques Attention should also focus on the deep posterior compartment muscles. These muscles help the mechanical function of the plantar fascia. With the client in a side-lying position, use the thumb or fingertips to strip in a proximal direction along the medial border of the tibia to reduce tightness in the tibialis posterior and other deep posterior compartment muscles (Fig. 6.18).

Figure 6.16 Compression broadening to triceps surae.

Figure 6.17 Deep stripping to triceps surae.

Figure 6.18 Deep stripping to deep posterior compartment muscles along tibial border.

E. Active engagement lengthening techniques A greater penetrating effect of pressure is achieved with active engagement techniques. Use the same initial position for the client as in (D). Have the client move their foot in full dorsiflexion and plantar flexion in a slow repeated motion. During the dorsiflexion, perform a short specific stripping technique to the deep posterior compartment muscles (Fig. 6.19). Only move a few inches proximally with each stroke during the dorsiflexion. Repeat this process until the entire length of the tibia has been treated. Moving proximally, this treatment also addresses the soleus attachments along the proximal tibia.

Figure 6.19 Active engagement lengthening to deep posterior compartment muscles.

Rehabilitation protocol considerations

- Be careful with the level of pressure applied with any of the techniques on the bottom surface of the foot. The client's pain is a good guide. If the treatment is too painful, reduce pressure.
- In early stages of the treatment when the plantar surface of the foot is very painful, focus treatment on the supportive structures of the plantar fascia (techniques C, D, & E).
- Ice applications are helpful after treatment to reduce post-treatment soreness.
- Stretching affected tissues is a crucial aspect of plantar fasciitis treatment and should be incorporated throughout the treatment process as tolerated by the client.

Cautions and contraindications Pressure that is too painful for the client should not be used. Be careful about applying pressure near the attachment site of the plantar fascia on the anterior calcaneus. If a bone spur is present in this area, additional pressure over the spur is painful and could cause further tissue damage as well.

TARSAL TUNNEL SYNDROME

Description

There is a soft-tissue tunnel on the medial side of the ankle called the tarsal tunnel. It is similar in structure to the carpal tunnel in the wrist. The flexor retinaculum creates the roof of the tunnel and the calcaneus and medial malleolus create the floor (Fig. 6.20). The tunnel contains the tendons of the tibialis posterior, flexor digitorum longus, and flexor hallucis longus muscles. There are tendon sheaths surrounding these tendons as they course through the tunnel to reduce their friction in the area.[23] Also within the tunnel are the posterior tibial nerve, artery, and vein. Tarsal tunnel syndrome is a compression or tension neuropathy of the tibial nerve in the tunnel.

The tibial nerve enters the tarsal tunnel after leaving the calf in the deep posterior compartment of the leg. Shortly after the nerve leaves the tarsal tunnel it divides into the medial and lateral plantar nerves. Sometimes this division occurs within the tarsal tunnel, making the nerve more susceptible to compression and tension neuropathies.[25]

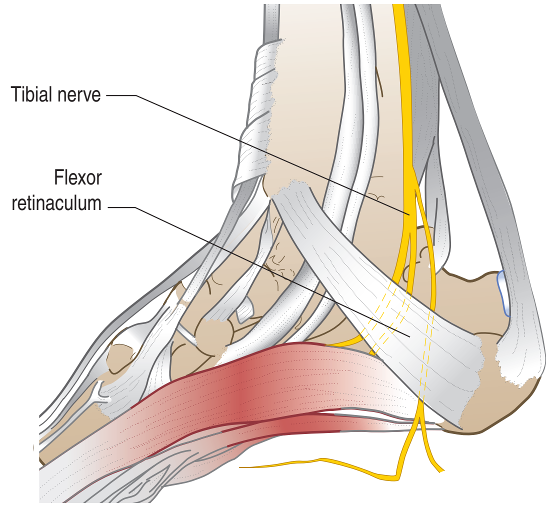

Figure 6.20 Medial view of the ankle showing the tarsal tunnel.

Tarsal tunnel syndrome usually develops as a compression neuropathy of the tibial nerve under the flexor retinaculum. Overuse of the tibialis posterior and flexor tendons cause swelling in the tendon sheaths (tenosynovitis) that in turn compress the tibial nerve. Space-occupying lesions such as small tumors or excess fluid that gathers in the tarsal tunnel can also press on the nerve in this region.[23,35]

Certain biomechanical factors increase the incidence of tarsal tunnel syndrome. Overpronation of the foot can cause tarsal tunnel syndrome due to excessive eversion of the foot. As the foot turns into greater eversion during overpronation, there is increased tension on the posterior tibial nerve. The increased tension injures the nerve and leads to the neuropathy.

Excess supination can also play a part in tarsal tunnel syndrome by compressing the tibial nerve. When the foot is over supinating there is a greater degree of inversion at the sub-talar joint. Increased inversion compresses the contents of the tarsal tunnel. Even a minor degree of nerve compression can become symptomatic as pressure in the area is increased from the foot inversion.

The symptoms of tarsal tunnel syndrome include pain near the medial side of the ankle or along the bottom surface of the foot. The pain is usually sharp or shooting in nature, and can extend all the way into the toes.[48] Pain may be felt proximal to the tarsal tunnel, but is much less common than distal projecting pain. Paresthesia is felt in the foot and in some cases motor function and weakness in the foot muscles supplied by the nerve may be evident.

Treatment

Traditional approaches

One of the primary aims of treatment for tarsal tunnel syndrome is biomechanical correction of the foot mechanics that have led to the problem. Tarsal tunnel syndrome occurs as an overuse activity, so treatment begins with an effort to reduce or eliminate offending activities that are contributing to the problem.

Orthotics are used for this purpose. For example, if the primary problem involves overpronation, an orthotic that is built up on the medial side can prevent the foot rolling into excessive eversion. If the individual is over supinating and has a calcaneal varus angulation, a lateral heel wedge is used to correct the foot mechanics.[48]

Anti-inflammatory medications such as non-steroidal anti-inflammatory drugs (NSAIDs) are used to reduce swelling of the synovial sheaths of the flexor tendons in the tarsal tunnel.[35] Corticosteroid injections into the region of the tarsal tunnel are also used to address inflammation in the area, although there is some controversy about the safety and effectiveness of this procedure.[49]

If conservative treatment is unsuccessful, surgery is an option. The surgical approach divides the flexor retinaculum to allow greater space for the structures underneath in the tunnel. There are detrimental biomechanical effects to cutting the flexor retinaculum, so conservative approaches are preferred.

Soft-tissue manipulation

General guidelines Massage can be beneficial for nerve pathologies such as tarsal tunnel syndrome. Yet, improperly applied massage techniques can cause further damage in the region. Because this condition involves a nerve compression pathology, avoid putting additional compression directly over the tarsal tunnel, except under certain circumstances described below. Massage approaches typically used for this problem are indirect, meaning they are aimed at reducing the factors that lead to tarsal tunnel syndrome, but do not specifically address the damaged nerve. For example, tenosynovitis in the deep flexor muscles of the foot and toes may be compressing the nerve. Massage treatment aims to reduce the tenosynovitis and thereby decrease nerve compression by the irritated tendons.

Adverse tension throughout the sciatic nerve can contribute to irritation of the tibial nerve in the tarsal tunnel. Therefore, it is helpful to encourage full mobility of the entire sciatic nerve. Stretching and neural mobilization procedures that are directed at the entire length of the sciatic nerve from the lumbar region to the toes is beneficial in tarsal tunnel syndrome.[50]

Tension in the tendons traveling through the tunnel can contribute to nerve compression, so these tendons should be stretched. One of the particular challenges to stretching the tibialis posterior is that the foot is limited in how much it can evert because the fibula stops eversion prior to a complete stretch of the tibialis posterior. Therefore, this muscle is susceptible to accumulated tension, because it can never fully lengthen. The tendons that course through the tarsal tunnel are stretched in dorsiflexion and some degree of eversion. However, if eversion or dorsiflexion increase the pain or paresthesia sensations, do not continue stretching as the nerve is most likely being overstretched.

Suggested techniques and methods

A. Deep longitudinal stripping Deep posterior compartment muscles are treated with longitudinal stripping techniques. Reducing tension in these muscles decreases stress on the tendons and lessens the chance that they will irritate the tibial nerve. (See Fig. 6.18 and Treatment D under Plantar fasciitis.)

B. Active engagement lengthening Greater effectiveness of pressure on the deep posterior compartment muscles is achieved with active engagement techniques. (See Fig. 6.19 and Treatment E under Plantar fasciitis.)

C. Gentle deep friction or thumb stroking Direct pressure on a nerve compression is usually contraindicated, but is beneficial in some cases. While massaging a dysfunctional nerve may seem counterintuitive there are some potential physiological benefits. The theory is that direct massage of the impaired nerve region moves fluid away from the tunnel, improves intraneural fluid pressures, and blood flow.[26] This technique may also reduce

Figure 6.21 Direct massage of the tarsal tunnel region (circular friction or thumb gliding).

sensitivity of the nerve as well. Apply gentle pressure and friction to the tarsal tunnel region (Fig. 6.21). Stretching and neural mobility should be encouraged immediately after these friction techniques.

D. Neural stretching Enhancing neural mobility is a crucial aspect of treating any nerve compression syndrome. Use the same neural stretching technique that is described for Morton's neuroma. (See Fig. 6.11 and Treatment C under Morton's neuroma.)

E. Deep stripping Neural mobility is further enhanced with deep stripping to the plantar surface of the foot. (See Fig. 6.14 and Treatment A under Plantar fasciitis.)

Rehabilitation protocol considerations

- The greater the level of nerve damage, the more sensitive the region to treatment and the greater the symptoms that the client reports. Gauge treatment pressure and intensity with the client's symptoms so that the region is not stressed.
- In nerve compression pathologies, aggravating the client's neurological sensations is not advised. If symptoms increase, it means the nerve is being aggravated and that is not conducive to nerve healing.
- Nerve tissue is considerably slower than other tissues in healing time, so allow ample time for symptoms to abate. Encourage the client to closely monitor symptoms to watch for even small signs of improvement.
- Because neural mobility is an important aspect of rehabilitation for this condition, stretching should be an integral part of the treatment from the start.
- In order for treatments to have the ideal opportunity for success correction of dysfunctional biomechanics or other offending activities must be encouraged throughout treatment.

Cautions and contraindications Use caution with massage applications performed directly over the tarsal tunnel (see C above), as they can aggravate the compression. Avoid techniques that significantly elevate symptoms. Likewise, avoid movement activities of the foot that either compress or stretch the aggravated structures, to the point of causing an increase in pain. Tibial nerve irritation can result from a space-occupying mass or lesion in the tarsal tunnel. If palpation of the region reveals a mass or cyst-like tissue in the tunnel, the client should be referred to a physician for a more comprehensive evaluation.

RETROCALCANEAL BURSITIS

Description

Retrocalcaneal bursitis produces pain on the posterior side of the heel. The retrocalcaneal bursa, as its name implies, is located directly behind the calcaneus. There are actually two bursae posterior to the calcaneus, and either one can be implicated (Fig. 6.22). The subcutaneous bursa, which sits just under the skin and superficial to the Achilles tendon, is generally the bursa irritated in this condition. It is usually the one referred to as the retrocalcaneal bursa. However, the subtendinous bursa that sits between the Achilles tendon and the calcaneus is also called the retrocalcaneal bursa.

Retrocalcaneal bursitis results from repeated compression of the bursa by footwear. The heel counter is the portion of the shoe that wraps around the posterior side of the heel and causes bursitis. This condition is a component of Haglund's syndrome. Haglund's syndrome is a swelling in the posterior heel region that can include: retrocalcaneal bursitis, thickening of the Achilles tendon, a convexity of the soft tissues at the Achilles tendon insertion, and a prominent calcaneal projection. The prominent calcaneal projection is an exostosis (bone spur), caused by constant tensile stress from the Achilles tendon insertion or pressure from the shoe's heel counter.

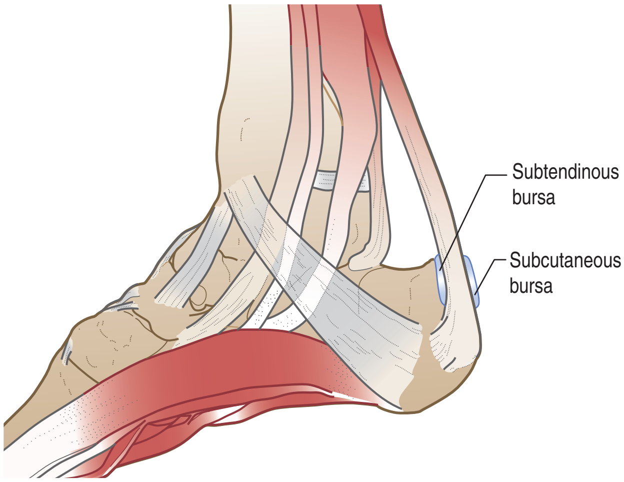

Figure 6.22 Medial view of the ankle showing retrocalcaneal bursae.

The spur is also called Haglund's deformity or a *pump bump*.[51,52] While direct pressure on the bursa is the most common cause of retrocalcaneal bursitis, there can be several other causes. Repeated tensile stress at the insertion site of the Achilles tendon can also cause bursitis.[53]

Treatment

Traditional approaches

As with any bursitis condition, an important aspect of treatment is to remove compression and friction on the bursa. Changing footwear and reducing or eliminating offending activities is the best strategy. Heel lifts that reduce tension on the Achilles tendon have also been suggested.[35]

Because bursitis is an inflammatory condition, various anti-inflammatory medications are frequently used. Corticosteroid injections may be used for the inflamed bursa, but caution is warranted because of potential damage to surrounding structures, especially the Achilles tendon[54,55] If conservative measures are not successful in treating bursitis, surgery can be used. However, it is not common.[52]

Soft-tissue manipulation

General guidelines If retrocalcaneal bursitis is present, avoid direct massage of the area. The additional compressive force of massage aggravates the inflamed bursa. However, reducing tension on the gastrocnemius and soleus muscles through massage and stretching helps, because tensile stress at the Achilles tendon insertion is a primary component of this problem. The most important part of treatment is relieving compression on the affected bursa. Change of footwear is an important means of reducing posterior heel compression.

Suggested techniques and methods

A. Compression broadening and longitudinal stripping techniques Reducing tension on the Achilles tendon can lessen irritation of the insertion site and decrease a Haglund's deformity. Reducing the Haglund's deformity decreases compressive forces on the posterior heel by the shoe. Muscle tension is decreased using compression broadening and stripping techniques for the triceps surae group. (See Figs 6.16 & 6.17 and Treatment C under Plantar fasciitis.)

B. Stretching Muscle tightness is also reduced in this area through proper and frequent stretching for the gastrocnemius and soleus muscles.

Rehabilitation protocol considerations

- Reducing compressive forces on the bursa is important. The treatment strategies described provide indirect benefits by decreasing irritation at the insertion site.
- In rare cases retrocalcaneal bursitis can result from a systemic infection and not from mechanical compression. In those cases soft-tissue interventions and relief of compression on the bursa may not be enough to address the condition. If the inflamed

bursa is resistant to treatment or the bursitis appears for no apparent reason, consider a systemic disorder and refer to a physician for evaluation.

Cautions and contraindications Do not put pressure directly on the bursa with massage or soft-tissue manipulation as it may aggravate the inflammatory condition. Some thickening of the Achilles tendon can occur from chronic overuse, but is not necessarily evidence of an inflammatory disorder (see the discussion of Achilles tendon disorder below). In those cases it is still appropriate to treat the Achilles tendon and triceps surae muscles to reduce tension, which could aid the bursitis treatment.

ACHILLES TENDINOSIS

Description

The Achilles tendon is the strongest tendon in the body. It has to be strong because of the extreme tensile forces from the gastrocnemius and soleus muscles during locomotion. With each plantar flexion of the foot, these muscles have to propel the weight of the body forward, so very strong contraction forces are required. They also produce very high loads during eccentric muscle activity such as stepping down or landing from a jump.

Tendons exposed to high tensile loads are continually repairing themselves to maintain optimal strength. Achilles tendinosis develops as the tendon is unable to repair the tendon and keep up with the demands placed on it. Adequate blood supply is needed in tendons to enhance tissue repair and bring proper nutritional supply to the tendon fibers. The blood supply to the tendon is poor throughout, but appears worst in the distal portion of the Achilles tendon. As a result, this is the region of the tendon that is most susceptible to overuse injury.[56–58]

Several factors in the client's history may indicate the presence of Achilles tendinosis. Sudden changes in activity level, inadequate stretching, training errors, rigid training surfaces, mechanical alignment problems, or certain systemic diseases play a role in its onset.[59] It was mentioned in Chapter 2 that often tendon overuse problems are not inflammatory in nature (tendinitis), but involve collagen degeneration (tendinosis) as the primary pathology. The Achilles tendon is one of the few that produces visible changes in its size when subjected to overuse. There can be fibrous thickening in the tendon, but it is not necessarily inflamed.

To reduce friction forces, the tendon is surrounded by a connective tissue layer called the paratenon.[31] Some tendons, especially those in the distal extremities that travel underneath a retinaculum, are surrounded by an additional synovial sheath that lies between the tendon fibers and the paratenon. An inflammatory condition that affects the synovial sheath is called tenosynovitis. However, the Achilles tendon does not have this synovial sheath, and inflammatory reactions in the Achilles paratenon are often mistakenly called tenosynovitis.[60]

Dysfunctional biomechanical patterns often play a role in the development of Achilles tendinosis. During normal foot pronation there is a whip-like force on the tendon from the point of foot contact through the push-off phase. If an individual overpronates, this whipping action is much more pronounced, and can lead to collagen degeneration in the tendon.[35,61]

Certain medications play a role in the onset of Achilles tendinosis. A group of antibiotics called fluoroquinolones can lead to tendon disorders. The fluoroquinolones appear to cause the greatest damage to tendons under high tensile load, such as the Achilles tendon. Use of these antibiotics can predispose an individual to either tendinosis or complete tendon ruptures.[62–64] Previous corticosteroid injections in the Achilles tendon are also related to tendon weakening and should be investigated in the client history.[65,66]

Treatment

Traditional approaches

A key factor in Achilles tendinosis treatment is to reduce the load on the tendon. A heel lift placed in the shoe is an effective means of reducing tendon load. Orthotics are used to correct biomechanical dysfunction, such as the whipping action of the tendon. Activity modifications that reduce tendon load are also important to include in treatment.

Anti-inflammatory medication is often used to treat Achilles tendinosis. However, there can be limits to the effectiveness of this approach, because the condition does not appear to be an inflammatory problem in most cases.[67] Despite their widespread use, anti-inflammatory medications do not appear very effective in addressing the primary problems in tendinosis conditions.[68]

Non-steroidal anti-inflammatory drugs (NSAIDS) are the most common type of anti-inflammatory treatment for tendinosis. Corticosteroid injections were formerly a common treatment for tendinosis with the idea that it was an inflammatory problem. This treatment is now strongly discouraged, due to evidence that steroid injections can cause tendon ruptures.

Soft-tissue manipulation

General guidelines A critical factor in treating Achilles tendinosis is to reduce tension on the tendon fibers. A variety of massage techniques applied to the triceps surae assist in this process. Deep transverse friction (DTF) is applied to the Achilles tendon to enhance fibroblast proliferation and promote faster healing of the tendon tissue.[69,70]

Short periods of friction massage application are followed with passive and active movement and other circulatory enhancing massage techniques. Refer to the discussion of deep friction massage in Chapter 4 for standard guidelines regarding friction massage applications and combining this approach with other techniques.

The process of collagen reformation in a damaged tendon is not fast. This is especially true in a tendon like the Achilles that is continually exposed to tensile forces while it is in the healing process. A recovery period of several months is not unreasonable to get a full return to function.[71]

Suggested techniques and methods

A. Sweeping cross fiber This technique reduces overall tension in the triceps surae group which lessens the pulling force on the Achilles tendon. It can be performed in conjunction with effleurage when first beginning treatment of this region. Use a broad sweeping motion with the thumb and hand that moves diagonally across the fibers of the triceps surae group (Fig. 6.23). This is a moderately superficial technique so it is best to perform it at the outset of the treatment to encourage tissue warming and begin enhancing pliability.

Figure 6.23 Sweeping cross fiber to triceps surae.

B. Compression broadening Additional muscle mobilization and relaxation of the triceps surae is achieved with compression broadening techniques (see Fig. 6.16). This technique uses more pressure than the sweeping cross fiber technique so it begins to address some of the deeper fibers of the muscle group.

C. Deep stripping Muscle relaxation and tissue pliability are enhanced with the deep stripping technique. Perform deep stripping techniques with a broad contact surface first for more general applications and then follow that up with a small contact surface for more specific applications (see Fig. 6.17).

D. Active engagement (shortening movements) After superficial applications, tension in deeper muscle fibers is addressed with active engagement methods. The client is in a prone position. Instruct the client to begin a slow but steady movement of the foot in full dorsiflexion and plantar flexion. During the plantar flexion (the concentric or shortening phase for the triceps surae muscles), perform a compression broadening technique to the triceps surae muscles. Remove pressure as the client lengthens the muscle during dorsiflexion and repeat the compression broadening technique on each plantar flexion until the entire muscle group is treated (Fig. 6.24).

E. Active engagement (lengthening movements) Deep fibers of the triceps surae are most effectively addressed for elongation and enhanced pliability with active engagement lengthening movements. The client is in the same position as in D (see above) and the technique begins with

Figure 6.24 Active engagement shortening to triceps surae.

the same repetitive slow flexion and extension movement. Perform a deep stripping technique as the triceps surae is lengthening during dorsiflexion (Fig. 6.25). This technique can be somewhat painful or intense for the client so pressure level should be gentle until the client's pressure tolerance has been determined.

F. Deep friction Friction techniques encourage fibroblast proliferation and tendon healing. Apply friction techniques longitudinally or in a transverse direction with the thumb or fingers (Fig. 6.26). Friction techniques are best performed while the tendon is on stretch.

G. Stretching Tissue elongation is an essential aspect of effective treatment. Stretch the gastrocnemius by moving the foot in dorsiflexion while the knee is extended. To stretch the soleus, simply dorsiflex the foot. The soleus does not cross the knee joint so the position of the knee is not as important for soleus stretching.

Figure 6.25 Active engagement lengthening to triceps surae.

Figure 6.26 Deep transverse friction to Achilles tendon.

Rehabilitation protocol considerations

- Collagen degeneration that causes tendinosis can develop over a long period and takes a long time to heal. Do not expect rapid treatment results (although that can occur in some cases).
- Orthotics or shoe inserts that decrease tension on the Achilles tendon are likely to speed the soft-tissue healing process.
- Fibrous thickening of the tendon can linger long after the primary symptoms of pain have abated.

Box 6.2 Clinical Tip

Due to the shape and location of the Achilles tendon, performing deep transverse friction on this tendon can be awkward sometimes. There are a few ways to address this positional challenge. Instead of trying to apply friction with the tip of the finger or thumb as is often done, use the interphalangeal joint of the thumb as the contact point and perform the transverse friction with the thumb's joint. This prevents rapidly flicking on and off the tendon as the transverse friction is applied. Research has indicated that tendinosis is effectively treated with longitudinal friction. Applying longitudinal friction to the Achilles tendon is much easier and prevents rapidly slipping off the edge of it during transverse movements.

Cautions and contraindications Achilles tendinosis can sometimes be a symptom of other systemic disorders such as Reiter's syndrome. Perform a comprehensive assessment to investigate if the client's symptoms are predominantly mechanical or if there are symptoms that indicate some type of systemic disorder. Use caution in applying friction to the site of primary discomfort. This is likely to be the site of greatest collagen breakdown in the tissue. Excessive pressure and friction in the area can cause the client pain during treatment. There can be a fine line in determining how much discomfort is an acceptable amount. It is often a matter of trial and error and will vary from individual to individual.

ANTERIOR COMPARTMENT SYNDROME

Description

The lower leg is composed of four separate compartments: the anterior, lateral, superficial posterior and deep posterior. Each compartment is separated from the others by strong fascial walls. The tibia and fibula also contribute part of the unyielding borders for these fascial compartments (Fig. 6.27). A compartment syndrome can occur in any of the limbs, but usually it develops in the lower leg, and especially in the anterior compartment.

Anterior compartment syndrome results from swelling of the muscles within the compartment.

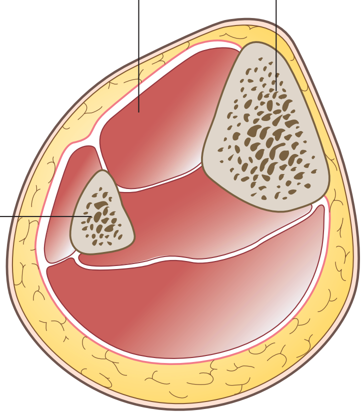

Figure 6.27 Cross section of the leg showing the fascial compartments.

Because the compartment walls are strong and unyielding, there is no extra room for the expanding muscles. As a result there is a pressure increase inside the compartment and the muscles press on other structures inside the compartment. During anterior compartment syndrome, there may be as much as a 20% increase in muscle mass.[72]

The anterior compartment of the lower leg contains three muscles: tibialis anterior, extensor digitorum longus, and extensor hallucis longus. It also contains the tibial artery and vein, as well as the deep peroneal nerve. Increased pressure inside the compartment can impair these structures. Pressure on the vascular structures can cause ischemia, possible color changes in the limb, and sensations of coldness in the extremity or the feet. Lack of circulation is a serious concern in compartment syndromes. Prolonged ischemia from compression of the vascular structures can lead to tissue necrosis. In severe cases, the necrosis can be damaging enough to warrant amputation of the limb.

Compression injury to the nerves that run through the compartment is also a primary concern. Symptoms of numbness, tingling, or loss of dorsiflexor function result from nerve compression. Sharp or shooting pain sensations on the dorsal surface of the foot may also be reported. Compression of the deep peroneal nerve in the anterior compartment can also occur from pressure on the nerve against the head of the fibula.[73]

The pain sensations of anterior compartment syndrome are often mistaken for shin splints. However, there are some distinct differences between the conditions. For example, shin splints rarely cause neurological sensations, as the deep peroneal nerve is not affected in shin splints. Treatment for these two problems is quite different, and an untreated compartment syndrome can be a serious condition. The primary indicator of a compartment syndrome is pain that is out of proportion to what is likely for shin splints.[74]

Anterior compartment syndrome occurs as either an acute or chronic condition. If it is an acute condition, it usually results from a direct blow to the anterior shin. However, it can occur along with a fracture or other acute trauma, such as a muscle strain. Several authors have reported acute compartment syndromes occurring directly after severe muscle strains to the muscles in the lower leg.[75,76]

As a result of the acute trauma, the muscles swell, become ischemic, and increase pressure levels within the compartment. It is not mandatory that an individual have a direct blow to cause the acute compartment syndrome. An excessive bout of activity can also cause the acute compartment syndrome.[77]

The chronic compartment syndrome is much more common. This condition is also called exertional compartment syndrome (ECS), because the primary cause is repetitive exertion and overuse of the lower leg muscles. It results from exercise on an unyielding surface, improper footwear, or activity that is out of proportion to what the individual has conditioned for.

A chronic compartment syndrome can develop into an acute compartment syndrome if the individual engages in a greater than normal level of activity or sustains a direct blow to the muscles in the compartment. A chronic compartment syndrome can also develop from an acute injury. One author reported a case of chronic compartment syndrome developing after an individual had sustained a direct blow to the lower leg.[78] The direct blow did not initiate an acute compartment syndrome, but some time later the individual developed symptoms of chronic ECS that had never been felt before.

The pain from a compartment syndrome increases as activity progresses. Because the compartmental pressure is increasing during activity, the pain continues to get worse. Even after stopping the activity, pain from an ECS can continue to increase for a short time.

Treatment

Traditional approaches

In a chronic ECS it is important to reduce the factors that lead to overuse injury. This may include the use of orthotics, changes in footwear, and modifying activity levels. Usually when activity is halted, the chronic ECS will subside. However, individuals often cannot cease their activity altogether. If this is the case, these other biomechanical modifications are increasingly important. NSAIDS are also sometimes used, but their effectiveness in dealing with this problem is minimal.[79]

The principle of RICE (Rest, Ice, Compression, and Elevation) is used as a standard approach for the treatment of acute injuries. However, compartment syndrome is one of those that are exceptions to the rule. Ice and elevation will both have a detrimental effect on the reduced circulation that is already present in the compartment. Compression is certainly contraindicated, as the pressure levels in this area are already too high.

Surgical treatment of anterior compartment syndrome may be necessary, especially for acute cases. If there is an acute compartment swelling and it is not treated soon enough, tissue necrosis can occur. If left unchecked, this can eventually lead to limb amputation. Surgical treatment may also be used for chronic compartment syndromes that do not respond to conservative treatment. The surgical procedure for treating a compartment syndrome will attempt to reduce compression in the compartment by cutting a longitudinal incision along the fascial wall and allowing the muscles to bulge and protrude out of the compartment.[80,81] This procedure is called a fasciotomy. Once the incision is made it is not immediately closed. It can be left open for about 48–72 hours to let the swollen tissues subside.[75]

Soft-tissue manipulation

General guidelines Massage treatment is not a good option for an acute compartment syndrome. This injury causes an immediate increase in compartmental pressure, and waiting any length of time to reduce that pressure can be dangerous. An individual with symptoms of an acute compartment syndrome should be immediately referred to a physician for appropriate evaluation and the possibility of surgery.

Chronic ECS can be effectively treated with massage. However, do not perform treatment at the time symptoms are aggravated. The practitioner should wait until symptoms have subsided before beginning soft-tissue manipulation. Because various biomechanical factors including muscle hypertonicity can contribute to a chronic compartment syndrome, reduction of excess muscle tension is a primary goal of massage treatment. Various forms of massage have a positive effect on chronic anterior compartment syndrome.[82]

Stretching methods reduce hypertonicity in the anterior compartment muscles. Plantar flexion stretches that elongate the dorsiflexors are the most helpful. Use the client's comfort level as a guide because stretching of the anterior compartment muscles is often painful when the condition is aggravated.

Lower extremity biomechanical dysfunctions can contribute to overuse of the muscles in the anterior compartment. Stretching and massage treatment for these other muscles is highly advised. Stretches should address all the muscles of the lower leg that act on the foot, as well as other lower extremity muscles such as the hamstrings and quadriceps.

Suggested techniques and methods These treatment techniques assume a chronic and not acute compartment syndrome.

A. Sweeping cross fiber Superficial muscle relaxation and tissue pliability is enhanced with this technique. The thumb applies a sweeping stroke to the anterior compartment muscles that travels diagonally across the fiber direction of the anterior compartment muscles (Fig. 6.28). Longitudinal gliding (effleurage) and broad sweeping cross fiber strokes reduce muscular tension and encourage tissue fluid movement, reducing compartmental pressure.

B. Deep longitudinal stripping Tension reduction in the anterior compartment muscles is further enhanced with deep stripping techniques. Stripping can begin with a broad contact surface, such as the heel of the hand or back side of the fist. Following broad contact surface applications, more specific stripping is performed with the finger tips or thumb (Fig. 6.29). Stripping techniques are performed from distal to proximal to follow the direction of venous return.

Figure 6.29 Deep stripping to the anterior compartment muscles.

C. Deep broadening Spreading fibers of the anterior compartment muscles helps decrease tension and can reduce overuse that leads to an increase in compartmental pressure. Begin with the thumbs against the lateral tibial border. Apply a moderate amount of pressure through the thumbs and then slowly move laterally until the anterior and lateral leg region has been covered (Fig. 6.30). Start in one location and then gradually treat the entire length of the lower leg with successive strokes.

D. Active engagement shortening movements Deeper tissues can be reached for tension reduction with active engagement techniques after the deep broadening methods. Instruct the client to repeatedly dorsiflex and plantar flex the foot and a slow, steady pace. Use the same deep broadening stroke with the thumbs as in C during the dorsiflexion (Fig. 6.31). Pressure is removed as the client plantar

Figure 6.28 Sweeping cross fiber to anterior compartment muscles.

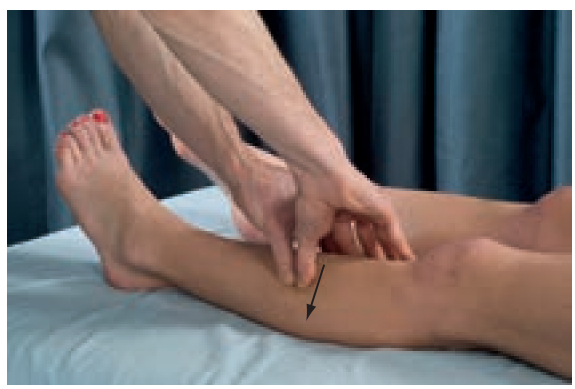

Figure 6.30 Deep broadening to anterior/lateral compartment muscles.

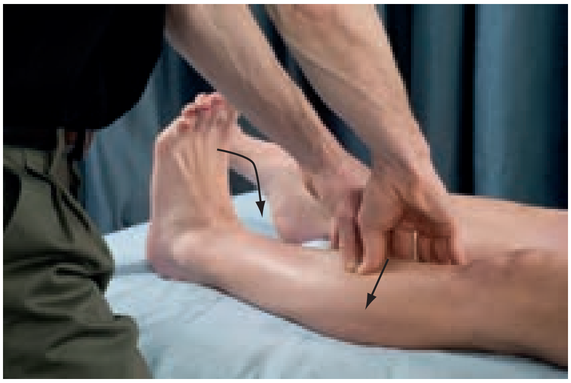

Figure 6.31 Active engagement shortening to anterior compartment muscles.

Figure 6.32 Active engagement lengthening to anterior compartment with additional resistance. Practitioner is gradually moving client's foot into plantar flexion as client pulls foot against practitioner's hand.

flexes the foot and resumes with the next dorsiflexion. Continue this process until the entire anterior compartment region has been treated.

E. Active engagement lengthening movements This technique can follow the shortening movements and is effective for enhancing flexibility and tension reduction in the anterior leg muscles. The same position is used as in D (see above). The client begins the repetitive slow dorsiflexion and plantar flexion movement. Perform a deep stripping technique on the anterior leg muscles as the client is plantar flexing the foot. Pressure is relieved as the foot is dorsiflexed and resumes again on the next plantar flexion. Due to the foot's position in relation to gravity there are relatively few anterior, leg-muscle fibers recruited to plantar flex the foot during the stripping technique. This technique is more effective if additional resistance is added during the plantar flexion to recruit more fibers (Fig. 6.32).

Rehabilitation protocol considerations

- Appropriate pressure level and choice of technique are dependent on the severity of the condition.
- Perform a comprehensive assessment to determine the severity of the compartment syndrome symptoms.
- Active engagement methods are best performed if the condition is not severe to begin with or in the later stages of the rehabilitation process when the client has improved significantly.
- Use caution when performing the active engagement methods. Active dorsiflexion can increase pressure levels in the anterior compartment and this can provoke greater discomfort.[83] If there is too much discomfort to perform the active engagement strokes, passive engagement methods can be used or simply stick with techniques A, B, and C.

Cautions and contraindications Recognition of the compartment syndrome's severity is very important in its treatment. If this condition is acute, massage should not be performed and the individual should be immediately referred to a physician for possible surgical intervention. If at any time during the treatment symptoms are increased, there is cause for concern that the treatment may be aggravating the problem. If this occurs, the current course of treatment should be stopped until the practitioner can re-evaluate the situation. If an acute compartment syndrome has occurred, the generally accepted rehabilitation principle of RICE does not apply to this condition.

SHIN SPLINTS

Description

The term shin splints is not clinically specific as it can encompass a number of different pathologies, including periostitis, muscle strain, stress fracture, and compartment syndromes.[84] However, there is a recent effort to be more consistent with terminology for these overuse leg conditions. In most cases the term applies to periostitis and muscle irritation resulting from overuse. Shin splints occur in two different regions. Both result from repetitive overuse of the lower extremity, making them common injuries in activities such as running or dancing.

The first type of shin splint is called anterior or lateral shin splints. Pain from this type of shin splints is felt in the anterior region of the lower leg, generally at the proximal one-third of the anterolateral region of the tibia. These shin splints are associated with overuse of the tibialis anterior and other anterior compartment muscles. The client feels pain throughout the anterior shin muscles and there is usually a history of lower extremity overuse affecting the dorsiflexor muscles. Eccentric overload is usually responsible for the onset of symptoms. Walking or running down a steep hill is a good example of eccentric overload of the dorsiflexors.

Anterior shin splints result from excessive tensile stress on the tibialis anterior attachment site along the tibial border. Constant tensile stress at the attachment of the tendon into the periosteum of the bone causes periosteal irritation, and therefore this problem is called periostitis. Although there are descriptions of shin splints as the muscle pulling away from the bone, they are erroneous. There is no evidence of tendon avulsion being a component of this condition.

The second type of shin splint produces pain in the medial and distal tibial region. Due to its location it is called posterior or medial shin splints. This condition is also called medial tibial stress syndrome (MTSS). As with the anterior shin splints, this problem also involves periostitis, although in this case it is from the tibialis posterior and soleus attachments.

The tibialis posterior is the primary muscle involved in MTSS. It works eccentrically during normal gait mechanics to prevent overpronation. Foot overpronation places excessive loads on the tibialis posterior, and tensile stress is concentrated at its origin site on the tibia. One study found the emphasis on a forefoot running stride to be the primary factor in a case of MTSS.[85] Landing on the forefoot puts excessive tensile stress on the tibialis posterior muscle. When the running stride was corrected the shin splint pain was relieved.

The soleus muscle is also a causative factor in MTSS.[86] The majority of symptoms in MTSS are felt in the distal one-third of the tibia, and a number of anatomy references suggest that the tibialis posterior does not attach that low on the tibia.[87] However, another study found that ten different specimens all had a portion of the tibialis posterior in the lower third of the tibia.[88] Based on these conflicting reports, both muscles can be involved in this condition.

Medial tibial stress syndrome can be a precursor to stress fractures in the tibia. Excessive use of the tibialis posterior or soleus muscles can cause a bowing of the tibia that leads to uneven stresses on the bone.[10] Therefore, stress fractures should always be considered as a possible cause of pain for individuals suspected of having shin splints.

Treatment

Traditional approaches

Treatment for both types of shin splints is similar. Rest from offending activities is paramount to reducing tensile stress on the attachment sites. If the offending activities can be reduced or avoided, this is often enough to alleviate the problem. Orthotics are sometimes used to correct biomechanical distortions in the client's gait pattern. Ice applications are recommended to reduce pain and resulting inflammation after activity. Anti-inflammatory medications are also recommended in some cases to reduce the inflammatory reaction of the periostitis.

Soft-tissue manipulation

General guidelines Both types of shin splints involve muscular overuse so massage is highly effective in this condition's management. For anterior shin splints, attention should focus on reducing chronic tightness in the muscles of the anterior compartment of the lower leg. The treatment techniques used to address anterior shin splints are the same as those described in the section above on anterior compartment syndrome. Pressure applied during these treatments should be within the client's tolerance levels. Treatment approaches for MTSS are slightly different and described below.

Stretching is an important component of treatment for either type of shin splints. For anterior shin splints, stretching emphasizes pulling the foot into plantar flexion as far as possible. Adding flexion of the toes also stretches the extensor digitorum and extensor hallucis longus muscles.

Stretching for MTSS is a challenge because the tibialis posterior is unable to fully stretch. It is primarily an inverter of the foot, so moving the foot into eversion is an effective stretching position. However, eversion is limited by the lateral malleolus of the fibula, and the strong deltoid ligament on the medial side of the foot. The stripping techniques and active engagement methods described below will encourage greater elongation in the tibialis posterior. Pulling the foot as far as possible into dorsiflexion stretches the soleus. If the knee is flexed, there is a greater emphasis on stretching the soleus than the gastrocnemius, with which it shares a common tendon.

Suggested techniques and methods Treatment techniques for anterior/lateral shin splints are the same as those described for anterior compartment syndrome in the previous section. All of these treatment techniques pertain to MTSS.

A. Deep stripping Tension is reduced in deep posterior compartment muscles with specific stripping techniques. With the client in a side-lying position, use the thumb or fingertips to strip in a proximal direction along the medial border of the tibia (Fig. 6.18 under the description for Plantar fasciitis treatment).

B. Active engagement lengthening movements More effective access to these deep posterior compartment muscles is possible with active engagement techniques. Use the same initial position for the client as in A. Have the client move their foot in full dorsiflexion and plantar flexion in a slow repeated motion. During the dorsiflexion, perform a short specific stripping technique to the deep posterior compartment muscles (Fig. 6.19 under the description for Plantar fasciitis treatment). Only move a few inches proximally with each stroke during the dorsiflexion. Repeat this process until the entire length of the tibia has been treated. Moving proximally, this treatment also addresses the soleus attachments along the proximal tibia.

C. Active engagement with resistance Deep muscles in the posterior compartment are addressed more effectively when engaged with additional resistance. This technique is effective for treating the deep posterior compartment muscles in the later stages of rehabilitation. The client is in a side-lying position just as in A and B (see above). Instruct the client to hold the foot in a plantar flexed position while resistance is offered (creating an initial isometric contraction). Instruct the client to slowly let go of the contraction as the client's foot is slowly pushed into dorsiflexion. While pushing the client's foot into dorsiflexion, perform a deep longitudinal stripping technique along the tibial border just as in B (see above) (Fig. 6.33). This technique can be painful for the client so the stripping techniques should be applied gently.

Figure 6.33 Active engagement lengthening to deep posterior compartment with additional resistance. Practitioner is gradually moving client's foot into dorsiflexion as client pushes against practitioner's hand.

Rehabilitation protocol considerations For both anterior and posterior shin splints:

- Shin splint pain is most pronounced around 12–36 hours after activity that initiated the problem. Massage can increase soreness if performed during the peak period so alter treatment intensity based on the severity of symptoms.
- Strengthening and conditioning of the region greatly reduces the likelihood of developing shin splints. Once the condition has developed, leave strengthening or conditioning activities until after the condition's symptoms have substantially reduced.
- Active engagement techniques and engagement with resistance can feel painful, especially for

MTSS. Use these techniques in the later stages of rehabilitation when the condition has already made considerable improvement.

Cautions and contraindications Both types of shin splints described here are effectively treated with massage. Yet there are situations where a more serious underlying condition, such as a stress fracture, can be present. Massage could decrease some of the symptoms, but offers little benefit for healing the stress fracture itself. Always consider the possibility of a more serious condition, such as a compartment syndrome or stress fracture, causing the symptoms attributed to shin splints. Proper assessment of the client's initial condition and ongoing status helps manage the condition appropriately.

Box 6.3 Clinical Tip

There are a variety of different positions that can be use to treat the deep posterior compartment muscles, such as the tibialis posterior. The side lying position described with the active engagement techniques is effective because it allows for easy access to the muscle as well as easy movement of the foot. Another very effective position to treat the tibialis posterior is with the client supine, hip flexed, and knee flexed with the foot flat on the treatment table (this is sometimes called the hook-lying position). In this position, gravity assists the technique by pulling the superficial posterior calf muscles, gastrocnemius and soleus, away from the tibial border. With the muscles being pulled away from the tibia by gravity, there is easier access for the treatment hand to get to the deep posterior compartment muscles.

POSTURAL DISORDERS

The next section includes a number of structural and postural disorders of the foot and ankle. These disorders are not considered injury conditions, as are the prior conditions in this chapter. However, they can produce considerable stress on other tissues or structures and contribute to their dysfunction. For some of these conditions there are massage treatment approaches that are helpful. In other cases massage is beneficial in addressing some of the symptoms resulting from the condition, but may not change the condition much itself.

HALLUX VALGUS

Description

A valgus angulation is one in which the distal end of a bony segment deviates in a lateral direction. In this condition the distal end of the hallux is forced in a lateral direction (Fig. 6.34). There are several factors that can cause a hallux valgus deformity including biomechanical, structural, or genetic disorders, lax ligaments, weak muscles, improper footwear, or abnormal bone structure.[89] Wearing shoes with a narrow toe region is considered the primary cause of this disorder.[90]

When the foot is in a shoe with a narrow toe region, the distal end of the hallux is forced toward the midline of the foot (a lateral direction in relation to the midline of the body). As the distal end of the hallux is pushed laterally (toward the foot's midline), the proximal end pushes the first metatarsal head medially against the edge of the shoe, resulting in callus formation and subcutaneous inflammation.[91] This callus formation is also called a bunion. Some sources call the hallux valgus deviation a bunion, so terminology is not always consistent in this condition.[92]

A hallux valgus deformity can contribute to numerous lower extremity biomechanical problems. The hallux has a primary role in maintaining foot

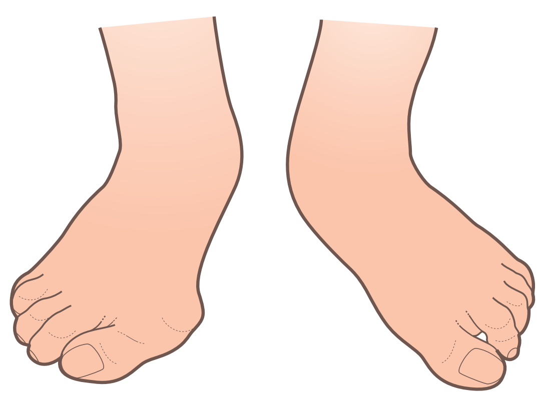

Figure 6.34 The hallux valgus deformity.

stability and absorbing forces during normal gait. When the distal hallux deviates laterally it is no longer able to carry out that crucial mechanical function. The loss of optimum foot mechanics from the hallux valgus deviation can lead to shin splints, myofascial trigger points, stress fractures, or overpronation. Some of these disorders can also create or increase a valgus deviation in the hallux. Overpronation, for example, puts a heavy biomechanical load on the distal hallux and metatarsophalangeal joint. If pronation is excessive it can gradually force the distal hallux into its deviated position.

There is a noticeable gender difference in hallux valgus occurrence. It is far more common in women than in men. However, it is unclear if this difference is caused by structural or physiological differences or if it is caused by the different type of shoes worn by men and women.[90]

There is a strong genetic pattern of hallux valgus occurrence. What is not clear is if the condition is more common within a family because of structural factors, sociological and cultural norms of particular shoes, or if there is just a genetic propensity for the condition that is exacerbated by outside factors. The condition does occur more commonly within families in the absence of particular shoes, indicating more important structural genetic factors.

Treatment

Traditional approaches

It is difficult to reverse a hallux valgus disorder because gradual pressure on the forefoot over time is responsible for the change in hallux angulation. In order to reverse the process it would be necessary to pull the distal hallux in the opposite direction (toward the medial side of the foot) for prolonged periods all day. In some cases there is inflammatory activity associated with the joint disorder. In those cases non-steroidal anti-inflammatory drugs (NSAIDS) or corticosteroid injections can be used to reduce inflammatory activity.[93] Orthotics or pads inside the shoe are used to reduce pressure from the bunion at the metatarsal head on the side of the shoe.

If the condition is severe and other conservative methods are not adequate to address the disorder, surgery is an option. Surgery involves a release of soft-tissue restrictions around the joint as well as a procedure called an osteotomy, which involves cutting a portion of the bone to aid in realignment.[94] Changing footwear is also an important part of treatment. It is not going to reverse the valgus drift of the hallux, but can sometimes prevent the condition from becoming worse.

Soft-tissue manipulation

General guidelines Massage can sometimes reduce foot pain and the discomfort that results from a hallux valgus deformity. The disorder cannot be reversed without more intensive interventions. Massage applications to the metatarsophalangeal joint can reduce fibrosity in that joint and make the joint more pliable. The hallux can then be stretched back toward its normal direction more easily. These techniques are helpful for encouraging motion in the intended direction of correction. However, lasting change is unlikely unless there is a constant force that pulls the hallux back into its normal alignment position for long periods every day.

Suggested techniques and methods

A. Deep friction Mobility of joint tissue is enhanced with friction techniques to the metatarsophalangeal joint. Apply the deep friction treatments in multiple directions to the joint tissue to enhance mobility (Fig. 6.35). Friction treatments can have longer duration than those that are used to treat scar tissue from torn muscles or tendons. Fibrous adhesion around the joint develops over time so longer and more aggressive bouts of friction are beneficial for joint mobilization.

B. Stretching of the hallux The position of the hallux can be altered somewhat by stretching the

Figure 6.35 Deep friction to metatarsophalangeal (MTP) joint to address hallux valgus.

tissues that span the joint. After soft-tissue mobilization techniques such as the deep friction techniques mentioned in A (see above), pull the hallux back toward a position of proper alignment. Fibrous scar tissue is likely contributing to holding the hallux in the deviated position. Long-duration stretches (at least 20 seconds) are most effective in flexibility enhancement for this fibrous tissue.[95,96] This stretching method can enhance flexibility, but correction of this postural disorder is unlikely without something pulling the hallux back in a neutral position for long periods.

Rehabilitation protocol considerations

- Hallux valgus deformities occur over a long period. Therapeutic interventions of short duration (such as a massage treatment) can reduce pain symptoms and encourage greater mobility, but are limited in their effectiveness in reversing the postural disorder.
- A hallux valgus condition that is of recent onset is more likely to benefit from soft-tissue treatment than one developed over a long time.

Cautions and contraindications Depending on the severity of the condition, callus formation (bunion) around the metatarsal head can be painful. Use caution with friction techniques in this area. The client's pain tolerance is an appropriate guide. Massage can be used to improve mobility after surgical procedures, such as the metatarsal osteotomy. Wait an appropriate period after the surgery before attempting massage and consult with the surgeon about any necessary precautions for that client's surgical procedure.

MORTON'S FOOT

Description

The hallux is usually longer than all the other toes. Morton's foot, also called Morton's toe or Grecian foot is a postural condition in which the second toe appears longer than the hallux. It is a common anatomical variation and appears in about 40% of the population.[97] It results from either a short first metatarsal or a long second metatarsal. This postural condition does not necessarily produce problematic symptoms. A large number of people have a Morton's foot and never have symptoms.

The condition becomes an issue for some people when it adversely affects gait and contributes to other lower-extremity conditions. If the second metatarsal is longer than the first, there is a change in weight distribution throughout the forefoot. The second metatarsal head takes a greater percentage of weight bearing due to its increased length. Calluses can then form underneath the second metatarsal head. If the individual is not doing an excessive amount of activity, the result of Morton's foot is usually not a problem. However, for the individual that is performing multiple foot strikes in occupational or recreational activities, the accumulated stress on the metatarsal head can lead to other disorders.

Another problem results if, in addition to a long second metatarsal, there is a short first metatarsal and shortened hallux. A primary biomechanical function of the hallux is to help resist overpronation during normal foot mechanics. If the hallux is shorter due to metatarsal or phalangeal length, it may not be able to adequately resist foot pronation. Other lower-extremity disorders such as shin splints, stress fractures, or plantar fasciitis could result.

Treatment

Traditional approaches

Morton's foot is a congenital bone structure of the foot and typically does not cause a problem. If a problem does result from altered foot mechanics, orthotics are common treatments.

Soft-tissue manipulation

General guidelines Morton's foot is a congenital bone structure so massage treatment will not change this condition. However, massage can be effective in addressing some of the detrimental ramifications resulting from the condition. Myofascial trigger points resulting from biomechanical compensation can occur in the peroneal muscles, knee extensors, as well as gluteus medius and minimus.[97] Static compression techniques, deep longitudinal stripping, and stretching techniques should be applied to trigger points identified in lower extremity muscles. Any of the techniques for muscular tension reduction described earlier in this chapter are helpful for addressing biomechanical strain from the Morton's foot.

Cautions and contraindications Other than general precautions there are no major contraindications for working on a client with Morton's foot.

PES PLANUS

Description

Pes planus is a postural disorder of the foot more commonly known as *flat foot*. It results from a dropped or fallen longitudinal arch (Fig. 6.36). The primary function of the longitudinal arch is to aid in propulsion of the foot and shock absorption during foot strike. A detrimental effect of pes planus is that it decreases the shock-absorbing capability of the longitudinal arch. Pes planus results from weakness or laxity in those soft tissues that support the longitudinal arch including the tibialis posterior and intrinsic foot muscles, plantar fascia, tarsal, deltoid, and calcaneonavicular ligaments.[98]

Of these, the tibialis posterior is considered the primary dynamic structural support for the arch. When other support tissues are weakened, even greater load is placed on the tibialis posterior to maintain the arch. Fatigue and dysfunction of the muscle is a common cause of pes planus and can lead to other problems such as shin splints, stress fractures, and plantar fasciitis.[91]

The condition can appear earlier in life as a congenital deformity, but is often the result of age, increasing weight, and gradual loss of residual strength in the soft tissues that support the arch. Pes planus does not always lead to other disorders of the lower extremity. Many people have pes planus and experience no symptoms.

Figure 6.36 Pes planus (flat foot).

Treatment

Traditional approaches

Pes planus is most commonly treated with orthotics. The orthotic is designed to support the longitudinal arch and take stress off the soft tissues, such as the tibialis posterior. If the pes planus involves a severe case of bone deformity, surgery is sometimes used to correct the disorder.

Soft-tissue manipulation

General guidelines Pes planus results from weakening of structures that support the longitudinal arch. Massage reduces symptoms from the soft-tissue stress. However, massage treatment will not restore the arch to its proper form on its own. Some form of postural re-education is necessary; biomechanical interventions such as orthotics and strengthening and conditioning exercises in the foot are beneficial.

Suggested techniques and methods The techniques listed in the descriptions under plantar fasciitis or medial tibial stress syndrome are helpful for reducing symptoms resulting from pes planus.

Rehabilitation protocol considerations

- Massage treatment for pes planus is primarily for symptom management and not for corrective measures and can be performed at any time throughout the rehabilitation process.
- The primary protocol consideration is for the practitioner to remember that soft-tissue therapy can change biomechanical relationships that are being addressed with other procedures, such as orthotics.

Cautions and contraindications As long as working on the foot and leg region is appropriate there are no major cautions or contraindications for working on a client with pes planus

PES CAVUS

Description

Pes cavus is a postural disorder characterized by a high longitudinal arch in the foot that does not flatten with weight bearing (Fig. 6.37). In pes cavus there is a shortening of soft tissues that support the longitudinal arch, such as the plantar

Figure 6.37 Pes cavus (high arch).

fascia and tibialis posterior muscles. Bone deformities can also cause or result from this foot disorder.[99] Intrinsic foot muscles, as well as the tibialis anterior and posterior, can be hypertonic and maintain the distorted position of the arch. The plantar fascia is in a shortened position causing increased tensile loads at its attachment points, especially at the anterior calcaneus.[91] Due to the altered pull of muscular imbalance lateral foot pain is frequently reported in clients with pes cavus.[100]

There are numerous causes of pes cavus. This postural disorder is often caused by neuromuscular disorders such as muscular dystrophy or Charcot–Marie–Tooth disease.[101,102] The condition can also be congenital. It is normal to see an increased incidence of other foot, ankle, or leg disorders that the pes cavus has contributed to, such as metatarsal stress fractures, plantar fasciitis, or Morton's neuroma. In some cases the condition results from traumatic injury that causes alterations in tarsal bone position.

Numerous biomechanical problems result from the high longitudinal arch. With increased arch height, there is greater weight-bearing pressure on the metatarsal heads. Increased pressure in this region can lead to Morton's neuroma, metatarsal stress fractures, or other biomechanical distortions such as claw-toe deformity.[103]

Treatment

Traditional approaches

If there is a progressive underlying disease or disorder that has produced the pes cavus, treatment options may be limited. In less severe cases orthotics can be helpful in correcting improperly distributed pressure levels on the foot. Physical therapy is used to stretch tight muscles and strengthen weak ones with the overall goal of addressing muscle imbalance to restore a proper arch. If the condition is severe, surgery may be necessary to correct the dysfunctional alignment. Surgical procedures may involve efforts to re-position bones or surgically release the plantar fascia, which has become shortened and fibrous.[103]

Soft-tissue manipulation

General guidelines Pes cavus usually involves a combination of some leg and foot muscles that are tight, and others that have become weakened. Various conditioning activities will be necessary to strengthen the weakened muscles, but massage is a valuable treatment approach for addressing the hypertonic muscles. The exact pattern of muscle tightness and weakness can differ among clients, but these general guidelines can help in a majority of cases.

There is usually greater weakness in the tibialis anterior and peroneus brevis muscles. These are the muscles that benefit from strengthening procedures. Tibialis posterior and peroneus longus tend more towards hypertonicity, so these muscles benefit from massage treatment.

Suggested techniques and methods

A. Longitudinal stripping to plantar surface of the foot Tension in soft tissues that shorten the arch is addressed with deep stripping techniques to the plantar surface of the foot. This technique is described in A under Plantar fasciitis and pictured in Figure 6.14.

B. Deep stripping and active engagement techniques Reduction of muscle tension that leads to pes cavus is also achieved with active engagement techniques that focus on the tibialis posterior. These techniques are described in D and E under Plantar fasciitis and illustrated in Figures 6.18 and 6.19.

C. Deep stripping to peroneal muscles Peroneal muscles can aid in pulling the arch in a higher position. Stripping techniques that emphasize the peroneal muscles reduce tension on the arch. This technique is virtually the same as that described in B under Anterior compartment syndrome and pictured in Figure 6.29. The only difference is emphasis of the stripping technique on the lateral region of the lower leg to address the peroneus longus and not as much on the anterior compartment.

Rehabilitation protocol considerations

- If another health professional is treating the client for biomechanical distortions associated with the pes cavus condition, consider the impact of massage treatment on those other procedures and adjust treatment accordingly.

Cautions and contraindications It is generally safe to use soft-tissue therapy on a pes cavus condition as long as there are no other major contraindications that would be cause for concern. If the client's pes cavus condition is the result of some neuromuscular disorder or systemic disease, consult with the client's health care provider. It is unlikely that massage would have adverse effects on other treatments, but it is better to first clarify that before treatment.

CALCANEAL VALGUS

Description

A valgus angulation is one in which the distal end of a bony segment deviates in a lateral direction. In this condition the distal calcaneus deviates laterally (Fig. 6.38). Excessive eversion of the sub-talar joint produces the valgus angulation. Calcaneal valgus is a contributing factor to overpronation (discussed later in this chapter). However, it is only one component of the dynamic postural distortion of overpronation.

The best position to view calcaneal valgus is looking at the client's foot from behind. The wear pattern on the underside of the shoe can also provide evidence of calcaneal valgus. If there is a more concentrated wear pattern on the medial side of the shoe's sole, there is a good chance that the client has calcaneal valgus, or they may be overpronating.

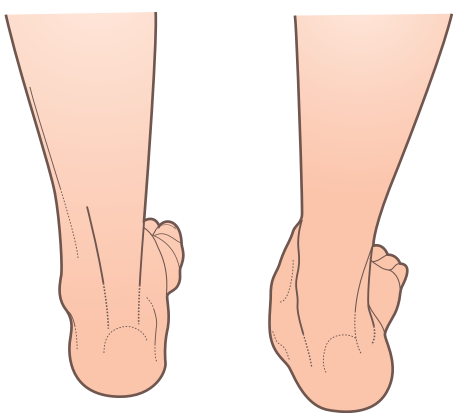

Figure 6.38 Calcaneal valgus.

A calcaneal valgus disorder places a disproportionate amount of body weight on the medial side of the foot. It can also cause additional problems in the foot or lower leg such as plantar fasciitis, stress fractures, tarsal tunnel syndrome, and shin splints. The compensatory pattern with calcaneal valgus is an increase in medial tibial rotation.[104] Knee disorders resulting from the tibial rotation can also be traced to the calcaneal valgus.

Treatment

Traditional approaches

The most common method of addressing calcaneal valgus is with orthotics. These inserts attempt to correct the biomechanical deviation, and are valuable in addressing the other disorders resulting from the valgus angulation. Orthotics are available from a variety of sources. Orthotics bought off the shelf in a pharmacy or medical supply store may be all that is needed to correct the client's postural challenge. In other cases over-the-counter products may not be as effective because they are not designed for that client's unique foot structure. In some cases, an improper orthotic can make the condition worse, so it is advisable to refer the client to a specialist in foot care and orthotics.

Soft-tissue manipulation

General guidelines The calcaneal valgus angulation is usually a complex biomechanical dysfunction with multiple factors. The primary muscular components involve weakness and overstretching in the foot inverters, such as tibialis anterior and posterior. There is also a corresponding shortness in the foot everters, such as the peroneal group, which is not necessarily due to tightness of the peroneal muscles. Calcaneal valgus is due more to alignment issues in the calcaneus that are exacerbated by weight bearing, rather than muscle tightness.

Although calcaneal valgus generally does not develop due to muscle tightness, soft-tissue treatment is still beneficial for hypertonicity that develops in other muscles due to the condition. If orthotics are used, massage can reduce overload on foot and ankle muscles that start to adjust to the new position.

Suggested techniques and methods

A. Deep stripping Stripping is applied to the peroneal muscles to reduce tension and aid muscular balance around the ankle joint. This technique is virtually the same as that described in B under anterior compartment syndrome and pictured in Figure 6.29. The only difference is emphasis of the stripping techniques on the lateral compartment of the leg to address the peroneal muscles.

B. Active engagement techniques After initial treatment to reduce tension in lateral compartment muscles, active engagement can further reduce tightness in the affected tissues. The tibialis anterior and posterior are usually somewhat overstretched in this postural disorder. However, being under high mechanical demand and held at longer than their normal resting length can cause them to develop myofascial trigger points. Techniques for addressing the tibialis posterior are described in D and E under Plantar fasciitis and demonstrated in Figures 6.18 and 6.19. Effective techniques for the tibialis anterior are listed in B and E under Anterior compartment syndrome and illustrated in Figures 6.29 and 6.32 respectively.

C. Stretching techniques After soft-tissue manipulation, stretching of the peroneal muscles is suggested.

Rehabilitation protocol considerations

- Massage treatment can alter biomechanical function in the foot and ankle region. In some cases orthotics have been prescribed and/or specifically designed for that client's foot condition. Massage is not likely to alter the biomechanical changes with the orthotics significantly, but consider it as a possibility if symptoms change significantly after the massage treatment.

Cautions and contraindications Other than general precautions there are no major contraindications for working on a calcaneal valgus foot posture.

CALCANEAL VARUS

Description

Calcaneal varus is a postural disorder in which the distal portion of the calcaneus deviates in a medial direction (Fig. 6.39). It is best viewed from the posterior side of the heel. The wear pattern on the bottom of the shoe often gives clues to calcaneal varus. Calcaneal varus produces excessive wear on the lateral aspect of the sole. Calcaneal varus is also a component of excessive supination and that may be the cause for the wear pattern as well.

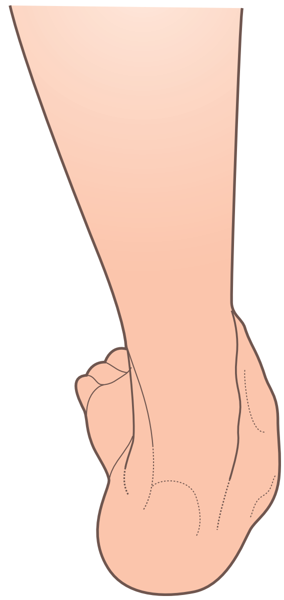

Figure 6.39 Calcaneal varus

Calcaneal varus can produce a number of soft-tissue problems throughout the foot and lower leg because of the altered shock absorbency and force loading on the foot. As with calcaneal valgus, varus angulations in the calcaneus can cause plantar fasciitis, shin splints, stress fractures, tarsal tunnel syndrome, or other lower extremity disorders. The varus angulation of the calcaneus and increased supination of the foot during gait also makes the individual more susceptible to lateral ankle sprains.

Treatment

Traditional approaches

Calcaneal varus is commonly treated with orthotics, just like calcaneal valgus. The same principles and concepts related to orthotic use and selection as described in that section apply for calcaneal varus as well. It is best to refer the client to a specialist in foot care and orthotics.

Soft-tissue manipulation

General guidelines Calcaneal varus is a chronic postural disorder that results from a number of factors. Treatment is most effective when it addresses the condition from multiple approaches. While this postural disorder is not created solely through soft-tissue dysfunction, treating soft-tissue components of the disorder is helpful.

The muscles producing foot inversion, such as tibialis anterior and posterior, are in a shortened position in calcaneal varus. Treatment should focus on encouraging elongation in these muscles. Stretching approaches are a valuable adjunct after massage treatment.

Suggested techniques and methods

A. Deep stripping to peroneal muscles These muscles are under greater stretch and increased length in calcaneal varus. Trigger points and muscular dysfunction can develop in the muscles as a result of being held in chronic stretch. Deep stripping technique is virtually the same as that described in B under Anterior compartment syndrome and pictured in Figure 6.29. The only difference is emphasis of the stripping techniques on the lateral compartment of the leg to address the peroneal muscles.

B. Active engagement techniques Treatment of tibialis anterior and posterior is emphasized for this condition. These muscles are in a shortened position in calcaneal varus, so the aim of treatment is to encourage elongation. Techniques for addressing the tibialis posterior are described in D and E under Plantar fasciitis and demonstrated in Figures 6.18 and 6.19. Effective techniques for the tibialis anterior are listed in B and E under Anterior compartment syndrome and illustrated in Figures 6.29 and 6.32 respectively.

C. Stretching techniques Following massage treatment with stretching of the tibialis anterior and posterior is encouraged.

Rehabilitation protocol considerations

- Soft-tissue work is valuable, but will have limited effectiveness without more forceful postural change, such as orthotics or changes in footwear. Massage treatment can be performed simultaneously with orthotic usage, but note that changes in muscle balance around the foot may require alteration of the orthotic.

Cautions and contraindications Other than general precautions there are no major contraindications for massage treatment on a calcaneal valgus foot posture.

EXCESSIVE SUPINATION

Description

The postural disorders presented so far in this section have all been evaluated primarily in static positions. The next two disorders, excessive supination and overpronation, are distinctly different in that they are dynamic postural disorders. That means they are more accurately evaluated in active movement as opposed to a static position. The concept of *acture* (active posture) presented by Chaitow and Delany is appropriate for these conditions.[105]

Supination is motion around an oblique or diagonal axis and is a combination of inversion, adduction and plantar flexion. When the foot is in a position that includes all three of these combined movements it is fully supinated. A foot with excessive supination bears more weight on the lateral edge (Fig. 6.40). A primary component of

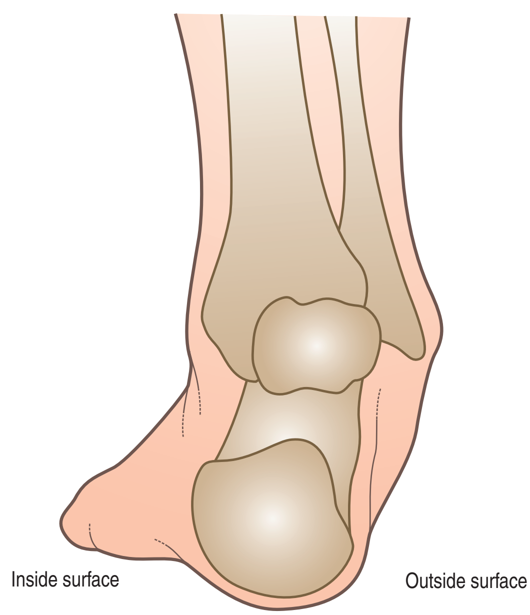

Figure 6.40 Right foot with excessive supination viewed from behind.

excessive supination is subtalar inversion. Therefore, an individual with calcaneal varus is likely to have excessive supination during the weight-bearing phase of gait. Indication of excessive supination is evident with a wear pattern on the outside lateral edge of the shoe.

The ability of the foot to supinate and pronate is particularly important for adapting to variations in ground surface. In the dynamic movement of gait the foot is in a slight degree of supination during the swing-through phase of the normal gait and begins to pronate immediately after contacting the ground.[91] If, however, the foot stays more supinated during the weight-bearing phase of gait, this is considered excessive supination.

Treatment

Traditional approaches

Traditional treatment approaches for excessive supination focus on biomechanical corrections through the use orthotics. Because of the biomechanical similarity between the conditions, the treatment strategies are virtually the same as those described in the section under calcaneal varus.

Soft-tissue manipulation

As with the traditional approaches to treatment, soft-tissue manipulation and rehabilitation protocol considerations are virtually the same as those described under the section on calcaneal varus.

Cautions and contraindications Other than general precautions there are no major contraindications for working on a calcaneal valgus foot posture.

OVERPRONATION

Description

Pronation is a dynamic movement of the foot that includes dorsiflexion, eversion, and abduction. A foot with overpronation bears more weight on the medial edge (Fig. 6.41). There is a natural degree of pronation as the foot moves through the different phases of weight-bearing during normal gait. The term pronation is sometimes inappropriately used to signify dysfunctional foot mechanics.

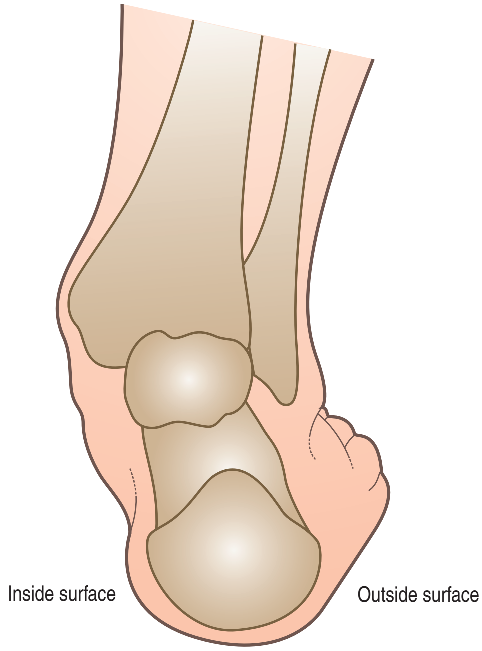

Figure 6.41 Right foot with overpronation viewed from behind.

Pronation is a normal part of movement, but excessive pronation is called *overpronation* or *hyperpronation*. Overpronation occurs when an individual moves either too far or too fast through the phases of pronation, placing more weight on the medial side of the foot during gait.

Unless there is a severe, acute injury, overpronation develops as a gradual biomechanical distortion. Several factors contribute to developing overpronation, including tibialis posterior weakness, ligament weakness, excess weight, pes planus, genu valgum, subtalar eversion, or other biomechanical distortions in the foot or ankle. Overpronation often includes a combination of factors.[91]

Tibialis posterior weakness is one of the primary factors leading to overpronation. Pronation is primarily controlled by the architecture of the foot and eccentric activation of the tibialis posterior.[106] If the tibialis posterior is weak, the muscle cannot adequately slow the natural pronation cycle.

Obesity is another cause of overpronation. The architecture of the foot is not designed to carry disproportionate weight. As a result, the excessive weight causes subtalar eversion and forces the longitudinal arch to collapse. A static calcaneal valgus is evident during examination of the foot, and this valgus angulation causes overpronation during the gait cycle.

Overpronation can be a contributing factor in other lower extremity disorders, such as foot pain, plantar fasciitis, ankle injuries, medial tibial stress syndrome, periostitis, stress fractures, and myofascial trigger points. Overpronation increases the degree of internal tibial rotation, thereby contributing to various knee disorders such as meniscal injury or ligament sprains.

The effects of the postural deviation are exaggerated in athletes due to the increase in foot strikes while running and the greater impact load experienced. When running, three to four times the body weight is experienced with each foot strike.[31] If overpronation exists, the shock force is not adequately absorbed by the foot and is transmitted further up the kinetic chain.

Treatment

Traditional approaches

The primary focus for overpronation treatments is correcting the dynamic position of the foot during the weight-bearing phase of gait. This is usually

Box 6.4 Case Study

Background

Nina is a 33-year–old entrepreneur who owns a baking shop. Owning a baking business means she spends a great deal of time on her feet. Her bakery has a concrete floor which seems to really make her feet hurt after long days. She has been complaining recently of increasing pain in her lower leg and foot, especially after long days at work. Her feet also feel stiff and somewhat painful upon first waking up and walking on them in the morning. She has recently started wearing running shoes at work and mentioned that the change in footwear has helped some, but the problem is still bothering her.

Observation of Nina's posture shows a slight degree of genu valgum and calcaneal valgus bilaterally. Physical examination reveals tenderness to palpation along the distal medial border of the tibia and the plantar surface of the foot. When these regions are palpated, it reproduces the primary pain and discomfort Nina has been experiencing. There are no signs of neurological disorder present. Stretching of the posterior calf muscles and plantar foot muscles by moving the foot in dorsiflexion creates a mild sensation of discomfort. This motion is one of the things she does during work that seems to help a little.

Questions to consider

- Nina's leg and foot discomfort appears to be related to her long hours of work while standing on a concrete floor. Because she is not able to change that significantly right now, what suggestions outside of soft-tissue manipulation might be helpful to reduce some of her symptoms?
- What do you think is the primary cause of her pain and discomfort? Name specific tissues or structures that you think are involved.
- If massage treatment is directed at muscles of the lower leg and foot to reduce overuse stress, how often do you think she should come for this treatment?
- If you think massage treatment is appropriate for her, what techniques do you suggest for her at this stage of her injury condition?
- What role should stretching play in the management of her condition? Consider stretching that you might perform in the treatment room as well as stretching that she could perform on her own.
- If this condition appeared to be primarily an overuse disorder and she did not choose to have any treatment for the problem, what are some of the possible detrimental outcomes?
- Do you think thermal modalities will be of use to her? If so, which ones and when should she use them.

accomplished with orthotics. The treatment strategies for overpronation are virtually the same as those described in the section under calcaneal valgus.

Soft-tissue manipulation

Soft-tissue treatment for overpronation emphasizes numerous muscles and soft tissues of the lower extremity. Massage treatment alone is not sufficient to create the needed biomechanical corrections of overpronation. The primary focus of massage treatment is to support and enhance other approaches such as orthotics and footwear changes. To address this condition follow the treatment suggestions and rehabilitation protocol considerations that are described in the section under calcaneal valgus.

Cautions and contraindications Other than general precautions there are no major contraindications for working on a client with overpronation.

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