PART III Conditions Affecting Locations Throughout the Body

CHAPTER 12

Muscle Strains

UNDERSTANDING MUSCLE STRAINS

Muscle strain, often called a pulled muscle, occurs when muscle fibers are overstretched. Increased tensile stress—force that elongates a muscle—is the primary cause of muscle strains. Overstretching may result in tears to the muscle fibers and tendons at the musculotendinous junction or at the site of attachment to the bone (Fig. 12-1). Overstretching can occur if the muscle is forced to lengthen beyond its normal range when the muscle is activated during a stretch or when a muscle affected by spasm, fatigue, scar tissue, dehydration, or other dysfunction is stressed by quick, intense movement, particularly against resistance, even within the normal ROM. Eccentric contraction of a compromised muscle is a common cause of strains. For example, a person with a sedentary lifestyle may develop shortened hip flexors with a high resting tone. If this person stands too quickly, the poorly conditioned hip flexors may not adapt to the quick, eccentric contraction, and strain may occur.

Strains can occur in any muscle but are most likely in muscles that cross two joints, particularly when the muscle lengthens across both joints simultaneously. Muscles commonly strained include the hamstrings, quadriceps, gastrocnemius, the muscles of the rotator cuff, pectoralis major, biceps brachialis, and the muscles of the neck (particularly with whiplash). An acute strain occurs when a muscle is recruited to perform a contraction quickly and intensely, particularly against resistance. Muscles with a high concentration of fast-twitch fibers that are frequently recruited to contract eccentrically are most susceptible to acute strain. A chronic strain occurs when a muscle is regularly recruited to perform repetitive actions or when an acute strain is not fully treated and continues to contribute to dysfunctional patterns. Postural muscles such as the erector spinae, which contract against gravity for long periods throughout the day, are most susceptible to chronic strain. Strain can occur in any part of a muscle and may involve just a few or all of its fibers (Fig. 12-2). The most common site of strain is at or near the musculotendinous junction, where the very elastic muscle fibers meet the less malleable tendon. The risk of acute strain increases when the health of the muscle is compromised.

The more a muscle is lengthened, the less able it is to absorb stress. As a muscle approaches its maximum length, muscle spindles initiate a reflex response to resist further stretching by activating or tensing the stretched fibers. This activation of the muscle increases its ability to absorb stress, protecting the muscle from injury. The velocity of contraction and reflex response, resistance against the action, muscle fatigue, weakness, tension, temperature, and prior injuries all affect whether the contraction is smooth and healthy or results in an injury.

Figure 12-1 Muscle strain. Fibers in the muscle, tendon, or musculotendinous junction or at the attachment site tear due to overstretching.

Common Signs and Symptoms

The signs and symptoms of muscle strains differ depending on the grade (severity of the injury) and stage (duration of symptoms) of the injury. Table 12-1 outlines the common signs and symptoms for each grade and stage of muscle strain.

Figure 12-2 Degrees of strain. Few fibers are torn in a first-degree strain (left). Several fibers are torn in a second-degree strain (middle). All fibers are torn in a third-degree strain (right). The muscle and tendons may shorten and bunch up near the attachment site. Adapted from Clay JH, Pounds DM. *Basic Clinical Massage Therapy: Integrating Anatomy and Treatment,* 2nd ed. Philadelphia: Lippincott Williams & Wilkins, 2008.

Table 12-1 Grades and Stages of Muscle Strain

	Grade 1	Grade 2	Grade 3
	Mild strain Minor stretch or tear Client can continue activity with mild pain	Moderate strain Tearing of several to the majority of fibers Pain and weakness may make continued activity difficult	Severe strain Complete rupture of muscle belly, separation of muscle from tendon, or tendon from bone. Pain and weakness halt continued activity.
Acute stage (symptoms typically last 3–4 days following injury)	Minimal loss of strength Mild discomfort with activity Minimal or no local edema Minimal or no bruising Mild local tenderness	Snapping sound or sensation at moment of injury Moderate local edema Moderate bruising, red or purple Possible hematoma Possible palpable gap at site of injury Moderate local tenderness Moderate pain with activity Moderate weakness with activity Moderate decrease in ROM Protective muscle spasm crossing affected joint(s)	Snapping sound or sensation at moment of injury Severe pain Immediate loss of strength Immediate loss of ROM Inability to perform activity involving the affected muscle Considerable local edema Considerable bruising, red or purple Possible hematoma Palpable gap at site of injury Ruptured muscle may contract and gather into a palpable mass Protective muscle spasm crossing affected joint(s)
Subacute stage (symptoms typically remain from 3 days to 3 weeks following acute stage)	Minimal to no pain Minimal to no reduction of strength Scar developing at site of injury Adhesions developing at site of injury and between surrounding muscles and other soft tissues Trigger points in affected muscle, synergists, and antagonists	Moderate to minimal pain improved since the acute stage Moderate to minimal reduction of strength improved since the acute stage Bruising remains and may be changing color to yellow or green Possible hematoma Palpable inconsistency in muscle shape at the site of injury Injury may be splinted or casted Scar at the site of injury Adhesions developing at the site of injury and between the surrounding muscles and other soft tissues Protective muscle spasm may diminish and may be replaced by hypertonicity Trigger points in affected muscle, synergists, and antagonists	Significant pain Significantly reduced strength, particularly against resistance Bruising remains, may be changing color to yellow or green Possible hematoma Palpable gap at the site of injury if muscle was not surgically repaired Significant scarring if muscle was surgically repaired. Injury may be splinted or casted Protective muscle spasm may continue, or may diminish and may be replaced by hypertonicity Trigger points developing in affected muscle, synergists, and antagonists

(*continued*)

Table 12-1 Grades and Stages of Muscle Strain (Continued)

	Grade 1	Grade 2	Grade 3
Chronic stage (symptoms continue beyond the subacute stage)	Bruising has cleared Trigger points, scars, adhesions, and hypertonicity may still affect injured muscle and compensating structures and may cause ischemia Discomfort when affected muscle is stretched Increased risk of re-injury if not properly treated Chronic inflammation if not properly treated	Bruising has cleared Trigger points, scars, adhesions, and hypertonicity affect the injured muscle and compensating structures and may cause ischemia Discomfort or pain when the affected muscle is stretched ROM in joint(s) crossed by the affected muscle has improved but is still restricted Increased risk of re-injury if not properly treated Chronic inflammation if not properly treated Possible atrophy if not properly treated	Bruising has cleared Trigger points, scars, adhesions, and hypertonicity affect the injured muscle and compensating structures and may cause ischemia Reduce ROM in joint(s) crossed by the affected muscle Reduced strength if the affected muscle was not surgically repaired Increased risk of re-injury if not properly treated Increased risk of overuse injury to synergists if the affected muscle was not surgically repaired Chronic inflammation if not properly treated Possible atrophy if not properly treated

In general, strains produce local pain, stiffness, pain on resisted movement or passive stretch, reduced strength, and impaired ROM.

Possible Causes and Contributing Factors

The cause of strain is overstretching with too much tensile stress. The affected muscle lengthens beyond its capability when the joint it crosses is forced beyond its maximum range, particularly when the movement occurs quickly and passively. Strain can also occur when an unhealthy muscle is unable to lengthen within the average normal range. Previous injury, even if the injury was minor and caused no reduction in activities of daily living, may result in scar tissue, weakness, hypertonicity, spasm, or trigger points, which if left untreated, increases the risk of strain. When scar tissue forms, it alters the shape and impedes the function of the affected fibers. Collagenous scar tissue does not have the flexibility or contractile strength of healthy muscle tissue, putting the torn fibers at risk for re-injury if the muscle is overstretched (Fig. 12-3). This dysfunction also increases the load that the healthy fibers must bear, putting them at risk for tearing and the muscle as a whole at risk for more serious injury including rupture. Previous strains, sprains, contusions, and dislocations often alter biomechanics and increase the risk of chronic strain if they are not properly treated.

When the antagonists of an action are much weaker than the agonists, an intense concentric contraction may overpower the eccentric contraction, forcing the joint beyond the antagonist's capability. This can also occur when the antagonist is fatigued and unable to adequately regulate motion at the joint. When a muscle is hypertonic, in spasm, or contains trigger points, it may be less capable of lengthening to accommodate an eccentric contraction. In this case, a strong or quick concentric contraction of an opposing muscle intensifies the tensile stress in the antagonist and may lead to tearing of its fibers. In addition, when the health of a muscle is compromised, the reflex response may be insufficient to inhibit overstretching.

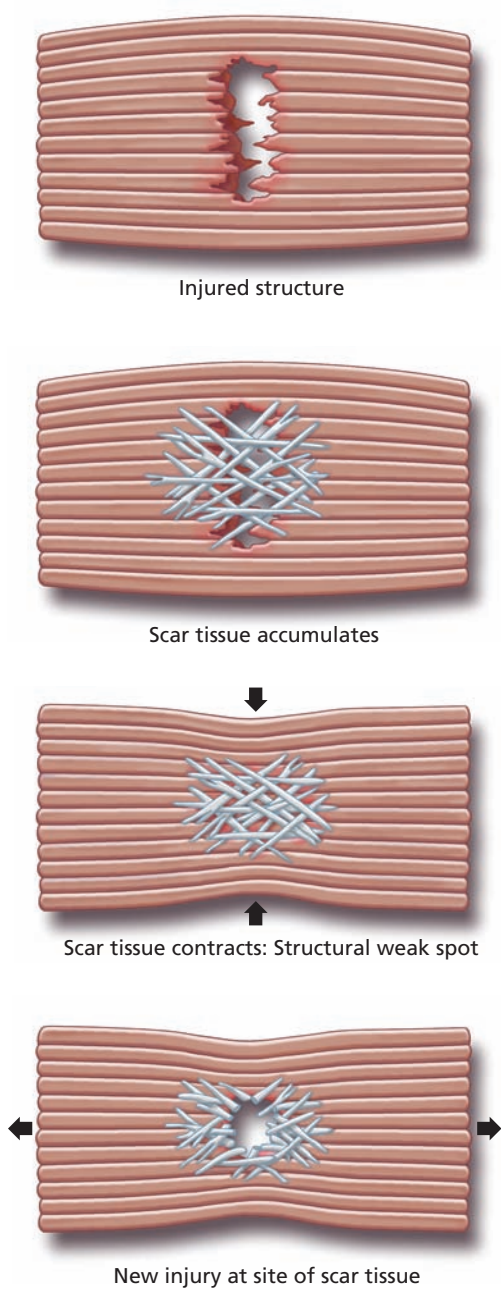


Figure 12-3 **Injury–re-injury cycle.** Scar tissue alters the shape and function of the affected fibers, leaving the muscle at risk for re-injury. From the top, overstretch tears muscle fibers; new scar tissue forms to restore integrity of fibers; scar tissue contracts and becomes dense, altering the shape of the muscle and leaving a weak spot; fibers with remaining dense scar tissue are at risk for re-injury. From Werner R. *A Massage Therapist's Guide to Pathology*, 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins, 2009.

Athletes are particularly prone to strains, particularly in sports involving quick, intense movements using maximum strength. Athletes are also more prone to other injuries, which, if they do not properly heal, increase the risk of strains. Athlete or not, the muscles of a person participating in an intense activity following a period of relative inactivity may not be well conditioned and may suffer from strains. In general, using improper techniques when participating in sports, dancing, or other intense activity increases the risk of muscle strains.

Age may also play a role in the increased risk for muscle strains. In adolescents, growth spurts sometimes increase the length of the bones more quickly than the muscle can adapt. This increases tensile stress and the risk of strain until the muscles grow to fit the joint. In older adults, the tone, strength, and general health of tissues begins to deteriorate, putting muscle fibers at risk for tearing. Temperature may also play a role in the risk of strain injuries. In cold temperatures, superficial vessels contract to prevent substantial heat loss. This cooling affects elasticity and may increase the risk of muscle fiber rupture. Simple contractions performed before intense activity can increase muscle temperature by a full degree or two.

Because strains can occur anywhere in the body, they can be confused with many other conditions throughout the body. For example, pain in the back of the calf may be a muscle strain, but it may also be a Baker's cyst or blood clot. Low back pain may involve strains, a herniated disc, or both. Pain in the chest could indicate a strain to the pectorals but can also be a symptom of a cardiac event. Muscle strain is usually associated with a precipitating event, whether a single, acutely painful injury or the introduction of new activity after a period of inactivity. Palpation of the area usually produces more intense pain at the specific site of the injury. Table 12-2 lists some general conditions commonly confused with or contributing to muscle strains. Because the pattern of pain from strains can present so differently, it is particularly important to understand the client's health history, precipitating events, and other possible causes of pain in the area before treatment. Consult your pathology book for more detailed information. If you are unsure and the client's symptoms resemble a more serious condition, particularly if the client has other risk factors, refer him or her to a health care provider for medical assessment.

Contraindications and Special Considerations

First, it is essential to understand the cause of the client's pain. If the client is unable to move the joint, heard a popping sound, or has significant weakness or if you suspect the client has a fractured bone or significant tearing to the tissues, work with the client's health care provider, and consult a pathology text for massage therapists before proceeding. These are a few general cautions:

- **Protective muscle splinting.** When a muscle is injured, its synergists and antagonists may spasm reflexively in an attempt to keep the joint's movement within a range that prevents further injury. Do not reduce protective muscle splinting in the acute stage of injury. Wait until the subacute or chronic stage, when sufficient scarring and muscle fiber regeneration reduces the need for protective splinting.
- **Bruises.** A bruise indicates damage to blood vessels allowing blood to accumulate in surrounding tissue. Avoid direct pressure to a bruise that is still healing. As the vessels heal and blood is reabsorbed, the color changes from red or purple to green or yellow. Severe bruising may result in a hematoma—a localized pooling of blood outside the vessels. In some cases, a sac-like enclosure forms around the pool of blood to minimize internal bleeding. A hematoma often resolves on its own, like a simple bruise, but if it grows or hardens it may require medical attention. Avoid direct pressure to a hematoma, and refer the client to a health care professional if the area becomes hard, if the client reports feeling pressure from the hematoma, or if it does not show signs of resolving over the course of a week or two.
- **Muscle testing.** Use only active ROM testing in the acute stage of a grade 2 or 3 strain. The client usually limits active movement to the pain-free range. P ROM and R ROM testing in the acute stage may cause further injury.
- **Hydrotherapy.** Do not apply heat near the edges of a cast to prevent the accumulation of fluid under the cast.
- **Reproducing symptoms.** Symptoms may occur during treatment. If treatment reproduces symptoms, adjust the client to a more neutral posture. Shortening or adding slack to the muscle may help. If this does not relieve the symptoms, reduce your pressure or move away from the area. You may be able to treat around the site that reproduced the symptoms, but proceed with caution.
- **Treatment duration and pressure.** If the client is older, has degenerative disease, or has been diagnosed with a condition that diminishes activities of daily living, you may need to adjust your pressure as well as the treatment duration. Frequent half-hour sessions may suit the client better.
- **Friction.** Do not use deep frictions if the health of the underlying tissues is at risk for rupture or if the client is taking anti-inflammatory medication or anticoagulants. Allow time for scarring and tissue regeneration to avoid re-injury. Friction creates an inflammatory process, which may interfere with the intended action of anti-inflammatory medication.

Table 12-2 Differentiating Conditions Commonly Confused with or Contributing to Muscle Strains

Condition	Typical Signs and Symptoms	Testing	Massage Therapy
Sprain	Inflammation, heat, redness, and pain in acute stage Remaining inflammation and weakness reduce ROM in subacute and chronic stages	Often self-assessed	Massage is indicated. See Chapter 13.
Tendinitis	Often has gradual onset Pain, tenderness, and swelling at affected tendon	Physical exam Localized pain on full passive stretch X-ray may be performed to rule out other conditions	Massage is indicated. See Chapter 14.
Spasm/cramp (contracture)	Sudden, often sharp pain in affected voluntary muscle Palpable and often visible mass of hypertonic muscle tissue	Most often self-assessed X-ray or MRI may be used to assess extent of damage	Massage is indicated. Discuss with health care provider if repeated spasm is related to an underlying condition or medication.
Myofascial pain syndrome	Persistent muscle aches or pain Muscle or joint stiffness Muscle tension Trigger points Pain interrupts sleep	Physical exam Palpate for trigger points Referred pain or twitch response Other tests may be performed to rule out other sources of pain	Massage is indicated. Myofascial pain syndrome is associated with trigger points. See Chapter 3.
Delayed onset muscle soreness (DOMS)	Stiffness and discomfort 24–72 hours after activity Common when new activity is initiated after a period of inactivity Risk increases with activities involving eccentric contractions Temporary reduction in strength Temporary reduction in ROM Continuing activity and increasing the frequency and intensity may improve symptoms	By signs and symptoms	Treatment is not necessary, although massage may improve symptoms and prevent further injury
Avulsion fracture	Bone fragments at the attachment site of a tendon or ligament Often accompanies strains and sprains Moderate local pain Bruising and inflammation	X-ray	Local massage is contraindicated in the acute stage. Caution is used when treating the surrounding tissues to avoid further injury. Massage may help to prevent further injury when muscle tension is a contributing factor.

(*continued*)

Table 12-2 Differentiating Conditions Commonly Confused with or Contributing to Muscle Strains (Continued)

Condition	Typical Signs and Symptoms	Testing	Massage Therapy
Bursitis	Pain, particularly with activity or palpation Heat, redness, swelling, or tenderness	Physical exam ROM tests X-ray or MRI if conservative treatment is not successful	Massage is systemically contraindicated if bursitis is due to infection, and locally contraindicated in the acute stage to avoid increased swelling. In the subacute stage, massage to the structures surrounding the joint is indicated.
Hernia	Bulge in the area Pain or discomfort, particularly when bending, coughing, sneezing, or lifting heavy objects	Physical exam	Massage is locally contraindicated until the hernia is repaired.

Recommend that the client refrain from taking such medication for several hours before treatment if the health care provider agrees. Because anticoagulants reduce clotting, avoid techniques that may cause tearing and bleeding.

Massage Therapy Research

Many articles and research studies describe a healing program for muscle strains including massage, deep friction, and stretching. There are also many articles that include massage as part of a program to prevent muscle strains in athletes. However, a thorough review of the literature resulted in no research, case studies, or peer-reviewed articles testing the benefits of massage therapy alone in the treatment of muscle strains, and none of the studies that include massage in a healing program specifies the treatment used. While massage is cited as an important element in healing strains, no study has tested the specific effect of massage therapy on the healing process, reduction of scar tissue and adhesions, release of protective muscle splinting, regeneration of muscle tissue, restoration of strength and ROM, or reduction in the risk of re-injury.

In "Evaluation of the Effect of Two Massage Techniques on Hamstring Muscle Length in Competitive Female Hockey Players," Hopper et al. (2005) reported that reduced muscle length predisposes the athlete to injury; they studied the benefits of two forms of massage therapy in lengthening the hamstrings of 35 subjects treated over 3 consecutive days. Treatment was performed by experienced physiotherapists. One group received what the authors refer to as "standardized classic massage intervention," which included proximal to distal effleurage, circular kneading, proximal to distal picking up, and shaking. Each massage lasted 8 minutes. The second group received what the authors refer to as "dynamic soft tissue mobilisation (DSTM)," which involved the classic massage described above for a shorter duration, followed by longitudinal and cross-fiber strokes to the specific tissues identified as tight. The technique was applied during passive then active extension of the knee. DSTM treatments also lasted 8 minutes. Hamstring length was measured before, directly after, and 24 hours after treatment. Both groups showed a significant increase in hamstring length following treatment, and there was no significant difference between the two groups. While the benefits were not maintained 24 hours after treatment, the authors recommended a study of the two treatments on subjects in the subacute phase of injury and recommended investigating treatment designed to reflect the clinical setting.

Delayed onset muscle soreness (DOMS) results from the breakdown of muscle fibers following exercise, seen more often following resisted eccentric contractions than following concentric contractions. Several sources refer to DOMS as mild muscle strain, although DOMS is differentiated as a random pattern of injury to muscle belly fibers that do not require rest for recovery while strain refers to an identifiable pattern of tearing—frequently involving the tendon or musculotendinous junction—which requires a period of rest for proper healing. In "The Effects of Therapeutic Massage on Delayed Onset Muscle Soreness and Muscle Function Following Downhill Walking," Farr et al. (2002) described performing a 30-minute massage to one leg of each of eight male subjects 2 hours after each performed a 40-minute, downhill treadmill walk. Massage included only effleurage and petrissage to all major muscles of the leg and did not include deep tissue massage. Participants experienced reduced pain in the leg massaged, but there was no significant improvement in the strength or function of the affected muscles. While treatment did not focus on a single strained muscle, the study did show the benefit of massage for reducing the pain associated with muscle damage due to repeated eccentric contraction by increasing local circulation, reducing edema and the accumulation of metabolites, and decreasing nerve sensitization and pain. Further study of the effects of massage on the healing process of muscle strains is needed.

WORKING WITH THE CLIENT

Client Assessment

Muscle strain is a common cause of musculoskeletal pain, experienced in some degree by most people. Strain is often one element of musculoskeletal injuries or chronic pain conditions. For example, when short plantar flexors contribute to plantar fasciitis, lengthening those muscles against resistance, such as when walking, can cause tearing of the fibers. When mild, first-degree strains contribute to the symptoms of other conditions, the following treatment recommendations can aid healing and reduce the risk of re-injury. Reducing adhesions and scar tissue, reorienting muscle fibers, lengthening shortened muscles, and strengthening weak muscles are the basic goals for treating muscle strains.

More serious second- and third-degree strains require more focused attention. An acute third-degree strain requires medical attention. You are not likely to see a client in the acute stage of a third-degree strain. When surgical repair presents more risk than benefit, the muscle may be left detached. In most cases, the muscle is surgically repaired, and the client is prescribed physical therapy. You are most likely to see a client in this condition as part of a program to reduce pain, limitations in ROM, or compensating patterns that may have developed. Swelling and bruising in the acute stage of a second-degree strain can be significant enough to contraindicate treatment locally or to a broad area surrounding the injury. Significant swelling that occurred within 20 minutes of injury may indicate bleeding that poses a greater risk for the development of a hematoma or injury to structures other than muscle and requires medical attention.

Because any muscle can be strained, the following descriptions do not identify specific muscles to be treated, as previous chapters have. Use the resources in the previous chapters as needed to determine fiber direction, joints crossed, superficial versus deep muscles, common trigger points and referral areas, and so on.

Assessment begins during your first contact with a client. In some cases, this may be on the telephone when an appointment is requested. Ask in advance if the client is seeking treatment for a specific area of pain so that you can prepare yourself.

Table 12-3 lists questions to ask the client when taking a health history.

Table 12-3 Health History

Questions for the Client	Importance for the Treatment Plan
Where do you feel symptoms?	Location of the symptoms helps to identify the precise location of stretched or torn fibers and contributing factors.
Describe what your symptoms feel like.	A description of symptoms including weakness, heat, or fullness in the area may help you to determine the stage and degree of strain. See Chapter 1 for descriptions of pain sensations and possible contributing factors.
What activity were you performing when you first felt the pain? Did you hear or feel a snap in the area at the time of injury?	The details of the activity or posture that initiated the pain may help you to determine its cause. A new regimen of exercise, weight-bearing activity, or repetitive action, particularly following a period of inactivity, may contribute to a strain.
When did the symptoms begin?	The date of the injury may help you to determine the stage of the injury and the health of the tissue.
To what degree were you able to continue activity following the injury?	The activity level after the injury may help you determine the degree of strain. An inability to continue activity suggests a third-degree strain and should be referred for medical assessment.
Do you have a history of injury or surgery to this area?	An explanation of prior injury to the area may help you to locate the strain and determine contributing factors. Surgery and resulting scar tissue may increase the risk of strain.
Do any movements make your symptoms worse or better?	Locate weakness in the structures producing such movements. Resisted activity of the affected muscle is likely to increase symptoms. Adding slack or reducing tension in the muscle may decrease symptoms.
Have you seen a health care provider for this condition? What was the diagnosis? What tests were performed?	Medical tests may reveal the degree of strain, fractures, or coinciding injuries. If no tests were performed to make a diagnosis, use the tests described in this chapter for your assessment. If your assessment is inconsistent with a diagnosis, ask the client to discuss your findings with a health care provider or ask for permission to contact the provider directly.
Are you taking any prescribed medications or herbal or other supplements?	Medication of all types may contribute to symptoms or have contraindications or cautions.
Have you had a corticosteroid or analgesic injection in the past 2 weeks? Where?	Local massage is contraindicated. A history of repeated corticosteroid injections may affect the integrity of the muscle and tendons, increasing the risk of tearing or rupture. Use caution when applying pressure or cross-fiber strokes even after the period of contraindication has passed. Analgesics reduce sensation and may cause the client to allow you to work too aggressively.
Have you taken a pain reliever or muscle relaxant within the past 4 hours?	The client may not be able to judge your pressure and may allow you to work too aggressively.
Have you taken anti-inflammatory medication within the past 4 hours?	Deep friction initiates an inflammatory process and should not be performed if the client has recently taken anti-inflammatory medication.

POSTURAL ASSESSMENT

Allow the client to walk and enter the room ahead of you while you assess his or her posture and movement. Look for imbalances in movement of the joint(s) crossed by the affected muscle or muscle group or patterns of compensation that may develop to protect the injured structures. If the lower body is affected, watch as the client walks or climbs steps. If the upper body is affected, watch as the client opens the door, takes off his or her coat or lifts a pen. If the thorax is affected, notice how the

client moves the spine. Look for reduced mobility or favoring of one side. Watch as the client sits, stands from sitting, lifts or sets down objects, turns to talk to you, and so on to see if he or she can perform these activities without assistance or if he or she avoids bearing weight on the affected joint. The grade and stage of the strain will influence the level of imbalance and compensation.

When assessing the client's standing posture, be sure that the client stands comfortably. If he or she deliberately attempts to stand in the anatomic position, you may not get an accurate assessment of his or her posture in daily life. When strain affects the lower body, the client may stand in a position that keeps weight off the affected joint(s). When the upper body is affected, the client may hold the joint in a position that keeps the injured muscle from stretching. If the client has a removable device bracing the injured area, ask him or her to remove it if it is possible to bear the weight without it so that you can get an accurate picture of the strength of the injured muscles.

ROM ASSESSMENT

Test the ROM of the joint(s) crossed by the strained muscle. Only active ROM testing should be performed with a second- or third-degree strain in the acute stage to avoid further injury.

Active ROM

Compare your assessment of the client's active ROM in the affected joint(s) to the values listed for the joint's average ROM in Chapters 4–11. Pain and other symptoms may not be reproduced during active ROM assessment because the client may limit movement to a symptom-free range.

- **Active ROM of the affected joint** will be limited. Limitations are more significant with more severe grades of strain and diminish as the stage of injury progresses from acute to chronic. A first-degree strain in the acute stage may be limited by discomfort caused by stretching the affected muscle; second-degree strains may be limited by pain with concentric and eccentric contraction; third-degree strains produce severe pain and allow little or no movement of the affected joint.

Passive ROM

P ROM should not be performed in the acute stage of a second- or third-degree strain to avoid further injury. Compare the client's P ROM on one side to that on the other when applicable. Note and compare the end feel for each range (see Chapter 1 for an explanation of end feel).

- **P ROM of the affected joint** in the acute stage of a first-degree strain may be slightly limited, may cause pain due to reflexive muscle spasm, and may cause pain when ROM lengthens the affected muscle. Results may be similar in the subacute and chronic stages for all grades of strain with varying degrees of limitation and pain according to grade. Note that ROM testing following a third-degree strain that was not surgically repaired is intended to assess the synergists and antagonists of the ruptured muscle.

Resisted ROM

R ROM should not be performed in the acute stage of a second- or third-degree strain to avoid further injury. Use resisted tests to assess the strength of the muscles that cross the affected joint for a first-degree strain and in the subacute or chronic stages of second- and third-degree strains. Compare the strength of the affected side to that of the unaffected side when possible.

- **R ROM of the affected joint** in the acute stage of a first-degree strain in all stages may be slightly limited or painful. R ROM with a second- or third-degree strain in the subacute and chronic stages should be performed with a gradual increase in resistance to avoid further injury when assessing muscle strength. R ROM is limited by reduced strength and pain at the injury site. The structure being tested may tremble as the client reaches his or her limit of strength. Note that ROM testing following a third-degree strain that was not surgically repaired tests the synergists and antagonists of the ruptured muscle.

SPECIAL TESTS

Because strains can occur in any muscle, there is no single special test. Length and strength assessment of the affected muscle, its synergists, and antagonists along with locating the specific site of injury are the primary assessment strategies for strains. Use ROM testing as described above to assess strength and length. When appropriate for the grade and stage of strain, test the strength of the muscle(s) you suspect to be injured with active and resisted concentric contraction. Test the length of the muscle(s) you suspect to be injured with passive or active eccentric contractions. Refer to Chapters 4–11 for special tests of the muscles affected by the conditions covered in those chapters.

PALPATION ASSESSMENT

Bruises may be present in the acute and early subacute stages (Fig. 12-4). Avoid direct pressure on a fresh bruise. Minor bruising may occur with a first-degree strain or with the second-degree strain of a small muscle or of relatively few fibers in a larger muscle. A larger bruise may be evident with a second-degree strain to a larger muscle or more than one muscle or with a third-degree strain. As the injury heals, bruising changes colors and then disappears. In the chronic stage, the bruise is usually gone unless repeated tearing continues to occur. Edema may also be present in all stages. Avoid direct pressure on an edematous area in the acute stage. In the acute stage, when the inflammatory process is active, the area may be red and hot, and the texture of the edematous area may be dense or hard as if the area is too full and stretching the skin. When the inflammatory process diminishes, the edematous area may feel softer and less dense. In the chronic stage, the edematous area may feel boggy or gelatinous. Swelling that persists and continues to feel dense or hard may indicate a hematoma. Refer the client to his or her health care provider for medical assessment.

On palpation, the site of injury may be tender in all stages. Tenderness diminishes as the injury heals. Tenderness on palpation may radiate to the surrounding tissue, and the area of radiating

Figure 12-4 Bruise following muscle strain. The darkest area of bruising suggests the precise location of torn fibers.

pain also diminishes as the injury heals. You may feel a gap in the affected fibers, particularly with a second- or third-degree strain. The gap will fill in with scar tissue as the injury heals. If a third-degree strain is not surgically repaired, the gap remains and can often be seen and palpated. You may feel the remaining muscle bunched up near one of the attachment sites if it ruptured at the opposite musculotendinous junction or detached from the bone, or more rarely, at both attachment sites if the muscle belly ruptured.

As time passes, scar tissue becomes thicker, denser, and possibly fibrous. Adhesions may develop, reducing mobility between the skin and affected muscle or between the affected muscle and those surrounding it. If not properly treated, scarring, adhesions, and remaining edema may reduce local circulation, resulting in ischemia. The ischemic area may feel cool to the touch. When assessing muscle tone, you may find protective spasms in the affected muscle, its synergists, or its antagonists in the acute and early subacute stages. This protective spasm serves to keep the joint from moving through a range that may cause further injury. Do not attempt to reduce protective spasms in the early stages. As healing progresses and the risk of re-injury diminishes, the spasm may cease naturally or can be treated manually. In the late subacute and chronic stages, the affected muscle and synergists may remain hypertonic. Holding the injured muscle in a shortened position to reduce the risk of pain or re-injury is a natural impulse and may cause the antagonists to remain overstretched and stressed. Trigger points may develop in any of the muscles involved in the movement of the joint crossed by the strained muscle. If the severity of the injury prevents movement of the joint or if the injury was not treated well enough to restore ROM, you may find atrophy in the affected muscle(s) or synergists.

To effectively treat a strain, it is essential to locate the precise site of injury and to know the direction of fibers of the affected muscle. Refer to the images of specific muscles throughout this text for fiber direction. Take your time palpating the location. Once you have identified the affected muscle(s) with ROM testing, palpate them slowly, covering approximately 1 inch of tissue in 5–10 seconds. Stay focused and allow the receptors in your fingers to transmit important information. Feel for gaps, scars, or other anomalies in texture, tone, temperature, and tenderness.

Condition-Specific Massage

This section focuses on first-degree strains in all stages and second- or third-degree strains in the late subacute or chronic stage. While massage therapy may be beneficial for second-degree strains in an earlier stage, the potential contraindications and complications require more advanced training. An acute third-degree strain requires medical attention. Healing in the subacute stage of a third-degree strain is best supervised by a professional experienced in treating severe muscle strains.

The treatment goals and techniques are the same for first-degree strains in all stages and second- or third-degree strains in the subacute or chronic stage, but the intensity of treatment should be adjusted according to the severity of injury. For example, a first-degree chronic strain that has developed minor scarring and dysfunction does not present as significant a risk of re-injury during a stretch as a second-degree strain with moderate scarring or a third-degree stain with severe scarring. A third-degree strain is likely to have developed much more extensive protective muscle spasms, adhesions, and scars, and requires more warming of superficial tissues and a slower pace approaching the deeper tissues. You are more likely to be able to focus directly on the injured muscle with a first-degree strain while a second-degree strain requires more attention to the compensating and surrounding structures before addressing the torn fibers directly.

It is essential for the treatment to be relaxing. You may not be able to eliminate the symptoms associated with muscle strain or any coexisting conditions in a single treatment. Do not attempt to do so by treating aggressively. Be sure to ask your client to let you know if the amount of pressure you are applying keeps him or her from relaxing. If the client responds by tensing muscles or his or her facial expression looks distressed, reduce your pressure. Remember that you are working on tissue that is compromised. Ask the client to let you know if any part of your treatment reproduces symptoms, and always work within his or her tolerance. Deep palpation of a trigger point may cause pain at the upper end of the client's tolerance. Explain this to your client, describe a pain scale and what level of pain should not be exceeded, and ask him or her to breathe deeply during the application of the technique. As the trigger point is deactivated, the referral pain will also diminish.

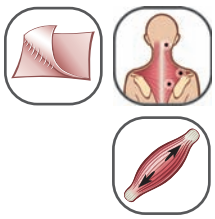
The following suggestions are for treating pain, weakness, and limited ROM caused by overstretching or tearing of muscle fibers. The following are general principles for any muscle affected by strain. Refer to Chapters 4-11 for resources pertaining to specific muscles.

- Positioning and bolstering depends on which muscles are to be treated. In the early stages following injury, the affected muscles should rest comfortably in a position that prevents stretching. Full lengthening of the affected muscle may cause pain and increase the risk of re-injury.

- If you find edema, apply superficial draining strokes toward the nearest lymph nodes and, when possible, bolster the area to allow gravity to draw fluid toward the thorax.

- If swelling is minor or absent and bruises have sufficiently faded, apply moist heat to the affected area to soften scars and adhesions and increase local circulation.

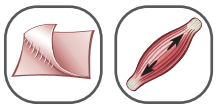
- Use your initial warming strokes to increase superficial circulation, soften tissues, and assess the tissues broadly surrounding the site of injury or compensating for the injured muscle. If time permits, apply initial warming strokes to the whole body. You should be able to minimally assess tissues surrounding the injury for adhesions, hypertonicity, protective muscle spasm, and tensile stress, which will help you to determine how to focus your time.



- Based on your findings, treat muscles proximal to the site of injury for adhesions, shortening, hypertonicity, and trigger points.

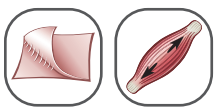
- Before applying emollient, assess for and treat fascial restrictions around the injured area. Tissues that have shortened to prevent re-injury, particularly those closest to the injury are most likely to develop fascial restrictions.

- Reduce tension in the tissues that surround the site of injury. Pay special attention to the synergists of the muscle's primary actions. If the antagonists are accessible, treat these now, or perform this after the client changes position.



- Once the superficial tissues are pliable enough to allow for deeper work, apply friction strokes to reduce the remaining adhesions and lengthening strokes to tissues that are short and tight. Muscles with fiber direction and actions in common with the injured muscle are likely to have shortened, possibly in spasm, to protect the injured muscle from overstretch and re-injury.

- Treat any trigger points found in the synergists of the affected muscle or in muscles compensating for the injury. Treat trigger points in antagonists if they are accessible now, or treat them later after the client changes position. Follow trigger point treatment with lengthening strokes, but do not stretch the muscles until you have treated the precise site of injury.



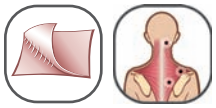
- Locate the precise site of the strain, and assess the direction of the tear. Using short, slow strokes within the client's pain tolerance, apply cross-fiber strokes to reduce scar tissue at the site of injury. Follow this with longitudinal strokes to redirect the fibers. Alternate rounds of cross-fiber and longitudinal strokes until you feel a change in texture. If the area gets hot or begins to swell, discontinue this step, and briefly ice the area.

Treatment icons: Increase circulation; Reduce adhesions; Reduce tension; Lengthen tissue; Treat trigger points; Passive stretch; Clear area

- Apply longitudinal strokes to the full length of the injured muscle.

- Treat tissues distal to the injury for compensating patterns if needed.

- Passively stretch the affected muscle or perform PIR within the client's tolerance to lengthen the affected muscle and its synergists. This may require repositioning the client.



- If you were earlier unable to address the antagonists of the injured muscle, reposition the client and address them now.

The treatment overview diagram summarizes the flow of treatment (Fig. 12-5).

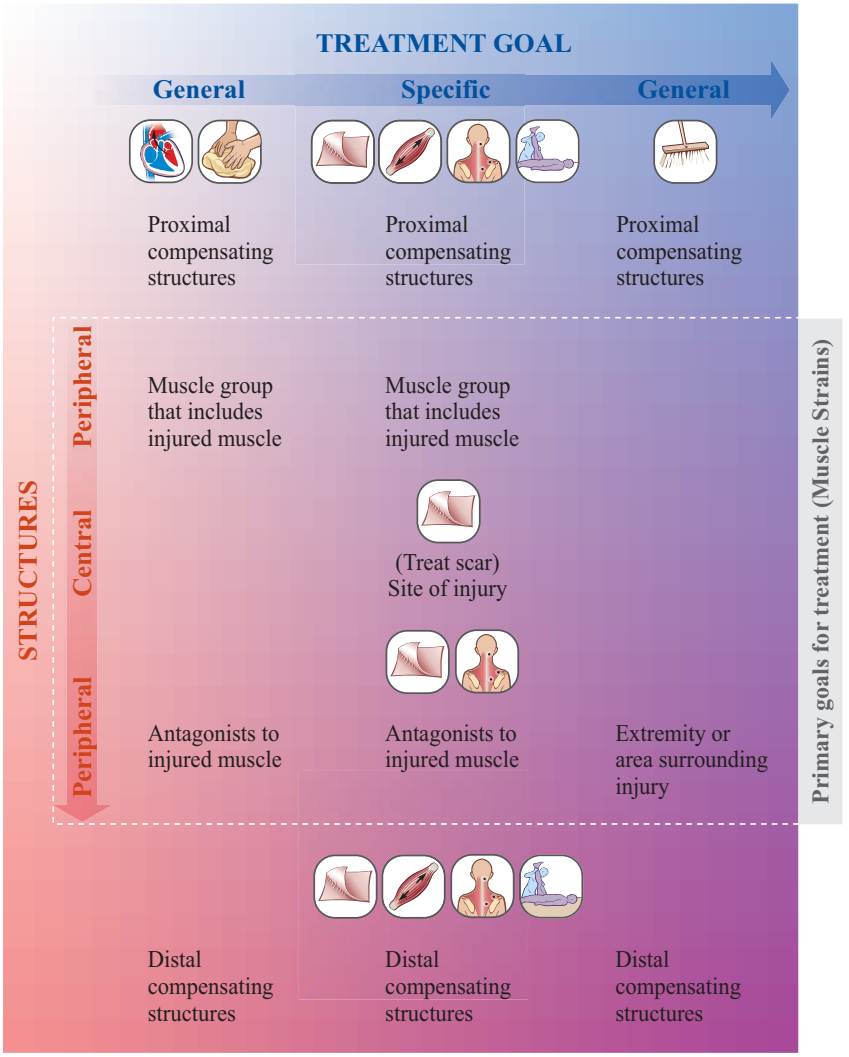


Figure 12-5 **Muscle strains overview diagram.** Follow the general principles from left to right or top to bottom when treating muscle strains.

CLIENT SELF-CARE

Avoiding re-injury is a primary concern when recommending self-care. Clients with an acute or subacute second- or third-degree strain should be prescribed self-care by a professional with advanced training and experience in treating severe musculoskeletal injuries. For clients with first-degree strains, or those in the chronic stage of a second- or third-degree strain, the following suggestions may encourage proper healing.

These suggestions are intended as general recommendations for stretching and strengthening the muscles involved in the client's condition. The objective is to create distance between the attachment sites of muscles that have shortened and to perform repetitions of movements that decrease the distance between the attachments of muscles that have weakened. If you have had no training in remedial exercises and do not feel that you have a functional understanding of stretching and strengthening, refer the client to a professional with training in this area.

Clients often neglect self-care due to time constraints. Encourage them to follow these guidelines:

- Instruct the client to perform self-care throughout the day, such as while talking on the phone, reading e-mail, washing dishes, or watching television instead of setting aside extra time.
- Encourage the client to take regular breaks from stationary postures or repetitive actions. If the client's daily activities include hours of inactivity, suggest moving for at least a few minutes every hour to prevent adhesions and reduced circulation. If the client's daily activities require repetitive actions that contribute to strains, suggest resting for at least a few minutes every hour.
- Demonstrate gentle self-massage of the tissues surrounding the injury to keep adhesions and hypertonicity at bay between treatments.
- Demonstrate all strengthening exercises and stretches to the client and have him or her perform these in your presence before leaving to ensure that he or she is performing them properly and will not cause harm when practicing alone. Stretches should be held for 15–30 seconds and performed frequently throughout the day within the client's limits. The client should not force the stretch or bounce. The stretch should be slow, gentle, and steady, trying to keep every other joint as relaxed as possible.
- Stretching and strengthening exercises should be recommended based on your findings in ROM testing and palpation.

Stretching

Maintaining proper length and tone of the strained muscle, its synergists, and its antagonists is essential to reduce the risk of re-injury. Stretches should be performed throughout the day, particularly before and after activity. ROM testing and palpation identify which muscles have shortened and need to be stretched. In general, stretching occurs when the distance between the attachment sites of the muscle is increased. Refer to Chapters 4–11 for stretches to specific muscles or groups of muscles. Take care to instruct the client to stretch slowly and to limit stretches to the comfortable range, beginning slowly and gradually increasing the stretch as symptoms diminish and the risk of re-injury is reduced. Stretching an injured muscle too quickly or too deeply may initiate a reflex response that may result in spasm. In addition, when the affected muscle is lengthened, its antagonists are shortened. If the antagonists are involved in protective splinting, contracting them too quickly or too deeply may also result in spasm.

Strengthening

Strengthening weakened or atrophied muscles is also important for restoring proper function of the affected joint. ROM testing and palpation identify which muscles have weakened and need to

be strengthened. In general, active or resisted concentric contractions strengthen muscles. As with stretching, a strengthening program should progress gradually. Pain-free, active ROM is effective for gradually restoring strength to weakened muscles. As healing progresses and the risk of re-injury diminishes, add resistance to active ROM. Refer to Chapters 4–11 for exercises to strengthen specific muscles or muscle groups.

SUGGESTIONS FOR FURTHER TREATMENT

Ideally, a client with a strained muscle will have treatments twice a week until the client can perform activities of daily living with minimal or no pain for at least 4 days. Once this has been achieved, reduce frequency to once per week until symptoms are absent for at least 7 days. When the client reports that he or she has been pain-free for more than 7 days, treatment can be reduced to twice per month. If the client is pain-free for 3 or more consecutive weeks, he or she can then schedule once per month or as necessary. There should be some improvement with each session. If this is not happening, consider the following possibilities:

- There is too much time between treatments. It is always best to give the newly treated tissues 24–48 hours to adapt, but if too much time passes between treatments in the beginning, the client's activities of daily living may reverse any progress.
- The client is not adjusting activities of daily living or is not keeping up with self-care. As much as we want to fix the problem, we cannot force a client to make the adjustments we suggest. Explain the importance of his or her participation in the healing process, and encourage the client to follow your recommendations, but be careful not to judge or reprimand a client who does not.
- The condition is advanced or has other musculoskeletal complications that are beyond your basic training. Refer this client to a massage therapist with advanced training. Continuing to treat a client whose case is beyond your training could turn the client away from massage therapy altogether and hinder healing.
- The client has an undiagnosed, underlying condition. Discontinue treatment until the client sees a health care provider for medical assessment.

If you are not treating the client in a clinical setting or private practice, you may not be able to take this client through the full program of healing. Still, if you can bring some relief in just one treatment, it may encourage the client to discuss this change with a health care provider and seek manual therapy rather than more aggressive treatment options. If the client receives regular treatments, the signs and symptoms are likely to change each time, so it is important to perform an assessment before each session. Once you have released superficial tissues in general areas, you may be able to focus more of your treatment on deeper tissues in a specific area. Likewise, once you have treated the specific symptoms of the strain, you may be able to pay closer attention to compensating structures and coexisting conditions.

PROFESSIONAL GROWTH

CASE STUDY

Andy is a 32-year-old male. Two weeks ago while playing basketball, he heard and felt a snap at the back of his thigh, immediately followed by pain. He could walk using the leg but felt pain and limped. Within half an hour after injury, only minimal swelling at the site of injury was present. Within 24 hours the back of his thigh was covered with bruises. He called this office, and PRICE plus a visit to his health care

provider was recommended before scheduling a massage. He iced the area immediately after returning home and intermittently for 1 week following injury. He also elevated the injured thigh and wrapped the injury. He felt the worst pain when seated due to pressure on the thigh against the chair, so he sat at the edge of the chair, which led to low back pain.

Andy's health care provider diagnosed a second-degree strain to the right semimembranosus. No MRI was performed. Diagnosis was made by palpation and the pattern of bruising and swelling, which followed the long, proximal musculotendinous junction of the semimembranosus. Andy stated that his provider agreed with the recommendation to rest, ice, and compress the area and to allow healing to start before beginning massage treatment. His first massage treatment was 1 week after the injury. At that time, Andy stated that the pain on walking had diminished somewhat but that he still felt sharp pain when the seat of a chair compressed the area of injury. He had been sitting on the edge of his seat at work to avoid contact with the injury, which he stated was causing some low back pain. He stated that he felt moderate pain when extending the knee upon lying down but noticed that if he extended the knee slowly, pain was minimal. Upon visual assessment, a spiral pattern of accumulated blood was evident, suggesting that the injury had been wrapped with a narrow ACE bandage, possibly too tightly. A solid compressive bandage without elastic edges contacting the bruised area was recommended to minimize this accumulation.

At the time of his first appointment, bruising was still too significant to work directly on the site of injury. Treatment focused on reducing compensatory low back pain and treating the uninjured leg to prevent hypertonicity and trigger points. Treatment to the injured leg focused on reducing edema at the site of injury, increasing local circulation, and reducing adhesions and hypertonicity in the synergists and antagonists. The injury is now 2 weeks old, and Andy has returned for a second treatment.

Subjective

Today, Andy states that he has been more mobile since his massage last week. He still feels some discomfort with activity but feels significant pain only at the end of the day when he is fatigued. He is still unable to fully extend the knee without pain, although the pain has decreased. Andy followed my recommendation to rest the foot of the injured leg on a box or stack of books while sitting to prevent his thigh from contacting his chair while at work, as an alternative to sitting at the edge of the chair. He has not experienced low back pain since the last session.

Objective

Andy is still limping slightly but can bear more weight on the injured leg. When standing still, Andy still bears weight on the left leg. The left hip is elevated slightly. The right hip and knee are flexed, and the right femur is slightly rotated medially. The bruise is now green and fading. Inflammation that followed the proximal musculotendinous junction of the semimembranosus is now gone, and the gap at the middle third of the proximal semimembranosus tendon has filled with scar tissue. It is still tender to the touch, but he can tolerate moderate pressure. ROM has improved, although he was unable to fully extend the knee and flex the hip due to pain.

Andy felt no tenderness on palpation of the proximal and distal ends of the hamstrings, minimal tenderness surrounding the injury, and pain upon palpation of the site of strain that radiated to the area immediately surrounding the strain. The local and radiating pain have diminished somewhat since last week. The texture of the surrounding muscles is dense and adhered.

The left gluteus maximus and the posterior fibers of the gluteus medius remain hypertonic, although they have improved since the last treatment. The hypertonicity of the right gastrocnemius has improved. Andy is able to rest the right foot flat when standing.

Action

I began in a prone position with the ankles bolstered to reduce hamstring stretch. I applied general Swedish and deep tissue strokes to the low back and glutes to assess the remaining compensatory patterns. I applied kneading, cross-fiber, and longitudinal strokes to continue reducing adhesions and hypertonicity in synergists and compensating limb. I applied slow muscle stripping to assess for trigger points. The client felt pain and referral upon crossing the site of injury. It is still unclear if this is due to a trigger point in the semitendinosus or scar tissue and referred pain from the semimembranosus strain. As healing continues and referred pain from the injury ceases, I will revisit this area to determine if compression produces trigger

point referral. A trigger point in the adductor magnus referred into the pelvis, and I treated it with compression and muscle stripping, reducing the referral from level 5 pain to level 3.

I applied cross-fiber strokes to the precise site of injury. The client's pain tolerance continues to prevent deep, direct access to the semimembranosus, but I was able to mobilize tissues through the semitendinosus and by working toward the injury from its periphery. I followed this with longitudinal strokes. The area was warm to the touch following treatment. I applied ice to prevent possible swelling, but removed the ice within 2 minutes to avoid chilling the muscle before the stretches. I used general kneading and gliding strokes to the distal limb to increase circulation and reduce remaining compensatory hypertonicity. I treated the unaffected leg with general Swedish techniques to keep hypertonicity and adhesions at bay.

Turning the client supine, I applied a slow and minimal passive stretch to the hamstrings and adductors but was unable to stretch either to full ROM because of the client's discomfort. I applied kneading and longitudinal strokes to the quadriceps of the affected leg and found minimal tension in the rectus femoris. I used general Swedish techniques on the unaffected leg and clearing strokes bilaterally toward the thorax.

Plan

Because the bruising is resolving and the protective muscle splinting is no longer needed, I suggested that warm hydrotherapy to the synergists and antagonists followed by gentle stretches may be effective to maintain pliability if he feels stiffness. I recommended continuing mild, pain-free exercises including gentle flexion and extension of the hip and knee and walking to maintain circulation and prevent adhesions and shortening of the muscles. I suggested increasing activity as tolerance permits but cautioned against stretching the hamstrings quickly or fully until the scar is strong enough to withstand tension. I suggested avoiding resisted activity for at least another week. I will reassess at the next appointment. Andy rescheduled for one week from today. If symptoms continue to improve, I will attempt to access the semimembranosus directly and continue to treat the scar. If this is possible, we will increase visits to twice per week for 1 or 2 weeks while realigning the scar tissue. Goals include softening and redirecting scar tissue, continuing to reduce hypertonicity, treating trigger points if found, and continuing to gradually increase ROM and strength. I explained that second-degree strains can take 1–2 months to heal completely.

CRITICAL THINKING EXERCISES

1. Your client states that she feels pain in her left shoulder and points to the medial border and superior angle of the scapula up to the neck. Her neck is laterally flexed and rotated to the right. Which muscle(s) might be strained? Which muscle(s) may be contributing to the strain because they are stronger, shortened, or hypertonic, causing the strained muscle(s) to lengthen? Write a SOAP note for this client. Create a scenario that describes how this pattern may have developed, signs and symptoms, possible coinciding conditions, a postural assessment, testing, precautions or contraindications, and specific treatment. Use a reference book that describes the actions of the affected muscles to help you associate signs and symptoms. There is no single, correct SOAP note for this exercise. Be creative as the possibilities are virtually endless.
2. This chapter contains references to the coincidence of strains with the individual conditions described in Chapters 4–11. Choose one of the conditions described in those chapters and identify which muscles could be strained or are at risk for strain based on the client's posture or activities. Strains may occur when impaired muscles are forced to stretch beyond their capacity or to contract quickly and intensely. How would you add treatment of the strain into the treatment described for the other condition?
3. Conduct a short literature review to learn about the relationship between chronic strains and the following:
   - Age
   - Insufficient hydration
   - Lactic acid accumulation

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CHAPTER 13

Ligament Sprains

UNDERSTANDING LIGAMENT SPRAINS

A sprain is an overstretch injury to a ligament. Ligaments are tough but flexible fibrous bands composed mainly of collagen. They function to stabilize joints, restrict excessive movement, and prevent the movement of a joint in a direction that may cause injury. Some ligaments, such as the flexor retinaculum of the wrist, also form structures like the carpal tunnel that contain tendons, nerves, and vessels that cross a joint. Ligaments vary in shape, allowing specific bundles of fibers to be recruited for a specific movement within the full ROM of the joint. They are functional only under tensile stress. During a contraction that moves a joint, the ligament that lengthens functions to keep the joint from moving out of its normal range. A ligament that is compressed during the movement of a joint has no real function.

In order to manage the complex, multidirectional forces associated with joint movement, ligaments are formed from dense regular connective tissue with fibers arranged in a slightly less parallel manner than tendon fibers (Fig. 13-1). Like tendons, the collagen fibers in ligaments are crimped to allow lengthening without causing damage (Fig. 13-2). When the tensile load increases, the collagen fibers begin to uncrimp, and the ligament lengthens. As tension increases due to additional load or when the load continues for an extended period, more fibers uncrimp, the ligament stiffens to resist the stretch, and energy is absorbed. This is referred to as creep. When this lengthening occurs slowly and the load does not exceed the ligament's ability, the ligament adapts to manage the load. On the other hand, swift and high-impact movements, as well as constant or repetitive tensile stress, reduces the ligament's ability to adapt to the load. If the tensile load exceeds the ligament's ability to resist, it can stretch to the point of failure—termed a sprain. In many cases, ligaments that are severely or repeatedly sprained never recover their full structural or functional strength; however, the joints they cross can recover full function if other structures affecting the joint are healthy.

If the tensile load that lengthens a ligament is constant or repetitive, the ligament may deform into a shape that is less effective for preventing movements that may cause injury. Likewise, if the position of a joint is repeatedly altered due to poor body mechanics or is constantly altered when tight muscles prevent the joint from maintaining an ideal posture, the ligament may deform to adapt to the postural deviation. As collagen regenerates, tension can be restored in the ligament if it is given enough time to recover. The greater the deformation, the longer it takes to recover. Constant or repetitive distortion can lead to ligament laxity, which puts the ligament at greater risk for sprain and increases the risk of injury to other structures crossing the joint.

Injury to a ligament often initiates an inflammatory response. Acute inflammation accompanies the healing process, and with rest, aids in restoring strength and proper functioning. Without sufficient rest and healing, however, inflammation can become chronic. Chronic inflammation can lead to atrophy, potentially weakening the ligament permanently. Scar tissue also forms during the healing process of a ligament injury. However, scar tissue has inferior

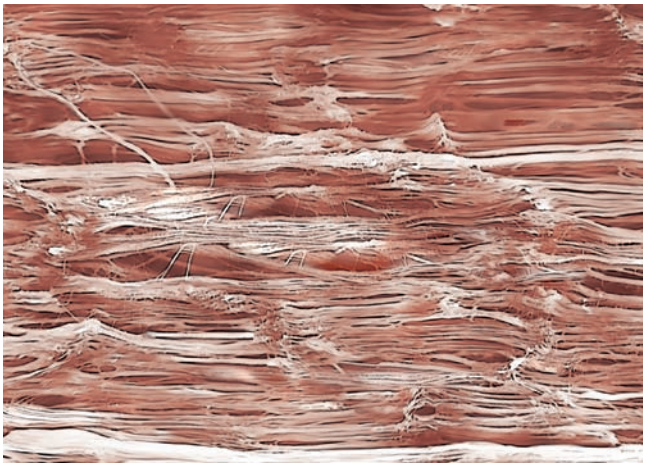


Figure 13-1 Ligament structure. Ligaments are made of dense collagen fibers arranged to manage multidirectional forces.

biomechanical function and stability compared to healthy ligaments. It deforms more easily under tensile stress and can bear only a fraction of the load that a healthy ligament can.

When a ligament is injured, neurological signals activate reflexive muscle activity to stabilize the joint. A reflexive contraction may develop on one side of the joint to compensate for the lost stability resulting from the ligament injury while reflexive inhibition may develop to keep opposing muscles from contracting intensely enough to pull the weakened joint out of place and further damage the ligament. For example, the radial collateral ligament of the wrist limits ulnar deviation. If it is sprained, the muscles that produce radial deviation (extensor carpi radialis longus and brevis and flexor carpi radialis) may contract while the muscles that produce ulnar deviation (extensor carpi ulnaris and flexor carpi ulnaris) may be inhibited to limit movements previously controlled by the now-injured ligament. In addition, muscles that do not cross the affected joint may also be activated or inhibited to improve stability indirectly.

Damage to a ligament also affects its mechanoreceptors and nerve endings, affecting proprioception, altering the client's perception of the normal position and function of the joint. During

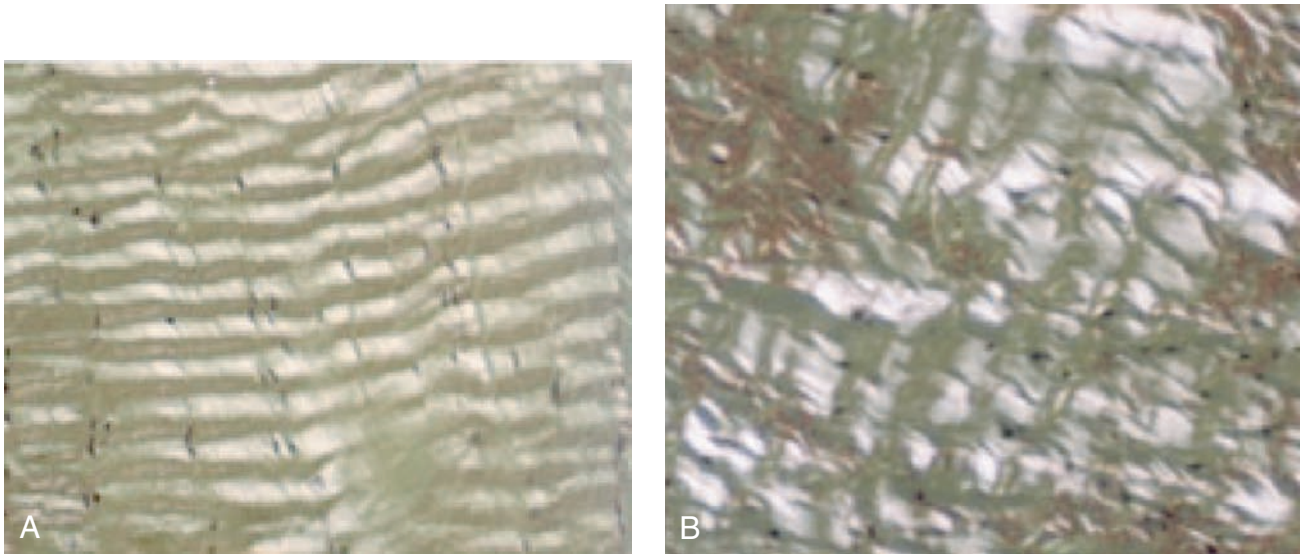


Figure 13-2 Crimped ligament fibers. (A) The collagen fibers in a healthy anterior cruciate ligament are crimped to allow lengthening without causing damage. **(B)** Once damaged, fibers with unhealthy crimps become more susceptible to tearing. From Murray MM. Effect of the intra-articular environment on healing of the ruptured anterior cruciate ligament. Journal of Bone & Joint Surgery. 2000;82-A:1390. Available at http://www.jbjs.org/Comments/c_p_murray.shtml.

the healing process, this compensation is essential to minimize the risk of re-injury. Once scar tissue has formed, collagen is regenerated, and the relative strength of the ligament is restored, rehabilitation must include restoring the normal resting tone of the muscles crossing the joint as well as normalizing proprioception.

Common Signs and Symptoms

Sprains can occur in any joint but occur most often in the ankles, knees, wrists, and fingers (Fig. 13-3). Overstretching may result in injury ranging from minor tears to a complete rupture of the ligament. Signs and symptoms differ depending on the grade (severity of the injury) and stage (duration of symptoms) of the sprain. In general, sprains produce local pain, stiffness, pain on passive stretch, and impaired ROM. Bruises and inflammation may be present in the acute and early subacute stages (Fig. 13-4). Table 13-1 outlines the common signs and symptoms for each grade and stage of ligament sprain.

Figure 13-3 Ligaments that cross the joints most commonly injured. It is essential to know the fiber direction of each of the ligaments that cross an injured joint in order to properly assess and treat the sprained ligament(s). Adapted from Clay JH, Pounds DM. *Basic Clinical Massage Therapy: Integrating Anatomy and Treatment,* 2nd ed. Philadelphia: Lippincott Williams & Wilkins, 2008.

Figure 13-4 Acute ankle sprain. Common signs of an acute sprain include inflammation and bruising.

Possible Causes and Contributing Factors

The most common cause of sprain is a swift, high-impact movement that stretches the ligament beyond its capacity. This often occurs in sports and other high-impact activities but may also occur when factors including systemic disorders, deconditioning, or repetitive actions weaken the ligament and destabilize the joint; in this situation, the ligament may sprain during common activities of daily living. Beginning a new activity following a period of inactivity without gradual reconditioning increases the risk of sprain. Similarly, sufficient warm-up prior to vigorous activity increases ROM and may help prevent sprain. Poor technique during new, intense, or repetitive activities increases the risk of sprain. Structures that are fatigued due to prolonged activity, improper warm-up, or poor technique may not be able to support the joint properly, thus, increasing the risk of sprain.

Once a sprain occurs, failing to allow sufficient time for healing in the early stages can slow or halt the natural healing process. When overstretching or small tears in the ligament results in scar tissue that is not strong enough to resist further tearing, the inflammatory process will continue, compromising the structure's integrity, and the risk of repeated injury increases. Similarly, continuing activity that encourages the inflammatory process may weaken the structure and cause compensating patterns to become habitual. Continuing aggravating activities once degeneration has begun may inhibit regeneration of collagen and continue to weaken the ligament.

However, immobility can also cause the ligament to degenerate and weaken, increasing the risk of injury with activity. Reduced loading can lead to rapid tissue degeneration. Sensible activity followed by rest strengthens the ligament, aids in collagen regeneration, and over time increases stability during more taxing activities. For this reason, it is important to ease into new activities after periods of inactivity to prevent injury and to ease into moderate activity as soon as possible following an injury to aid healing. While some rest or at least limiting of the aggravating activity is necessary to allow healing to begin, movement also keeps adhesions at bay and reduces ischemia.

Table 13-1 Grades and Stages of Ligament Sprains

Stage	Grade 1 or First Degree	Grade 2 or Second Degree	Grade 3 or Third Degree
	Mild sprain Minor stretch or tear	Moderate sprain Tearing of several to most fibers	Severe sprain Complete rupture of ligament or separation of ligament from bone
Acute (symptoms typically last 2-3 days following injury)	Joint remains stable Mild, localized discomfort with activity and at rest Minimal or no local edema Minimal or no bruising	Joint becomes slightly unstable Snapping sound or feeling when injured Moderate local edema Moderate bruising Moderate local tenderness Moderate pain with activity and at rest Moderate decrease in ROM Possible strain to muscles crossing the injured joint Possible protective muscle spasm crossing affected joint(s)	Joint is unstable Snapping sound or feeling when injured Severe pain at time of injury Difficulty or inability to continue activity ROM is impaired Considerable local edema Considerable red or purple bruising Possible hematoma, particularly if joint capsule is injured Possible strain to muscles crossing the injured joint Possible protective spasm in muscles crossing affected joint(s)
Subacute (symptoms typically remain from 2-4 weeks following the acute stage)	Joint is stable Minimal to no pain Scar developing at site of injury if tearing occurred Adhesions developing at and around site of injury Reduced ROM Possible trigger points in muscles crossing the affected joint	Joint is stable but may be hypermobile in the direction normally restricted by the injured ligament Pain improved since acute stage Bruising remains and may be changing color to yellow or green Scar developing at site of injury Reduced ROM Adhesions developing at and around the site of injury Protective muscle spasm may diminish and may be replaced by hypertonicity Possible trigger points in muscles crossing affected joint Impaired proprioception at the joint	Joint remains unstable and hypermobile in the direction normally restricted by the injured ligament Pain may have improved since the acute stage Bruising remains and may be changing color to yellow or green Adhesions developing at and around the site of injury Significant scarring if ligament was surgically repaired Reduced ROM Protective muscle spasm may continue or may diminish and may be replaced by hypertonicity Possible trigger points in muscles crossing the affected joint Impaired proprioception at the joint

(*continued*)

Table 13-1 Grades and Stages of Ligament Sprains (Continued)

Stage	Grade		
	Grade 1 or First Degree	**Grade 2 or Second Degree**	**Grade 3 or Third Degree**
Chronic (symptoms continue beyond the subacute stage)	Joint is stable Trigger points, scars, adhesions, and hypertonicity may still be present in compensating structures and surrounding tissues Discomfort when affected ligament is stretched Increased risk of re-injury if not properly treated Chronic edema if not properly treated Loss of proprioception at joint if not properly treated	Joint is stable Bruising has cleared Trigger points, scars, adhesions, and hypertonicity affect compensating structures and surrounding tissues Discomfort or pain when affected ligament is stretched Reduced ROM in affected joint Increased risk of re-injury if not properly treated Chronic edema if not properly treated Possible atrophy if not properly treated Loss of proprioception at joint if not properly treated	Joint may remain unstable if the ligament was not surgically repaired Bruising has cleared Atrophy may result if a joint has been immobilized Trigger points, scars, adhesions, and hypertonicity affect compensating structures and surrounding tissues Reduced ROM in affected joint Increased risk of overuse injury to compensating structures if affected ligament was not surgically repaired Chronic edema if not properly treated Loss of proprioception at joint if not properly treated

Insufficient rehabilitation following a sprain, as well as repeated sprain to the same ligament, reduces tension in the ligament and often leaves a joint unstable. Joint instability significantly increases the risk of injury. As the body ages, regeneration of collagen and elastin fibers slows. Once this occurs, ligaments are at greater risk for sprain, and it becomes increasingly less likely that full function of an injured ligament will be restored. Maintaining strong, healthy muscles increases joint stability and may reduce the risk of injury.

Being overweight as a result of pregnancy or weight gain increases demand on the musculoskeletal system during all activities and may increase the risk of spraining a ligament, particularly in weight-bearing joints. During pregnancy, women also produce higher levels of the hormone relaxin, which softens collagen and loosens the ligaments to allow the uterus and surrounding structures to adapt to the growing fetus and prepare for childbirth. This can cause systemic ligament laxity, increasing the risk for sprain. Similarly, fluctuations of estrogen and progesterone during the menstrual cycle may also affect the integrity of ligaments. Ligament laxity can also be a genetic condition, often associated with Marfan Syndrome, Stickler's Syndrome, and Ehlers-Danlos Syndrome. With these conditions, other organs and connective tissues may be affected. Consult your pathology book for contraindications and special considerations for clients with these conditions. Rheumatoid arthritis and osteoarthritis may also predispose a client to ligament injuries.

Sprains have fairly distinct signs and symptoms but can be confused with other conditions or may contribute to pain associated with another condition. For example, pain and swelling with minimally reduced ROM may result from a grade 1 sprain but can also be a symptom of tendinosis. Sprains can be confused with or can contribute to many of the conditions common to specific joints, such as carpal tunnel syndrome and patellofemoral syndrome. Neck pain, back pain, and low back pain can involve sprains to the ligaments that stabilize the vertebrae, which should be considered in treatment. A swift, high-impact movement that causes a sprain may also fracture a bone. If you suspect a fractured bone, refer the client for medical assessment before initiating treatment.

Table 13-2 Differentiating Conditions Commonly Confused with or Contributing to Ligament Sprains

Condition	Typical Signs and Symptoms	Testing	Massage Therapy
Muscle strain	Swelling, bruising, and local pain Reduced ROM Pain on active contraction or stretching of the affected muscle Weakness	Often self-assessed Physical exam	Massage is indicated. See Chapter 12.
Tendinopathy	Often has gradual onset Pain, tenderness, and swelling at affected tendon	Physical exam Localized pain on full passive stretch X-ray may be performed to rule out other conditions	Massage is indicated. See Chapter 14.
Avulsion fracture	Bone fragments at the attachment site of a tendon or ligament often accompany strains and sprains Moderate local pain Bruising and inflammation	X-ray	Local massage is contraindicated in the acute stage. Caution is used when treating surrounding tissues to avoid further injury. Massage may help to prevent further injury when muscle tension is a contributing factor.
Bursitis	Pain, particularly with activity or palpation Heat, redness, swelling, or tenderness local to the affected bursa	Physical exam ROM tests X-ray or MRI if conservative treatment is not successful	Massage is systemically contraindicated if bursitis is due to infection. Massage is locally contraindicated in the acute stage to avoid increased swelling. In the subacute stage, massage to the structures surrounding the joint is indicated.

It is important to understand the client's health history, precipitating events, and other possible causes of pain in the area before proceeding with treatment. Table 13-2 lists some general conditions commonly confused with or contributing to sprains. Consult your pathology book for more detailed information. If you are unsure and the client's symptoms resemble those of a more serious condition, particularly if the client has other risk factors, refer him or her to a health care provider for medical assessment.

Contraindications and Special Considerations

First, it is essential to understand the cause of pain. If the client is unable to move the joint, heard a popping sound, or has significant weakness, or if you suspect the client has a fractured bone or experienced significant tearing to the tissues, work with the client's health care provider, and consult a pathology text for massage therapists before proceeding. These are a few general cautions:

- **Hemarthrosis.** Significant swelling that occurs within the first 20 minutes of injury to a joint may indicate hemarthrosis—bleeding in the joint capsule (Fig. 13-5). Other signs may include burning or tingling in the joint and a feeling of fullness that may prevent movement

Figure 13-5 Acute hemarthrosis. Rapid, significant swelling following an injury may indicate hemarthrosis.

of the joint. The client should be referred to a medical professional for assessment and possible aspiration of the joint.

- **Bruises.** A bruise indicates damage to capillaries allowing blood to accumulate in surrounding tissue. Avoid direct pressure on a bruise that is still healing. As the capillaries heal and blood is resorbed, the color changes from red or purple to green or yellow. In some cases, severe bruising may result in a hematoma—a localized pooling of blood outside the vessels. In some cases, a sac-like enclosure forms around the pool of blood to minimize internal bleeding. A hematoma often resolves on its own, similarly to a simple bruise, but if it grows or hardens, it may require medical attention. Avoid direct pressure to a hematoma, and refer the client to a health care professional if the area becomes hard, if the client reports feeling pressure from the hematoma, or if it does not show signs of resolving over the course of a week or two.
- **Muscle testing.** Use only active ROM testing in the acute stage of a grade 2 or 3 sprain. The client usually limits active movements to the pain-free range. P ROM and R ROM testing may cause further injury.
- **Protective muscle splinting.** When a ligament is injured, the muscles that cross the affected joint may spasm reflexively in an attempt to limit the joint's movement to prevent further injury. Do not reduce protective muscle splinting in the acute stage of injury. Wait until the late subacute or chronic stage, when sufficient scarring and fiber regeneration reduce the need for protective splinting.
- **Re-injury.** Avoid ROM and traction techniques that stretch the injured ligament until the integrity of the structure is restored.
- **Treatment duration and pressure.** If the client is elderly, has degenerative disease, or has been diagnosed with a condition that diminishes activities of daily living, you may need to adjust your pressure as well as the treatment duration. Frequent half-hour sessions may suit the client better.
- **Friction.** Do not use deep frictions if the health of the underlying tissues is at risk for rupture. Allow time for scarring and fiber regeneration to avoid re-injury. Do not use friction if

the client is taking anti-inflammatory medication or anticoagulants. Friction creates an inflammatory process, which may interfere with the intended action of anti-inflammatory medication. Recommend that the client refrain from taking such medication for several hours prior to treatment if the health care provider is in agreement. Because anticoagulants reduce clotting, it is best to avoid techniques that may cause tearing and bleeding.

Massage Therapy Research

Several reports on the use of massage in the treatment of sprains were written in the late nineteenth and early twentieth century. While we have learned much more about the structure and function of ligaments since then, as well as about the benefits of massage, few studies investigating the specific effects of massage therapy on the healing of sprains have been conducted more recently. Several studies do report significant improvement of sprains treated with a combination of therapies including ultrasound, acupuncture, chiropractic manipulation, and massage techniques such as transverse friction. Because it is impossible to distinguish the specific value of massage techniques when combined therapies are used, these studies are not cited here.

In "A Theoretical Model for Treatment of Soft Tissue Injuries: Treatment of an Ankle Sprain in a College Tennis Player," Gemmell et al. (2005) present a case study exemplifying the potential benefits of manual therapy for the healing of sprains. The subject was a 21-year-old male tennis player with ankle pain for 6 weeks following an inversion sprain. Although the subject was able to walk pain-free after 6 weeks of cryotherapy, electrotherapy, and anti-inflammatory medication prescribed by the team physician, he was unable to perform activities such as running or jumping and could not return to tennis, reporting a pain level of 8 out of 10. When asked to indicate the area of pain, he pointed to the anterior aspect of the ankle and the lateral, distal lower leg. At the time of his initial visit with the study's authors, 6 weeks after the injury, the subject presented with mild swelling, no bruising or crepitus, limited dorsiflexion, and tenderness on palpation of the anterior talofibular and tibiofibular ligaments. The study's authors diagnosed a mild sprain with dysfunction of the anterior ankle ligaments and myofascial distortions in the peroneal muscles. Manual therapy consisted of firm stroking of the peroneal attachment sites and muscle stripping to the peroneal muscles to repair myofascial distortions. The subject played tennis for 2 days following treatment and returned with mild discomfort when jumping. The peroneals were treated once more, and 1 week later, the subject returned to competitive tennis. Nine months after treatment, the client reported no pain or dysfunction of the ankle.

WORKING WITH THE CLIENT

Client Assessment

While swift, high-impact movements often cause obvious, and often self-diagnosed, sprains, less obvious sprains can result from poor body mechanics and repetitive actions. For example, improper lifting, twisting, and obesity can affect the spinal ligaments and those that connect the spine to the pelvis and may contribute to low back pain. Consistently standing with the weight on one leg forces changes in the alignment of the leg, pelvis, and spine, increasing the risk of spraining ligaments that cross those joints. Assessing sprains with less obvious signs may require advanced training, although some clues may be present. Pain upon palpation along the length of a ligament or its attachment sites that is greater than tenderness in muscles around it may suggest a sprain. Localized pockets of inflammation may also suggest a sprain. In addition, unexplained spasm of muscles that cross a joint may be a protective mechanism for a sprained

ligament. The good news is that with these sorts of sprains, reducing muscle spasm and hypertonicity, releasing fascial restrictions and adhesions, and adjusting body mechanics can greatly encourage the ligament's natural healing process.

With readily recognizable sprains, assessment and treatment of the surrounding soft tissues is essential. When mild, grade 1 sprains contribute to the symptoms of another condition, the following treatment recommendations are meant to aid healing and reduce the risk of re-injury. Reducing adhesions and scar tissue, reorienting ligament fibers, lengthening shortened muscles, and strengthening weak muscles are the basic goals of treating sprains.

More serious grade 2 and 3 sprains require more focused attention. If you do not have the advanced training necessary to treat a complicated case or if symptoms in the subacute stage continue to significantly reduce activities of daily living, the client should be assessed by a health care provider and cleared for massage therapy prior to treatment. Swelling and bruising in the acute stage of a grade 2 sprain can be significant enough to contraindicate local treatment. Significant swelling that occurred within 20 minutes of the injury may indicate bleeding that poses a greater risk for hemarthrosis, hematoma, or injury to structures other than a ligament; this requires medical attention. An acute, grade 3 sprain requires medical attention. If surgical repair poses more risk than benefit, the ligament may be left severed, although in most cases the ligament is surgically repaired, and the client is prescribed physical therapy. Regardless of whether the ligament has been surgically repaired, you are most likely to see a client in subacute or chronic stage of a grade 3 sprain as part of a program to reduce pain, limitations in ROM, or compensating patterns that may have developed.

Because sprain can occur in any ligament, the following descriptions do not specify structures as in previous chapters. Refer to the previous chapters as needed to determine fiber direction, joints crossed, superficial versus deep structures, and so on.

Assessment begins during your first contact with a client. In some cases, this may be on the telephone when an appointment is requested. Ask in advance if the client is seeking treatment for specific area of pain so that you can prepare yourself.

Table 13-3 lists questions to ask the client when taking a health history.

POSTURAL ASSESSMENT

Allow the client to enter the room ahead of you while you assess his or her posture and movement. Look for imbalances in movement of the joint crossed by the affected ligament or patterns of compensation that may develop to protect the injured structures. If the lower body is affected, watch as the client walks or climbs steps. If the upper body is affected, watch as the client opens the door, takes off his or her coat or lifts a pen. If the thorax is affected, notice how the client moves the spine. Look for reduced mobility or a favoring of one side. Watch as the client sits, stands from sitting, lifts or sets down objects, turns to talk to you, and so on to see if he or she performs these activities without assistance or if he or she avoids bearing weight with the affected joint. The grade and stage of the sprain influence the level of imbalance and compensation.

When assessing standing posture, be sure that the client stands comfortably. If he or she deliberately attempts to stand in the anatomic position, you may not get an accurate assessment of his or her posture in daily life. When sprain affects the lower body, the client may stand in a position that keeps weight off the affected joint. When the upper body is affected, the client may hold the joint in a position that keeps the injured ligament from stretching. If the client has braced the injury with a removable device, ask him or her to remove it if it is possible to bear the weight without it so that you can get an accurate picture of the strength of the injured joint.

ROM ASSESSMENT

Test the ROM of the joint crossed by the sprained ligament. Only active ROM testing should be performed with a grade 2 or 3 sprain in the acute and early subacute stages to avoid further injury. In the chronic stage, the client may have developed compensating patterns, causing pain in other joints that should also be tested. Advanced training that includes more detailed instruction and precautions for ROM testing in the acute and early subacute stages is necessary.

Table 13-3 Health History

Questions for the Client	Importance for the Treatment Plan
Where do you feel symptoms?	The location of symptoms helps to identify the precise location of stretched or torn fibers and contributing factors.
Describe what your symptoms feel like.	A description of symptoms including weakness, heat, or fullness in the area may help you to determine the stage and degree of sprain and whether there may be more significant damage. See Chapter 1 for descriptions of pain sensations and possible contributing factors.
When did the symptoms begin?	The date of injury may help you to determine the stage of the injury and the health of the tissue.
What were you doing when you first felt the pain? Did you hear a snap or feel a twinge in the area at the time of injury?	In the absence of a clear incident of swift, forceful stretching of a ligament, the details of the activity or posture that initiated the pain may help you to determine its cause.
To what degree were you able to continue activity following the injury?	The level of activity following injury may help you to determine the degree of the sprain. Inability to continue activity suggests a grade 3 sprain and should be referred for medical assessment.
Did significant swelling occur within the first 20 minutes of injury?	Rapid swelling at the time of injury may indicate hemarthrosis or hematoma. The client should be referred for medical assessment.
Do you have a history of injury or surgery to this area?	An explanation of a prior injury to the area may help you to locate the sprain and determine contributing factors. Surgery and resulting scar tissue may increase the risk of sprain.
Do any movements make your symptoms worse or better?	Locate weakness in structures producing such movements. Lengthening of the affected ligament is likely to increase symptoms. Adding slack or reducing tension in the ligament may decrease symptoms.
Have you seen a health care provider for this condition? What was the diagnosis? What tests were performed?	Medical tests may reveal the degree of sprain, fractures, or coexisting injuries. If no tests were performed to make a diagnosis, use the tests described in this chapter for your assessment. If your assessment is inconsistent with a diagnosis, ask the client to discuss your findings with a health care provider or ask for permission to contact the provider directly.
Are you taking any prescribed or over-the-counter medications or herbal or other supplements?	Medication of all types may contribute to symptoms or involve contraindications or cautions.
Have you had a corticosteroid or analgesic injection in the past 2 weeks? Where?	Local massage is contraindicated. A history of repeated corticosteroid injections may affect the integrity of soft tissues increasing the risk of tearing or rupture. Use caution when applying pressure or cross-fiber strokes. Analgesics reduce sensation and may cause the client to allow you to work too aggressively.
Have you taken a pain reliever or muscle relaxant within the past 4 hours?	The client may not be able to judge your pressure and may allow you to work too aggressively.
Have you taken anti-inflammatory medication within the past 4 hours?	Deep friction initiates an inflammatory process and should not be performed if the client has recently taken anti-inflammatory medication.

Active ROM

Compare your assessment of the client's active ROM in the affected joints to the values listed in the Average ROM boxes in Chapters 4-11. Pain and other symptoms may not be reproduced during active ROM assessment because the client may limit movement to a symptom-free range. Protective muscle spasm may reduce ROM in the direction that would stretch the ligament.

- **Active ROM of the affected joint** will be limited, particularly in the direction that stretches the injured ligament. Limitations are more significant with more severe grades of sprain and diminish as the stages of injury progress from acute to chronic. A grade 1 or 2 sprain in the acute stage may be limited by discomfort upon stretching of the affected ligament; grade 3 sprains produce severe pain and little to no movement of the affected joint(s), due in part to swelling and protective muscle spasm.

Passive ROM

P ROM should not be performed in the acute or early subacute stages of a grade 2 or 3 sprain to avoid further injury. In the late subacute or chronic stage, perform P ROM slowly to pinpoint which ligament is injured. Note and compare the end feel for each range (see Chapter 1 for an explanation of end feel). Compare the client's P ROM on one side to the other when applicable.

- **P ROM of the affected joint** in the acute stage of a grade 1 sprain may be slightly limited and may cause pain when movement lengthens the affected ligament. Results may be similar in the subacute and chronic stages for all grades of sprain with varying degrees of limitation and pain depending on the stage of healing. ROM testing following a grade 3 sprain that was not surgically repaired is intended to assess whether the muscles crossing the joint are strong enough to stabilize it and whether persistent muscle spasm restricts mobility.

Resisted ROM

R ROM should not be performed in the acute or early subacute stages of a grade 2 or 3 sprain to avoid further injury. Use resisted tests to determine if muscles crossing the affected joint were also strained and to assess the strength of the muscles that cross the affected joint for a grade 1 sprain, and in the late subacute or chronic stages of grade 2 or 3 sprains. Compare the strength of the affected side to the unaffected side when possible.

- **R ROM of the affected joint(s)** with a grade 1 sprain in all stages and with a grade 2 or 3 sprain in the subacute and chronic stages may be limited because of pain if the muscles were also injured. R ROM should be applied with a gradual increase in resistance to avoid further injury while assessing muscle strength. ROM is limited by reduced strength and pain at the site(s) of injury to the muscle. If protective muscle spasm persists into the subacute and chronic stages of sprain, ROM may be limited because of pain on contraction of the muscle(s) in spasm or of their weakened antagonists.

SPECIAL TESTS

A swift, high-impact movement causing a ligament sprain may also injure the muscles crossing the affected joint. In the subacute and chronic stage of the sprain, use ROM testing to assess the strength and length of muscles that may have been strained. In addition, protective muscle spasm may occur to help stabilize the injured joint. Once protective muscle spasm is no longer necessary, treating muscles that cross the injured joint and those that compensate for joint instability is essential for recovery. Refer to Chapter 12 for a more detailed description of testing and treating muscle strains and to Chapter 1 for a more detailed description of end feel.

A ligamentous stress test is used in the late subacute and chronic stages of sprains to determine which ligament crossing the injured joint is sprained and the grade of the sprain. Because the ligamentous stress test involves applying overpressure at the end of the ROM that stretches the ligament, it is not used in the acute stage to avoid further injury before natural healing has begun to strengthen the affected structures.

Ligamentous stress test (Fig. 13-6):

1. Passively move the joint in the direction that stretches the ligament. To determine which ligament(s) is sprained, it is necessary to know the attachment sites of each ligament crossing the joint in order to move the joint in the precise direction that stretches each ligament.

Figure 13-6 Ligamentous stress test. Determine which ligament crossing an injured joint may be sprained.

2. In the late subacute or chronic stage of sprain, carefully apply slight overpressure at the end of the ROM to minimally stress the ligament without causing further injury or undue pain.
3. A grade 1 sprain will produce local pain specific to the injured ligament with overpressure. There is a soft capsular end feel with no joint laxity. A grade 2 sprain will produce significant local pain specific to the injured ligament with overpressure. There is a loose ligamentous end feel with possible joint laxity. Because a grade 3 sprain is the complete rupture of a ligament, ROM will not stretch the injured ligament, and any pain produced with overpressure is not specific to the injured ligament. Pain produced with ROM of a known grade 3 sprain may indicate a lesser grade sprain to another ligament, a muscle strain, or a tendinopathy, or it may occur if the client contracts opposing muscles to prevent further ROM. The end feel is empty with joint laxity.

PALPATION ASSESSMENT

Avoid direct pressure on a fresh bruise or an edematous area in the acute stage. In the acute stage, when the inflammatory process is active, the area may be red and hot, and the texture of the edematous area may be dense or hard as if the area is too full and stretching the skin. When the inflammatory process diminishes, the edematous area may feel softer and less dense. In the chronic stage, the edematous area may feel boggy or gelatinous, and the area may feel cool due to ischemia. Swelling that persists and continues to feel dense or hard beyond the acute stage may indicate a hematoma. Refer the client to a health care provider for medical assessment.

The site of injury may be tender to the touch in all stages, although the amount of pressure needed to elicit a response differs according to the grade of sprain and increases as the injury progresses into later stages. Tenderness diminishes as the injury heals. Although most ligaments are very deep, you may be able to feel a gap in the affected fibers, particularly with a grade 2 or 3 sprain. The gap will fill in as scar tissue forms and collagen regenerates. If a grade 3 sprain was not surgically repaired, the gap will remain. As time passes, scar tissue that forms to stabilize the

affected structures will become thicker, denser, and possibly fibrous. Adhesions may develop, reducing mobility between the ligament and surrounding tissues. If not properly treated, scarring, adhesions, and remaining edema may reduce local circulation, resulting in ischemia, which may feel cool to the touch. When assessing muscle tone, you may find protective spasms in the muscles crossing the affected joint in the acute and early subacute stages. This protective spasm occurs to keep the joint from moving to a point that may cause further injury. Do not reduce protective spasms in the early stages. As healing progresses, the spasm may cease naturally, but the muscles may remain hypertonic. Trigger points may develop in any of the compensating soft tissues. If the severity of the injury prevents movement of the joint or if the injury was not treated well enough to restore ROM, you may find atrophy in the affected muscles.

To effectively treat a sprain, you must locate the precise site of injury and know the direction of the fibers of the affected ligament. Take your time palpating the location. Once you have identified the affected ligament(s) with ROM testing, palpate them slowly, covering approximately 1 inch of tissue over 5-10 seconds. Stay focused, and allow the receptors in your fingers to transmit important information. Feel for gaps, scars, or other anomalies in texture, tone, temperature, and tenderness.

Condition-Specific Massage

The remainder of this chapter focuses on grade 1 sprains in all stages and grade 2 and 3 sprains in the late subacute and chronic stages. While massage therapy may be beneficial for grade 2 sprains in earlier stages, because of the potential for contraindications and complications, advanced training is needed. An acute grade 3 sprain requires medical attention. In the later stages of healing following a grade 3 sprain that was not surgically repaired, focus on releasing restrictive adhesions, hypertonicity, and trigger points to compensating structures, and restoring ROM and strength in the affected joint(s). If the ligament was surgically repaired and is accessible, releasing restrictive adhesions and realigning scar tissue are an integral part of restoring ROM and strength. For sprains to ligaments that are inaccessible manually, such as the cruciate ligaments of the knee, focus on the surrounding structures with the goal of restoring ROM, strength, and stability.

The treatment goals and techniques are the same for grade 1 sprains in all stages and grade 2 or 3 sprains in the late subacute and chronic stages, but the intensity of treatment should be adjusted according to the severity of injury. For example, a grade 1 chronic sprain resulting in minor scarring and dysfunction does not present as significant a risk of re-injury during a stretch as a grade 2 sprain with moderate scarring or a surgically repaired grade 3 sprain with severe scarring. A grade 3 sprain is likely to have developed much more extensive protective muscle spasms and adhesions than lower grade sprains, and it will require more warming of superficial tissues and a slower pace when approaching the deeper tissues than lower grade sprains require. You are more likely to be able to focus directly on the injured ligament in the earlier stages of a grade 1 sprain, while a grade 2 sprain requires more attention to the compensating and surrounding structures before addressing the torn fibers directly.

In general, it is best to wait at least 24–48 hours after a grade 1 or 2 sprain before beginning treatment to allow the natural healing process to set in. Following this period, the extent of treatment depends on the severity of the sprain. A grade 1 sprain can be treated with manual therapy directly following the waiting period. For a grade 2 sprain, the focus for the initial treatment is short sessions focused on gentle mobilization, particularly if swelling persists and the tissues are tender to the touch. As the ligament heals and the client is better able to tolerate pressure, longer and more focused treatment including friction is indicated. Massage for a grade 3 sprain is best applied in the subacute stage under the supervision of a health care provider, or in the chronic stage when the joint has stabilized, and can be of a longer duration.

It is essential for treatment to be relaxing. You may not be able to eliminate the symptoms associated with a ligament sprain or any coexisting conditions in a single treatment. Do not attempt to do so by treating aggressively. Be sure to ask your client to let you know if the amount of pressure that you are applying keeps him or her from relaxing. If the client responds by tensing

muscles or has a facial expression that looks distressed, reduce your pressure. Remember that you are working on tissue that is compromised. Ask the client to let you know if any part of your treatment reproduces symptoms, and always work within his or her tolerance.

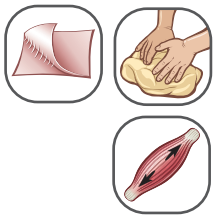
The following are suggestions for treating pain, weakness, and limited ROM caused by the overstretching or tearing of a ligament. These suggestions are generalized for any ligament affected by sprain. Refer to Chapters 4–11 for resources pertaining to specific muscles crossing the affected joint.

- Positioning and bolstering depends on the structures being treated. The affected joint should rest comfortably in a position that prevents overstretching of the injured ligament.

- If you find local inflammation, bolster the area when possible to allow gravity to draw fluid toward the nearest lymph nodes, and apply superficial draining strokes. If necessary, apply ice to the area for just a few minutes to reduce swelling, taking care not to chill the surrounding tissues that are hypertonic or in spasm.

- If local swelling is minor or absent and bruises have sufficiently faded, apply brief, moist heat to the affected ligament to soften scar tissue and adhesions and to increase circulation. If protective muscle spasm is no longer beneficial to prevent re-injury, apply moist heat to hypertonic, compensating muscles.

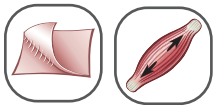
- Use your initial warming strokes to increase superficial circulation, soften tissues, and assess the tissues broadly surrounding the site of injury and compensating for the injured joint. You should be able to initially assess for adhesions, hypertonicity, protective muscle spasm, and tensile stress, which will help you to determine how to focus your time.



- Based on your findings, treat compensating muscles proximal to the site of injury for myofascial restrictions, adhesions, shortening, and hypertonicity.

- Assess for and treat trigger points that may have developed in compensating structures during the protective phase of healing and those that refer to the general area of injury.

- Assess and treat fascial restrictions surrounding the injured ligament.



- Using focused palpation, locate the precise site of the sprain and, if possible, the direction of tearing. Using short, slow strokes within the client's pain tolerance, apply cross-fiber friction to reduce adhesions and scar tissue at the site of injury. Follow this with longitudinal strokes to realign the developing scar tissue in the functional direction. Alternate rounds of cross-fiber and longitudinal strokes until you feel a change in texture.
- Apply pain-free ROM techniques that gently stretch the ligament to further encourage re-alignment of the fibers. While it is important to use techniques that gently stress the ligament by increasing the distance between its attachments, take care not to overstretch the ligament to avoid re-injury.
- If the area became hot or began to swell while applying friction, apply ice for just a few minutes to reduce heat and swelling without overly chilling the area.

Treatment icons: Increase circulation; Reduce adhesions; Reduce tension; Lengthen tissue; Treat trigger points; Passive stretch; Clear area

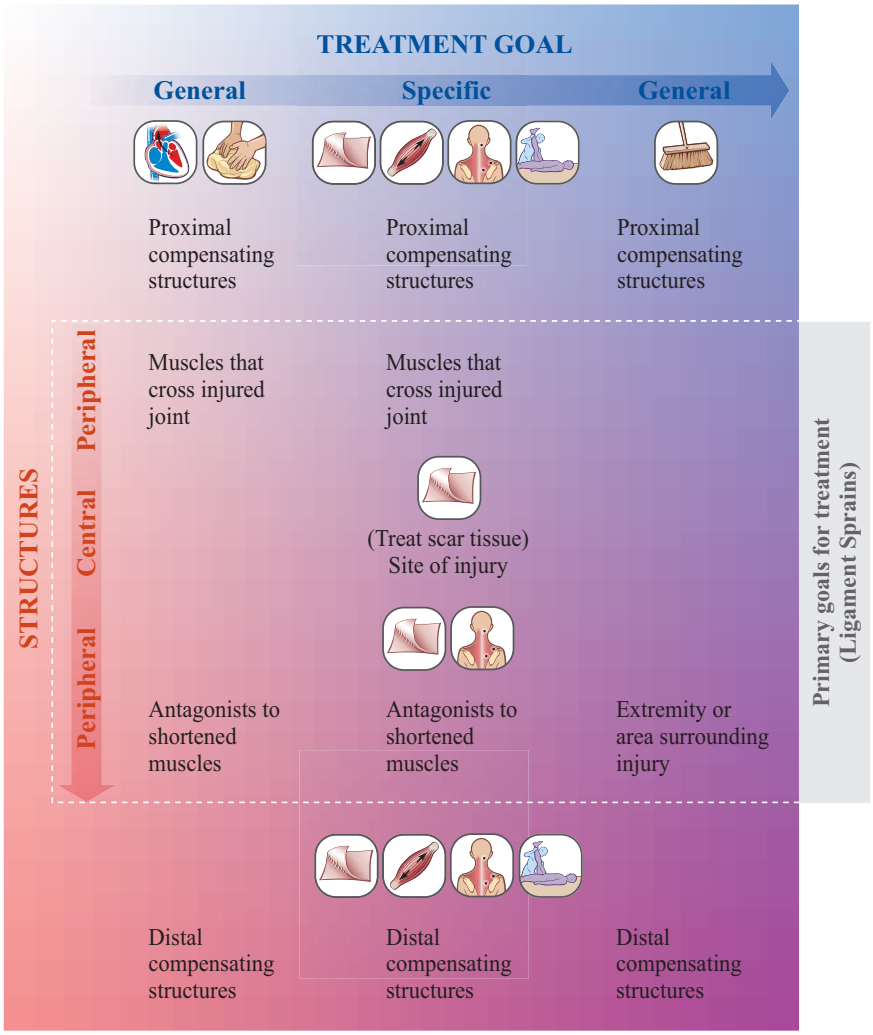
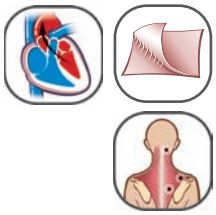


Figure 13-7 **Ligament sprains overview diagram.** Follow the general principles from left to right or top to bottom when treating ligament sprains.



- Treat tissues distal to the injury for compensating patterns, if needed, and to increase circulation.

- Passively stretch or perform PIR to local, compensating muscles within the client's tolerance as necessary. This may require repositioning the client.

The treatment overview diagram summarizes the flow of treatment (Fig. 13-7).

CLIENT SELF-CARE

Avoiding re-injury is a primary concern when recommending self-care. For clients with a grade 1 sprain in any stage, or a grade 2 or 3 sprain in the late subacute or chronic stage, the following suggestions may encourage proper healing.

These suggestions are intended as general recommendations for stretching and strengthening structures involved in the client's condition. The objective is to create distance between the attachment sites of muscles that have shortened and to perform repetitions of movements that decrease the distance between the attachments of muscles that have weakened. If you have had no training in remedial exercises and do not feel that you have a functional understanding of stretching and strengthening, refer the client to a professional with training in this area.

- Instruct the client to perform self-care throughout the day, such as while talking on the phone, reading e-mail, washing dishes, or watching television if this can be accomplished without stressing the injured ligament or compensating structures. This minimizes the need to set aside extra time.
- Encourage the client to take regular breaks from stationary postures or repetitive actions that may affect the health of a ligament or the joint it crosses. If the client's daily activities include hours of inactivity, suggest moving for a few minutes every hour to prevent adhesions and reduced circulation. If the client's daily activities require repetitive actions that contribute to sprains or compensating patterns resulting from sprains, suggest resting for a few minutes every hour.
- Demonstrate gentle self-massage of the tissues surrounding the injury to keep adhesions and hypertonicity at bay between treatments.
- Demonstrate all strengthening exercises and stretches to your client and have him or her perform these in your presence before leaving to ensure that he or she is performing them properly and will not cause harm when practicing alone. In all stages of a sprain in any degree, it is essential not to stretch the joint to the extent that the injured ligament is overstretched or re-injured. In the chronic stage or when appropriate for a healing sprain, stretches should be held for 15–30 seconds and performed frequently throughout the day within the client's limits. The client should not force the stretch or bounce. Stretching should be slow, gentle, and steady, trying to keep every other joint as relaxed as possible.
- Stretching and strengthening exercises should be recommended according to your findings in ROM testing and palpation.

Stretching

Depending on the severity of the injury, early mobilization and moderate, controlled stress to an injured ligament may aid the healing process. Mobilization increases circulation to the area, reduces adhesions, and helps to restore normal proprioception when performed within the client's tolerance. When possible, moving the injured joint to produce the shapes of the letters of the alphabet may help to restore and maintain mobility. Instruct the client to draw small letters, and to draw only as many letters as possible without feeling pain or excessive fatigue, taking care not to fully stretch the injured ligament. In the later stages of healing, recommend increasing the ROM by drawing bigger letters so that controlled but pain-free stress is placed on the joint.

Because muscles crossing the injured joint may also have been injured or may have responded to protect the joint, it is important to recommend self-care to aid in healing. For strained muscles, refer to Chapter 12. Muscles that have shortened to maintain stability in the joint may need stretching once their protective splinting is no longer necessary. The results of ROM testing and palpation will help you to determine which muscles have shortened and need to be stretched. Refer to Chapters 4–11 for stretches to specific muscles or groups of muscles. Take care to instruct the client to stretch slowly and to limit stretches to the comfortable range, gradually increasing the stretch as symptoms diminish and the risk of re-injury is reduced.

Strengthening

Strengthening weakened or atrophied muscles is equally important for restoring proper function of the affected joint. The results of ROM testing and palpation determine which muscles have weakened and need to be strengthened. In general, active or resisted concentric contractions strengthen muscles. As with stretching, a strengthening program should progress gradually. Pain-free, active ROM is effective for gradually restoring strength to weakened muscles. As healing progresses and the risk of re-injury diminishes, add resistance to active ROM by including weight-bearing activities. Refer to Chapters 4–11 for exercises to strengthen specific muscles or muscle groups.

SUGGESTIONS FOR FURTHER TREATMENT

In the acute stage, shorter treatments focused on reducing inflammation and increasing mobility are recommended until inflammation is minimal and the client can tolerate manual pressure to the tissues. A grade 1 sprain often heals in approximately 1 week, and treatments can be scheduled twice per week until symptoms subside. Grade 2 sprains can heal in as little as 2 weeks, but could take up to 6 weeks to heal well enough to return to activity without symptoms. Treatments can be scheduled twice per week until mobility and strength are restored, and weekly after that until compensating patterns are resolved. Grade 3 sprains, depending on whether the ligament is surgically repaired, may take up to 2 months to heal sufficiently to perform normal activities of daily living without symptoms. Depending on the progress of healing and complications, you may want to discuss the injury with the client's health care provider before initiating treatment. With proper clearance, treatments can be scheduled twice per week until mobility and strength are restored, and weekly after that until compensating patterns resolve.

There should be some improvement with each session. If this is not happening, consider the following possibilities:

- There is too much time between treatments. It is always best to give the newly treated tissues 24–48 hours to adapt, but if too much time passes between treatments in the beginning, the client's activities of daily living may reverse any progress.
- The client is not adjusting activities of daily living or is not keeping up with self-care. As much as we want to fix the problem, we cannot force a client to make the adjustments we suggest. Explain the importance of his or her participation in the healing process, and encourage the client to follow your recommendations, but be careful not to judge or reprimand a client who does not.
- The condition is advanced or has other musculoskeletal complications that are beyond your basic training. Refer this client to a massage therapist with advanced training. Continuing to treat a client whose case is beyond your training could turn the client away from massage therapy altogether and hinder healing.
- The client has an undiagnosed, underlying condition. Discontinue treatment until the client sees a health care provider for medical assessment.

If you are not treating the client in a clinical setting or private practice, you may not be able to take this client through the full program of healing. Still, if you can bring some relief in just one treatment, it may encourage the client to discuss this change with a health care provider and seek manual therapy rather than more aggressive treatment options. If the client agrees to return for regular treatments, the symptoms are likely to change each time, so it is important to perform an assessment before each session. Once you have released the superficial tissues in general areas, you may be able to focus more of your treatment on deeper tissues in a specific area. Likewise, once you have treated symptoms specific to sprains, you may be able to pay closer attention to compensating structures and coexisting conditions.

PROFESSIONAL GROWTH

CASE STUDY

Adila is a 39-year-old mother of three. She has sprained her left ankle three times, each time toward the end of the second trimester of her three pregnancies. The last sprain was about 1 year ago. Since the first sprain, she has always been very protective of the ankle because she is worried that it is weak. After each of the three sprains, she was able to use the ankle without symptoms within a few days of twisting it, and until recently, she has had no limitations in mobility and no pain. Approximately 1 month ago, she began to feel pain in the ankle and lower leg when she walks long distances and when she climbs stairs, particularly when carrying a child, laundry, or other heavy load. Fearing the ankle would sprain again, she has been using a brace for

stability. This decreases the level of pain in the ankle, but she continues feeling pain in the leg, creeping up toward the knee. She has also been feeling some discomfort in her lower back recently.

Subjective

When asked, Adila explained that there was minimal swelling and bruising each time she sprained the ankle. She used ice each time, and after resting for a day, she continued activity with the ankle braced. She did not seek medical attention because she read on the Internet that if she was able to bear weight, had minimal swelling, and noticed improvement 48 hours after injury, there was little chance of a broken bone, and the sprain would probably heal on its own. She explained that she had gained more weight with her last pregnancy and has been unable to lose it as easily as with the first two. She described herself as being 20 pounds heavier than her normal weight. When asked, she described the pain she feels as a tightness that begins to fatigue after walking for about 5–10 minutes and when climbing up the stairs.

Objective

Adila is not limping. When standing still, she carries her body weight on the right leg. The left hip is slightly more laterally rotated compared to the right. The right hip is slightly elevated. She has slight hyperlordosis. The ankle is slightly everted and dorsiflexed when not bearing weight. There is no hypermobility in the ankle. Active inversion and plantar flexion are reduced compared to the right ankle. Passive inversion is restricted without pain, and passive inversion and plantar flexion produced an "uncomfortable stretching feeling" along the anterior leg. Resisted inversion is weak. There is a small pocket of edema just anterior to the left lateral malleolus with minor, superficial adhesions along the inferior extensor retinaculum and significant adhesions with dense scar tissue along the anterior talofibular ligament. This area is tender to the touch. I found nothing remarkable along the calcaneofibular ligament. Tissues of the left anterior and lateral leg are dense and adhered. The iliotibial band is dense and adhered.

Action

The primary treatment goals include reducing adhesions along the anterior talofibular ligament and anterior lateral leg and reducing adhesions and lengthening the peroneus longus, peroneus brevis, and extensor digitorum longus. Future goals include reducing adhesions and density in the iliotibial band, reducing hyperlordosis, and leveling the pelvis.

I elevated the left leg to initiate drainage of the edema. I applied superficial strokes toward the lymph nodes at the ankle and knee to continue draining. I used general Swedish massage on the thighs and right leg while drainage continued. The pocket of edema reduced sufficiently to allow more specific palpation and treatment of the area. I applied myofascial release to the left anterior lateral leg and ankle. I used superficial and deep kneading to the full left leg with a focus on reducing adhesions along the anterior lateral leg. I used muscle stripping to the peroneus longus, peroneus brevis, and extensor digitorum longus. I applied deep transverse friction to the anterior talofibular ligament followed by longitudinal strokes to reduce adhesions and scar tissue and to realign ligament fibers. I applied gentle mobilization of the left ankle with a focus on placing tensile stress on the anterior talofibular ligament. Each mobilization ended with inversion and plantar flexion of the ankle. Very localized heat and minor swelling developed along the ligament. I applied ice for approximately 5 minutes, followed by a minimal, general mobilization of the ankle.

I began releasing the superficial tissues of the left thigh, bilateral gluteals, and low back. The thoracolumbar fascia is dense and adhered. The right sacroiliac joint is less mobile than the left. The right quadratus lumborum is dense with a possible trigger point. I will return to these areas as time permits in subsequent visits. I will also assess the iliopsoas.

Plan

I recommended self-care beginning with drawing the alphabet with her ankle. I instructed Adila to begin slowly, within her pain tolerance, and to only draw as many letters as she can before the leg feels weak or fatigued. After drawing the alphabet, I instructed her to walk around for approximately 1 minute, and then stretch the lateral leg by inverting the ankle within her tolerance, using external surfaces if necessary to feel a stretch along the lateral leg and ankle. As symptoms improve, I suggested she consider adding jumping exercises and activities that include criss-cross steps to continue strengthening the ankle and to restore proper proprioception. Adila rescheduled 4 days out to reassess the leg and continue with treatment if necessary and to assess the hips and low back and treat as necessary.

CRITICAL THINKING EXERCISES

1. Choose two joints and describe which muscles may be reflexively activated or inhibited if a ligament providing stability to that joint is injured. Remember that muscles that cross the joint may have a direct effect while muscles that do not cross the joint may have an indirect effect. Describe how reflexive activity in these muscles may protect the affected joint.
2. Your client started feeling pain in her wrist, particularly when she works at her computer. She believes she has carpal tunnel syndrome, but she has no tingling in her fingers and your tests are negative for carpal tunnel. She mentions that she fell off her bicycle about a year ago and hurt her wrist, but she did not have it evaluated at the time. Discuss the possible injuries that may have occurred when she fell that may mimic symptoms of carpal tunnel syndrome a year later. In what direction may the impact have bent the wrist? Which soft tissue structures may have been stressed? Is there a ligament sprain in the wrist that, if untreated, may produce symptoms in the chronic stage that resembles carpal tunnel syndrome? How will you treat this client?
3. Your client had a grade 3 complete rupture of the anterior cruciate ligament during a skiing accident 6 months ago. He opted not to have the ligament surgically repaired but had six sessions of physical therapy following the injury to restore ROM. He is able to walk without limping and has no pain in the knee but has been experiencing low back pain and pain along the spine. Describe how the injury may contribute to his current dysfunctions. Would compensating patterns contribute to back pain? Which muscles or other structures may have been affected during the healing process? There are many possibilities here, so take your time thinking about it, and be creative.
4. Discuss which ligaments might be affected in clients with the following chronic conditions:
   - Hyperkyphosis
   - Hyperlordosis
   - Plantar fasciitis
   - Piriformis syndrome
   - Patellofemoral syndrome
   - Tension headaches
5. Conduct a short literature review to learn about the relationship between chronic sprains and the following:
   - Age
   - Rheumatoid arthritis
   - Osteoarthritis
   - Generalized ligament laxity
   - Thyroid dysfunction
   - Down or Asperger Syndrome

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CHAPTER 14

Tendinopathy

UNDERSTANDING TENDINOPATHY

In the past, research into musculoskeletal pain and injury often considered the muscle and tendon as one mechanism. In recent years, the tendon itself has been studied in more clinical detail, revealing remarkable details about its composition, function, and role in injury. Because of this, many previously held beliefs about tendon injuries have been revised, and new research continues to reevaluate our understanding of tendons. Knowledge of the mechanisms of tendon failure and the pain originating from injured tendons continues to become more specific and refined. The term "tendinopathy" refers generally to pathology that affects a tendon. This chapter covers three common tendinopathies: tendinosis, tendinitis, and tenosynovitis. These tendinopathies have several similar qualities. The treatments for each are also similar. They vary in underlying causes, however, so while the treatment for each may be similar, the treatment goal for each differs. In all three cases, an untreated tendinopathy increases the risk for rupture of the tendon. Understanding the form and function of tendons helps one differentiate these conditions and their treatment.

Muscle fibers contract to produce the force that moves a joint. That force is transmitted to the bones by tendons. Tendons are tough structures made largely of collagen and protein that are less flexible and less elastic than muscles but have tensile strength comparable to that of bones. The structure and composition of the body's many tendons differ slightly according to their particular function. These differences also play a role in the risk of injury and the process of repair. Tendons under high functional demand, such as the superior tendon of the long head of the biceps brachii, have a higher level of collagen remodeling than those that are under lower demand, such as the inferior tendon of the biceps brachii.

In general, collagen fibers in tendons are densely packed and arranged longitudinally, parallel to each other and parallel to the forces commonly applied to them. This arrangement reinforces their resistance to tensile stress. These collagen fibers are bundled into fascicles (Fig. 14-1). Each fascicle is wrapped in connective tissue called the endotenon, which also wraps around groups of fascicles forming the tendon. Vessels and nerves that supply the tendon are found mainly in the endotenon. Endotenons are wrapped in a layer of continuous, loose connective tissue called the peritenon. Tendons that work together, such as the wrist flexors, may be wrapped in an additional layer called the epitenon. Tendons that bend around joints or pass beneath a retinaculum are subject to greater amounts of friction. These tendons are each encased in a sleeve-like synovial sheath called the tenosynovium (Fig. 14-2). These sheaths contain synovial fluid that lubricates the tendons, allowing them to glide freely and protecting the tendon itself from friction. Between the tendon and its synovial sheath is a fatty connective tissue matrix called the paratenon.

In a relaxed tendon, the parallel collagen fibers are slightly crimped (Fig. 14-3). This structure, like a spring, provides shock absorption during activity. When a muscle contracts, its tendon lengthens before shortening. As tensile stress is applied, these crimps flatten, allowing the tendon

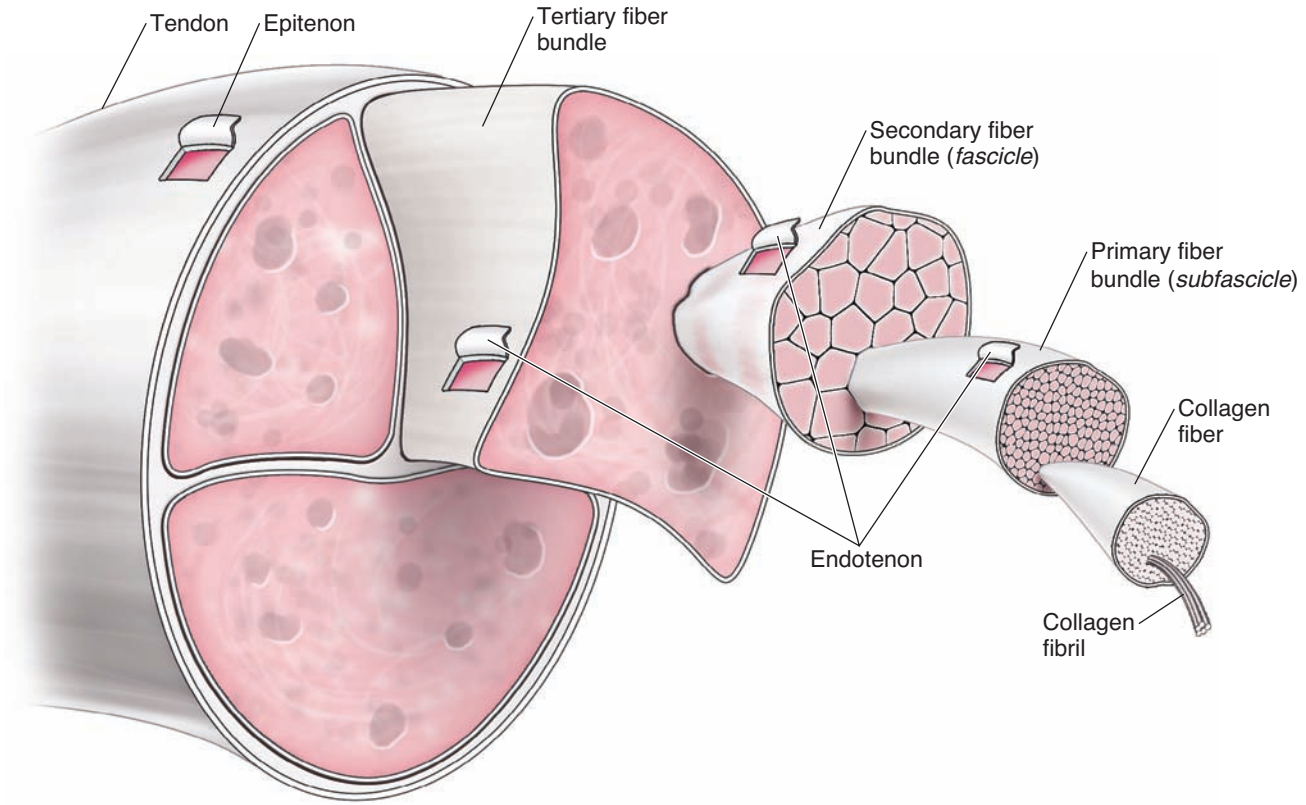


Figure 14-1 Tendon structure. Tendons are made of dense, parallel collagen fibers wrapped in layers of connective tissue.

to lengthen slightly while making it stiffer and resistant to further lengthening. This protects both the tendon and its muscle from overstretching and strain. The breaking point (when fibers tear under tensile stress) is reached when tension increases the length of a tendon by approximately 8%. Golgi tendon organs—proprioceptors found at the musculotendinous junction—detect muscle tension during a contraction. When healthy muscles contract in a controlled manner, a reflex response initiated by the Golgi tendon organs relaxes the muscle when the

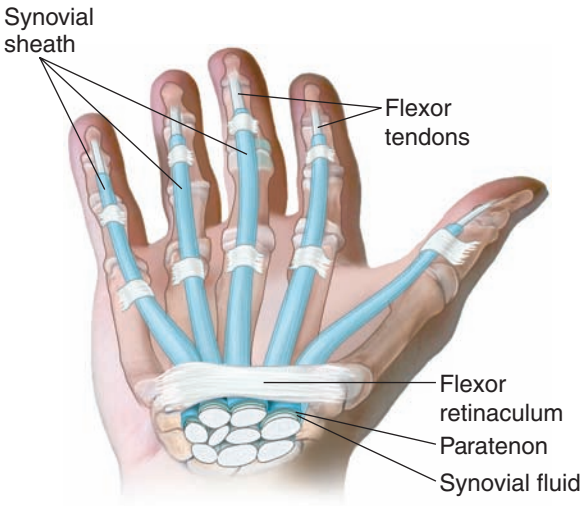


Figure 14-2 Tenosynovium. Tendons subject to great amounts of friction are encased in sleeve-like synovial sheaths called tenosynovium.

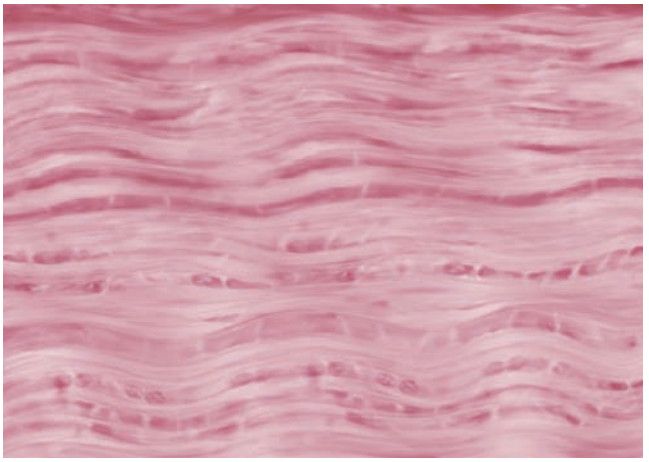


Figure 14-3 Crimped tendon fibers. The parallel collagen fibers of tendons are slightly crimped when relaxed, providing shock absorption during activity. Adapted from http://www.sacs.ucsf.edu/home/cooper/Anat118/ConnTiss/conntiss2.htm

amount of tension approaches the point of failure. When the muscle, tendon, or proprioceptors that detect tension are not healthy, or when a contraction occurs too quickly or forcefully for the reflex response to protect the musculotendinous unit, overloading can occur. Because the tendon is so much stronger than muscle, when tearing does occur, it usually occurs in the muscle belly or the musculotendinous junction or the tendon detaches from the bone. Although rare, tearing of the tendon fibers does occur. These tears, the underlying cause of tendinitis, are also called strains, as described in Chapter 12.

Like a spring, as the tendon lengthens and stiffens, it also stores energy. At the end of a ROM, the tendon recoils, releasing energy and generating a greater force for movement, which reduces the energy expenditure required by the muscle. Similar to a rubber band, the size and shape of a tendon influences the amount of stretch and the amount of energy released in recoil. A long, thin tendon stretches further, requires less force from its muscle to stiffen, and accumulates more energy for release on recoil to produce broad movement. This is ideal for muscles that primarily propel the body and that fatigue quickly as well as those that control fine motor skills. A short, flat tendon stretches less, requires more force by the muscle to stiffen, and accumulates less energy to be released on recoil, producing strong but more subtle movement. This is ideal for muscles that maintain posture and that fatigue slowly and for tendons that assist in stabilizing joints.

Painful conditions involving a tendon are often referred to as tendinitis. Tendinitis is the inflammation of a tendon, usually resulting from acute injury or chronic overuse that results in small tears in tendon fibers and interrupts the already limited blood supply (Fig. 14-4, *A*). The treatment goal for tendinitis is to reduce inflammation, reduce adhesions and scar tissue, and realign fibers. Rest is often recommended in the early stage to allow the fibers to begin healing naturally. Treatment involves transverse strokes to reduce adhesions and scar tissue and to increase circulation that supplies nutrients as well as longitudinal strokes and stretching to realign the torn fibers and encourage collagen repair. However, current studies assessing cellular changes to injured tendons have shown that inflammation—the response to tearing and repair—is not as frequently involved in tendon injuries as previously believed and that tendinitis is actually quite rare. The suffix "-itis," which denotes inflammation, has been incorrectly applied for common tendon injuries. Instead, new research has demonstrated that tendon injuries are more often the result of chronic collagen degeneration, disorganized fiber arrangement, and increased vascularization. Inflammation seems mainly to be an issue when fibers have torn.

The suffix "-osis" denotes degeneration, and the term "tendinosis" has since become more widely used in describing chronic tendon injuries (Fig. 14-4, *B*). The treatment goals for tendinosis are to reduce adhesions, encourage collagen regeneration, and realign the collagen fibers. Mechanical loading, characteristic of friction, firm pressure, and stretching or eccentric exercise encourages collagen remodeling. Tendinitis and tendinosis can affect any tendon, but most commonly affected are the tendons of the rotator cuff, the long head of the biceps brachii, the common flexor and extensor tendons at the elbow, the patellar tendon, the tendons of popliteus and tibialis posterior, and the Achilles tendon.

Tenosynovitis, an inflammation of the tenosynovium, can occur in any tendon wrapped in a synovial sheath (Fig. 14-4, *C*). Inflammation of the synovium is often the result of injury or overuse that causes a roughening of the otherwise smooth tendon, hindering efficient movement through the sheath, creating friction and inflammation and impeding the restoration of synovial fluid. Tenosynovitis can also result from infection in the synovium, usually as a result of an injection, bite, or other injury that pierces the tendon or from complications of gonorrhea. These cases are often accompanied by rash and fever, and the client should be referred to his or her health care provider for medical treatment. Gout may also contribute to tenosynovitis, particularly in the lower extremities. If the client is at risk for gout, refer him or her to a health care provider for uric acid testing. In this case, massage is contraindicated in the acute stage. Refer to a pathology book for detailed suggestions for treating a client with gout. The treatment goal for tenosynovitis that is not infectious in origin is to reduce the adhesions between the tendon and synovial sheath, smooth the roughened surface of the tendon within the sheath, and encourage the restoration of synovial fluid. Again, transverse friction and lengthening the tendon are preferred techniques for these goals. Common areas of tenosynovitis include the abductor and extensor pollicis tendons

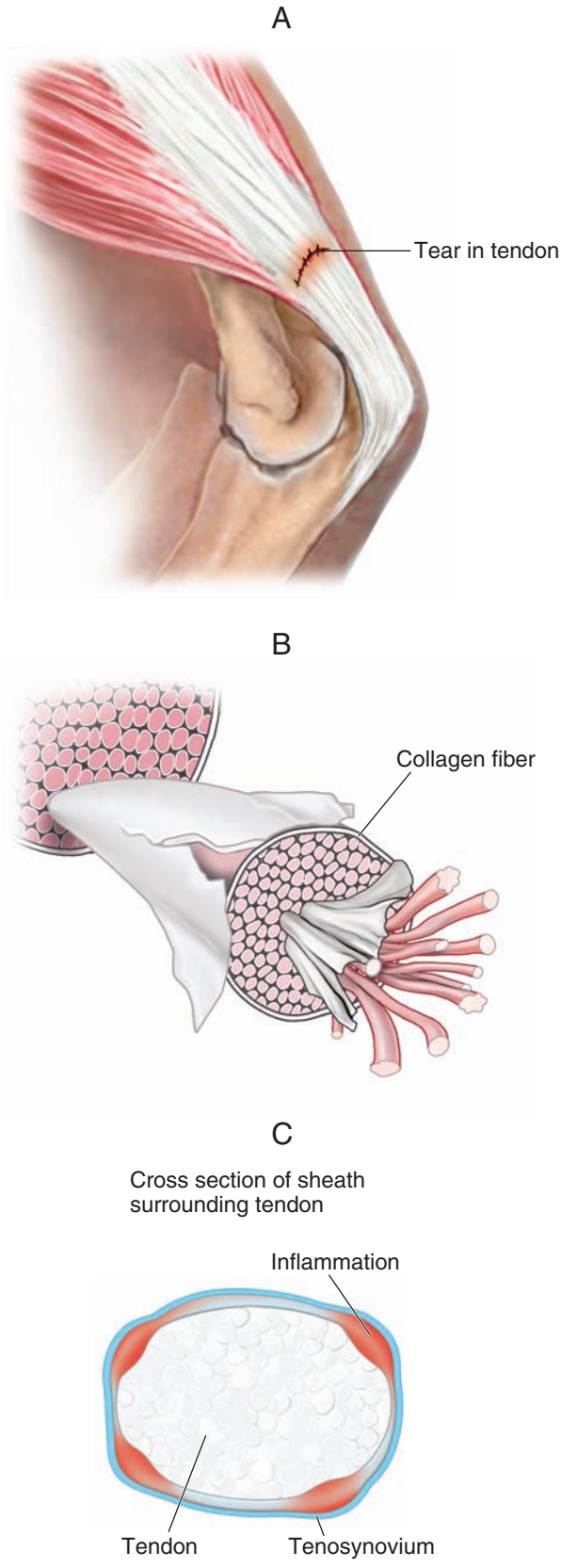


Figure 14-4 **Tendinopathies. (A)** Tendinitis is inflammation of the tendon due to tearing of tendon fibers. **(B)** Tendinosis is degeneration of collagen fibers. **(C)** Tenosynovitis is inflammation of the tenosynovium due to increased friction or trauma.

(called DeQuervain's tenosynovitis), finger flexors (called trigger finger), and the tendons of the ankle dorsiflexors.

Common Signs and Symptoms

The signs and symptoms of tendinopathies often develop gradually as a result of overuse, improper biomechanics, or the degenerative process that results from illness or aging. Acute injuries including grade 2 or 3 strains to a musculotendinous unit do occur and are sometimes the first sign that a tendinopathy was developing. Tendinopathy, the general condition of tendon injury, is marked by pain or tenderness local to the tendon, decreased strength of the musculotendinous unit, and crepitus, stiffness, and reduced ROM in the joint it crosses. These symptoms often increase with use, particularly during repetitive and resisted activities, and especially when the tendon is stretched or recoils. Symptoms may wake one from sleep, and pain and stiffness are often worse in the morning or after immobility. Gentle movement often improves symptoms that result from immobility, although intense activity may aggravate the condition. A full passive stretch of the affected tendon may elicit pain at the tendon. Local pain at the site of a tendon helps to differentiate tendinopathy from injury to a muscle belly. The muscle of the affected tendon may be hypertonic, hypotonic, or adhered and may contain trigger points. The synergists and antagonists of the affected muscles may develop compensating patterns including hypertonicity, adhesions, and trigger points. When the client compensates by avoiding lengthening the tendon, the joint may begin to lock into the shortened position.

It may be difficult to differentiate tendinitis, tendinosis, and tenosynovitis without medical testing. However, a few distinguishing characteristics may give you some clues. Tendinitis is an inflammatory condition and is often accompanied by swelling, redness, and heat at the site of the tendon. Because tendinitis involves torn fibers, eliminating the aggravating activity and allowing the tendon to rest and form scar tissue supports the healing process. Additionally, inflammation characteristic of tendinitis is interrupted by anti-inflammatories and corticosteroids, minimizing pain and other symptoms while supporting the healing process. If your client has rested, iced the injury, and used anti-inflammatory medication for a few weeks with only short-term relief that returns when the medication is not used, this may indicate that inflammation is not a primary contributing factor and that the condition is not tendinitis. With rest, improvement often begins shortly after the acute stage. With treatment, tendinitis usually resolves completely in a few weeks. Without proper treatment, the tendon may continue to degenerate, putting the client at greater risk for rupture or tendinosis.

Tendinosis is not an inflammatory condition. Therefore, while anti-inflammatories may temporarily reduce pain, they are not likely to improve symptoms over the long term. In fact, studies have shown that anti-inflammatories may inhibit collagen regeneration, and thus, healing. Corticosteroids have also been shown to reduce collagen regeneration, and while they may offer temporary relief of pain, they can ultimately hinder healing and increase the risk of further injury. Ice, which is often used to reduce inflammation, also initiates vasoconstriction. Since increased vascularity is a sign of tendinosis, ice may reduce symptoms and encourage healing. Because tendinosis is the result a degenerative process, and regeneration of collagen occurs more slowly than repair of torn tissues, improvement may take several weeks to months. The presence of heat and swelling, the duration of symptoms, and the effect of medication may help you differentiate between tendinitis and tendinosis.

Signs and symptoms of tenosynovitis include pain, swelling, and heat at the joint crossed by the tendon, reduced mobility of the affected joint, and pain with movement of the joint. Crepitus may also be present. When infection is the underlying cause of tenosynovitis, fever and redness may also be present. If you suspect infection, refer the client to a health care provider for medical assessment. Palpable nodules may also be found in the affected tendon. Nodules may be recognized before the client experiences other symptoms. ROM is limited, particularly when attempting to lengthen the tendon, sometimes requiring passive force to release the tendon from adhesion to its sheath. While movement may be painful, immobility reduces the production of synovial fluid and may lead to adhesions and locking of the joint in the shortened position. Movement is essential to prevent adhesions and immobility.

Possible Causes and Contributing Factors

Repetitive activity is a common contributing factor in tendinopathies. Tailors and seamstresses, computer and cash register operators, and musicians are at risk for tendinopathies, particularly in the upper extremities. Poor biomechanics and postural or muscle imbalances may cause overloading of a tendon during sport or recreational activities, work, or general activities of daily living and may contribute to a tendinopathy. Improper warming prior to activity, improper technique during activity, and unsuitable accessories such as shoes can also contribute to overloading a tendon. Athletes and assembly line employees are particularly affected by tendinopathies due to overloading. Golfers and tennis players are at risk for tendinopathies in the elbows, while runners are more likely to develop tendinopathies in the knees or ankles. Assembly line work that involves lifting puts the employee at greater risk of tendinopathies in the shoulder.

Once a tendinopathy arises, failing to allow sufficient time for healing in the early stages can slow or halt the natural healing process. With tendinitis, if small tears in the tendon do not form scars that are strong enough to resist further tearing, the inflammatory process will continue, compromising the structure's integrity, and the risk of further injury increases. Similarly, continuing activity that encourages the inflammatory process characteristic of tenosynovitis may weaken the structure and cause compensating patterns to become habitual. With tendinosis, continuing aggravating activities once degeneration has begun may inhibit the regeneration of collagen and continue to weaken the tendon.

However, recent studies have begun to reveal that inactivity or underuse may also play a role in chronic tendinopathy. Movement encourages collagen regeneration and the production of synovial fluid. Immobility discourages collagen regeneration, encourages adhesions, and can lead to atrophy. While some rest or at least limiting the aggravating activity is necessary to allow healing to begin, movement is an important element of the natural healing process.

Being overweight increases demand on the musculoskeletal system during all activities and may contribute to tendinopathies. Diabetes—often associated with obesity—as well as drugs used to control diabetes may cause metabolic changes that increase fibrosis and may alter the structure of tendons. Statins—the drugs used to reduce cholesterol—and some antibiotics include risk factors for both muscle and tendon pathologies. Rheumatoid arthritis—a systemic inflammatory pathology—increases the risk of tendinitis and tenosynovitis and may exacerbate symptoms. Gout—an accumulation of uric acid in the joints—may also contribute to inflammatory tendinopathies. Most commonly, the process of aging, which reduces elasticity and increases intolerance to tensile stress in both muscles and tendons, is a contributing factor. Infectious tenosynovitis can be caused by injuries that expose the tendon to bacteria, improper injection technique, IV drug use, and injuries that require medical attention. Individuals with a compromised immune system may be at greater risk for infectious tenosynovitis.

Because tendinopathies can occur anywhere in the body, they can be confused with many other conditions throughout the body. For example, pain in the toe may be a tendinopathy, but it can also be the result of gout. Wrist pain may be the result of tendinopathy, carpal tunnel syndrome, or both. Table 14-1 lists some general conditions commonly confused with or contributing to tendinopathies. Because tendinopathies may be difficult to distinguish, it is particularly important to understand the client's health history, precipitating events, and other possible causes of pain in the area before treatment. Consult your pathology book for more detailed information. If you are unsure and the client's symptoms resemble those of a more serious condition, particularly if the client has other risk factors, refer him or her to a health care provider for medical assessment.

Contraindications and Special Considerations

First, it is essential to understand the cause of pain. If the client cannot move the joint, heard a popping sound, or has significant weakness or if you suspect the client has a fractured bone or significant tearing to the tissues, work with the client's health care provider and consult a pathology text for massage therapists before proceeding. These are a few general cautions:

Table 14-1 Differentiating Conditions Commonly Confused with or Contributing to Tendinopathy

Condition	Typical Signs and Symptoms	Testing	Massage Therapy
Calcific tendinitis (inflammation of tendon due to calcium deposits)	Can affect any tendon, most common in the shoulder Pain, inflammation, stiffness, weakness, crepitus Aggravated by activity Symptoms worsen during periods of calcium shedding and reabsorption	X-ray	Massage is indicated within the client's pain tolerance. Client should be made aware that shedding of calcium deposits may temporarily intensify symptoms. ROM techniques may prevent frozen shoulder.
Osteoarthritis	Tenderness with pressure on joint Stiffness, particularly after rest or inactivity Inflexibility Swelling Grating sensation or sound	Physical exam X-rays Blood tests Synovial fluid tests Arthroscopy	Massage is contraindicated during an acute flare-up, indicated otherwise.
Rheumatoid arthritis	Periods of flare-ups and remission Pain, swelling Aching and stiffness, particularly after rest or inactivity Reduced ROM Distortion of joint Rheumatic nodules Occasional low-grade fever and malaise	Physical exam Blood tests Synovial fluid tests Radiography	Massage is indicated in nonacute stages. Work with the health care team.
Reiter's syndrome (reactive arthritis)	Often preceded by infection, low-grade fever, or conjunctivitis Tendon pain Joint pain Skin lesions in palms or soles Redness, burning, or discharge from eyes Urinary urgency or burning	Physical exam Joint x-ray Urinalysis HLA-B27 antigen	Massage is contraindicated until infection is resolved, and during active flare-ups of arthritis. Work with the health care provider to tailor the treatment plan to meet the individual's needs. Avoid skin lesions.
Carpal tunnel syndrome	Pain, numbness, and tingling in thumb, index, and middle fingers, and lateral half of ring finger Gradual atrophy and reduced fine motor skills	Phalen's test Tinel's sign EMG Nerve conduction test	Massage is indicated. See Chapter 7

(*continued*)

Table 14-1 Differentiating Conditions Commonly Confused with or Contributing to Tendinopathy (Continued)

Condition	Typical Signs and Symptoms	Testing	Massage Therapy
Plantar fasciitis	Often develops gradually but can be acute Sharp, burning, or aching pain in arch of foot Swelling in arch Symptoms worse at push-off phase of gait, particularly after periods of inactivity Possible tearing of fibers and bone spur in calcaneus	X-ray, MRI to rule out other causes of pain Dorsiflexion-eversion test Windlass test	Massage is indicated. See Chapter 11
Sprain	Usually acute Inflammation, heat, redness, and pain in acute stage Remaining inflammation, weakness, reduced ROM in chronic stage	Often self-assessed Physical exam MRI	Massage is indicated. See Chapter 13.
Spasm/cramp (contracture)	Sudden, often sharp pain in the affected voluntary muscle Palpable and often visible mass of hypertonic muscle tissue	Often self-assessed X-ray or MRI may be used to assess extent of damage	Massage is indicated. Discuss with health care provider if repeated spasm is related to an underlying condition or side effects from medication.
Myofascial pain syndrome	Persistent muscle aches or pain Muscle or joint stiffness Muscle tension Trigger points Pain interrupts sleep	Physical exam Palpate for trigger points Referred pain or twitch response Other tests may be performed to rule out other sources of pain	Massage is indicated. Myofascial pain syndrome is associated with trigger points. See Chapter 3.
Bursitis	Pain, particularly with activity or palpation Heat, redness, swelling, or tenderness	Physical exam ROM tests X-ray or MRI if conservative treatment is not successful	Massage is systemically contraindicated if bursitis is due to infection, and locally contraindicated in the acute stage to avoid increased swelling. In the subacute stage, massage to the structures surrounding the joint is indicated.
Diabetes	Frequent urination, frequent thirst, increased appetite, fatigue, nausea	Physical exam Fasting blood sugar test	Indicated when tissues and circulation are not compromised.
Gout	Redness, heat, and swelling Sudden, intense pain, often at night, which diminishes gradually over a couple of weeks	Physical exam Blood and urine uric acid concentration tests Synovial fluid test	Massage is contraindicated during acute attacks. Gout may indicate other systemic conditions. Work with health care team.

- **Infection.** When tenosynovitis is infectious, massage is contraindicated until the infection has resolved and the client receives clearance from his or her health care provider.
- **Reproducing symptoms.** Symptoms may occur during treatment. If treatment reproduces symptoms beyond the client's pain tolerance, adjust the client to a more neutral posture. Shortening or adding slack to the tendon may help. If this does not relieve the symptoms, reduce your pressure or move away from the area. You may be able to treat around the site that reproduced the symptoms and return to it after treating superficial and peripheral tissues, but proceed with caution.
- **Treatment duration and pressure.** If the client is elderly, has degenerative disease, or has been diagnosed with a condition that diminishes activities of daily living, you may need to adjust your pressure as well as the treatment duration. Frequent half-hour sessions may suit the client better.
- **Friction.** Do not use deep frictions if the health of the underlying tissues is at risk for rupture. Allow time for scarring and tissue regeneration to avoid re-injury. Do not use friction if the client is taking anti-inflammatory medication or anticoagulants. Friction initiates an inflammatory process, which may interfere with the intended action of anti-inflammatory medication. Recommend that the client refrain from taking such medication for several hours prior to treatment if the health care provider agrees. Because anticoagulants reduce clotting, avoid techniques that may cause tearing and bleeding.

Massage Therapy Research

Tendinopathy is being studied intensely. New research continues to revise our understanding of the structure and function of tendons, the causes of pathology, and treatment options. Because of this, there are as many new questions as there are answers.

In 1999, Gehlsen et al. conducted a study titled "Fibroblast Responses to Variation in Soft Tissue Mobilization Pressure" that assessed morphologic changes in the Achilles tendon of rats after applications of augmented soft tissue mobilization therapy (ASTM). The study supports the premise that microtrauma, such as pressure or friction, facilitates the healing process in tendons and asks what magnitude of microtrauma is necessary to induce change. Thirty rats were randomly assigned to one of five groups: tendinitis, tendinitis plus light ASTM, tendinitis plus medium ASTM, tendinitis plus extreme ASTM, and a control group (healthy tendon). Tendinitis was induced using an injection of collagenase. The three ASTM groups received a massage every 4 days, totaling six treatments. Fibroblasts were assessed by microscope 1 week after the final ASTM treatment. The control group showed parallel collagen fibers, as in healthy tendons. The tendinitis group showed fiber misalignment. The ASTM groups also exhibited fiber misalignment with an increased number of tendon fibroblasts indicating the healing process, with the extreme ASTM group exhibiting the greatest number of fibroblasts. The authors concluded that ASTM stimulates fibroblast proliferation and that the amount of pressure used affects the level of cellular response. ASTM involves the use of instruments other than the hands to apply pressure to the soft tissues. This is generally performed to spare the practitioner from developing overuse injuries. It is unclear whether applying the same amount of pressure with the hands instead of instruments would significantly alter the outcomes.

In a 2008 study titled "The Effect of Mechanical Load on Degenerated Soft Tissue," Warren Hammer presents three case studies in which he assesses the Graston Technique of soft tissue mobilization for the treatment of supraspinatus tendinosis, Achilles tendinosis, and plantar fasciosis (degeneration of the plantar fascia). Like ASTM, the Graston Technique is a form of mechanical loading of soft tissues that uses stainless steel instruments with curved edges contoured to fit shapes of the body. The client with supraspinatus tendinosis was treated twice a week for 5 weeks. The client with Achilles tendinosis was treated twice a week for 6 weeks and performed eccentric exercises at home. Both of these clients were asymptomatic following this regimen. The client with plantar fasciosis was treated 12 times over the course of 6 weeks and advised to use orthotics. She reported 95% improvement but had to discontinue treatment due to insurance conflicts. Hammer's conclusions support previous studies suggesting that mechanical loading of soft tissues facilitates fibroblast production and

collagen remodeling and is thus effective in treating conditions in which collagen degeneration is a primary contributing factor. He also suggests the need for further study to examine how Graston Technique compares to other manual techniques, how mechanical loading differs in the case of acute versus chronic injuries, and how the magnitude of load relates to anti-inflammatory versus pro-inflammatory processes of healing. It is important to note that the conclusions of this study are based solely on the clients' reports of symptom relief, ROM and strength testing, and comparative palpation following treatment. No histological studies were performed to measure fibroblast proliferation.

Pedrelli et al. (2009) concentrated their inquiry on the role of fascial restrictions in tendinopathies. In their study titled "Treating Patellar Tendinopathy with Fascial Manipulation," 18 patients with a history of unilateral patellar tendon pain were treated with the fascial manipulation technique described by physiotherapist Luigi Stecco, with the goal of restoring gliding between intrafascial fibers. Pain with movement was evaluated before treatment, immediately after treatment, and one month after treatment. A single therapist performed all treatments, which included applying pressure mid thigh between the vastus lateralis and rectus femoris with force toward the vastus intermedius. Deep friction or mobilization of the fascia was subsequently applied. Participants were asked not to perform sports for 4 days following treatment to avoid stressing the structures. All participants reported reduced pain immediately following treatment. Two participants reported complete relief that was maintained 1 month after treatment. Nine participants reported a relief following treatment that continued to improve between treatment and the 1-month follow-up. Three participants reported feeling pain relief immediately following treatment, with a recurrence of some pain between treatment and the 1-month follow-up, but the level of pain was still less than before treatment.

While these studies are encouraging, it is important to note that while pain is reduced and strength is regained, it is still somewhat unclear how or why this occurs. Without fully understanding the mechanism of tendon pathologies, treatments are more frequently geared toward symptom relief. While valuable, symptom relief does not necessarily result in long-term recovery or reducing the risk of re-injury. Further studies are needed to determine the exact effect that massage techniques have on repairing or regenerating the collagen fibers in tendons or in reducing inflammation.

WORKING WITH THE CLIENT

Client Assessment

Assessment begins during your first contact with a client. In some cases, this may be on the telephone when an appointment is requested. Ask in advance if the client is seeking treatment for specific area of pain so that you can prepare yourself.

Table 14-2 lists questions to ask the client when taking a health history.

POSTURAL ASSESSMENT

Allow the client to enter the room ahead of you while you assess his or her posture and movement. Look for imbalances in the movement of the joint crossed by the affected tendon or patterns of compensation that may develop to protect the injured structures. Watch as the client walks and climbs steps if the lower body is affected. Watch as the client opens the door, takes off his or her coat, or picks up a pen if the upper body is affected. Watch as the client sits, stands from sitting, lifts or sets down objects, turns to talk to you, and so on to see if he or she can perform these activities without assistance or if he or she avoids resistance against the affected tendon. Look for reduced mobility or the favoring of one side.

Table 14-2 Health History

Questions for the Client	Importance for the Treatment Plan
Where do you feel symptoms?	The location of symptoms helps to locate the injured tendon or to differentiate tendinopathy from other soft tissue injuries.
Describe what your symptoms feel like.	A description of symptoms including weakness, heat, or fullness in the area may help you to differentiate tendinosis, tendinitis, and tenosynovitis. See Chapter 1 for descriptions of pain sensations and possible contributing factors.
What activity were you performing when you first felt the pain?	The details of the activity or posture that initiated the pain may help you to determine its cause. A new regimen of exercise, weight-bearing activity, or repetitive action, particularly following a period of inactivity may contribute to tendinopathies.
When did the symptoms begin?	Onset of symptoms may help you to determine the stage of the injury and the health of the tissue.
Do you have a history of injury or surgery to this area?	An explanation of prior injury to the area may help you to determine contributing factors. Surgery and resulting scar tissue may increase the risk of tendinopathy.
Do any movements make your symptoms worse or better?	Locate weakness in structures producing such movements. Resisted activity or activities that stretch the tendon are likely to increase symptoms. Adding slack or reducing tension in the tendon may decrease symptoms.
Have you seen a health care provider for this condition? What was the diagnosis? What tests were performed?	Medical tests may reveal the location and stage of tendinopathy or coinciding injuries. If no tests were performed to make a diagnosis, use the tests described in this chapter for your assessment. If your assessment is inconsistent with a diagnosis, ask the client to discuss your findings with a health care provider or ask for permission to contact the provider directly.
Are you taking any prescribed or over-the-counter medications or herbal or other supplements?	Medication of all types may contribute to symptoms or have contraindications or cautions.
Have you had a corticosteroid or analgesic injection in the past 2 weeks? Where?	Local massage is contraindicated. A history of repeated corticosteroid injections may affect the integrity of muscle and tendons, increasing the risk of injury. Use caution when applying pressure or cross-fiber strokes. Analgesics reduce sensation and may cause the client to allow you to work too aggressively.
Have you taken a pain reliever or muscle relaxant within the past 4 hours?	The client may not be able to judge your pressure and may allow you to work too aggressively.
Have you taken anti-inflammatory medication within the past 4 hours?	Deep friction initiates an inflammatory process and should not be performed if the client has recently taken anti-inflammatory medication. Regular use of anti-inflammatories may also contribute to collage degeneration.

When assessing the standing posture, be sure that the client stands comfortably. If he or she deliberately attempts to stand in the anatomic position, you may not get an accurate assessment of his or her posture in daily life. If the client has the joint braced with a removable device, ask him or her to remove it if it is possible to bear weight without it so that you can get an accurate picture of the strength of the injured structures. When tendinopathy affects the lower body, the client may stand in a position that keeps the weight off the affected joint. This, in turn, may initiate imbalances in posture from the feet up to the spine. Check for irregularities in the ankles, knees, hips, and low back. When the upper body is affected, the client may hold the joint in a position that keeps the injured tendon from stretching. This may initiate compensating patterns that protect the affected tendon. Look for imbalance in the shoulders, rota-

tions in the arm, forearm, and cervical or thoracic spine. You may not be able to attend to all of the compensating patterns in the early treatments but may be able to return to them once the aggravating injury begins to heal.

ROM ASSESSMENT

Test the ROM of both the agonists and antagonists that cross the joint also crossed by the injured tendon. Since it allows the client to control the amount of movement and stay within a pain-free range, only active ROM testing should be performed in the acute stage to avoid further injury. In the chronic stage, the client may have developed compensating patterns causing pain in other joints that should also be tested.

Active ROM

Compare your assessment of the client's active ROM in the affected joints to the values listed in the Average ROM boxes in Chapters 4–11.

- **Active ROM of the affected joint** may be limited but will not likely produce localized pain when tendinosis or tendinitis is present. The client may limit movement to the pain-free range. More likely, an active contraction without resistance may not stress the tendon to the point of discomfort, but may cause discomfort in the affected muscle or compensating structures. With tenosynovitis, pain will likely result with any activity that involves the tendon gliding within its sheath. If the joint is already stuck in a flexed position, the value of active ROM testing is limited.

Passive ROM

Compare the client's P ROM on one side to the other when applicable. Note and compare the end feel for each range (see Chapter 1 for an explanation of end feel). P ROM should not be used in the acute stage of injury.

- **P ROM of the affected joint** may produce no symptoms or demonstrate restriction when shortening the muscle, but often produces pain on a full passive stretch. The location of pain during a full passive stretch of the affected joint may help to determine if the injury is in the muscle belly or the tendon. Pain local to the tendon suggests tendinopathy. With tenosynovitis, passive movement that requires the tendon to move through its sheath may be painful. A full passive stretch may require more force than usual, and clicking, grating, or crepitus may be present as the tendon detaches from its sheath. Apply the passive stretch slowly, and limit it to a range within the client's pain tolerance.

Resisted ROM

Use resisted tests to assess the strength of the affected musculotendinous unit. Compare the strength of the affected side to the unaffected side when possible. R ROM should not be used in the acute stage of injury.

- **R ROM of the affected joint** may produce pain at the tendon that may refer into the muscle. It may be necessary to perform the test in a variety of positions to elicit symptoms and to assess synergists to the affected musculotendinous unit. Weakness is not likely in the early stages of tendinitis or tendinosis but may develop if the condition is not treated. With tenosynovitis, if the joint is stuck in the shortened position there is no benefit to performing R ROM of the affected joints.

SPECIAL TESTS

There are numerous orthopedic tests for tendinopathies that are specific to the affected tendon. These specific, named tests are largely comprised of combinations of passive lengthening and resisted contractions of the affected muscles. It will be important to learn these orthopedic tests

if you choose to focus your advanced training on clinically oriented treatments or research. At a beginner's level, length and strength assessment, a full passive stretch of the affected tendon, and palpation are sufficient assessment tools for distinguishing tendinopathies from other potential causes of pain. Use ROM testing as described above, and refer to Chapters 4-11 for special tests of the muscles affected by those conditions.

PALPATION ASSESSMENT

If the affected tendon passes directly over a bone, the bursa beneath it may be inflamed. Treating bursitis requires advanced training. If you suspect bursitis as a coexisting condition, avoid deep pressure and friction locally in all stages. In the subacute stage of bursitis, massage to the surrounding structures is indicated, but direct pressure is avoided. Additionally, if you suspect bursitis that may be infectious in nature, refer the client to his or her health care provider for assessment before providing massage therapy.

The area around the affected tendon may be warm or swollen due to inflammation, particularly if the affected tendon is superficial and if tendinitis or tenosynovitis is the condition to be treated. The site of injury may be tender on palpation. Tenderness diminishes as the injury heals. Tenderness on palpation may radiate to surrounding tissue, and the area of radiating pain will also diminish as the injury heals. The tendon itself may feel thick and dense. Adhesions may be present around the affected tendon and among the synergists and antagonists of the affected musculotendinous unit. Crepitus may be notable around the affected tendon and with movement of the affected joint. With tenosynovitis, grating may be evident when making the tendon glide within its sheath by lengthening the affected musculotendinous unit. If the tendon is pulled taut over the bones of the joint it crosses, it may strum over the bone with movement of the joint or with manual manipulation. Hypertonicity and trigger points may be found in the affected musculotendinous unit, its synergists, and its antagonists. If the joint has been immobilized for an extended period, if the client has developed protective patterns, or if the injury involves serious strain or compression or lesions to the nerves, the affected muscles may begin to atrophy. In addition, if the injury coincides with a strain, which is often the case with tendinitis, scar tissue may form to heal tears. If not properly treated, scarring and adhesions may reduce local circulation, resulting in ischemia. The ischemic area may feel cool to the touch.

To effectively treat a tendinopathy, it is essential to locate the precise tendon and to know the direction of fibers of the affected tendon and muscle. Refer to the illustrations of specific muscles throughout this text to determine fiber direction. Take your time palpating the location, and be very precise. Once you have identified the affected tendon, palpate slowly, covering approximately 1 inch of tissue in 5–10 seconds. Stay focused, and allow the receptors in your fingers to transmit important information. Feel for adhesions, scars, or other anomalies in texture, tone, temperature, and tenderness.

Condition-Specific Massage

Tendinopathy may be one element of a musculoskeletal injury or chronic pain condition. For example, carpal tunnel syndrome may involve a tendinopathy of a flexor tendon; strains that occur at the musculotendinous junction may be the cause or result of a tendinopathy; and the pain associated with patellofemoral syndrome may involve or be confused with patellar tendinopathy. These are just a few examples. Always consider the health of the tendon when assessing musculoskeletal conditions. When tendinopathy contributes to the symptoms of another condition, the following recommendations are incorporated into the treatment and meant to aid healing and reduce the risk of re-injury of the tendon. Reducing adhesions, reducing scar tissue if present, encouraging collagen regeneration and reorienting collagen fibers, reducing hypertonicity and tensile stress, and strengthening weak muscles are the basic goals of treating tendinopathies. When tendinopathy is the primary condition, the following suggestions can be used alone.

Because tendinopathy can occur in any tendon, the following descriptions do not specify particular muscles as in earlier chapters. Use the resources in Chapters 4–11 when needed to determine

fiber direction, joints crossed, superficial versus deep tissues, and so on. Although the treatment goals for tendinitis, tendinosis, and tenosynovitis differ, transverse friction, pressure, and controlled tensile stress applied to the tendon, along with treating the affected muscle and its synergists and antagonists, are common to all treatments. In some cases, tendinopathies are complicated by other conditions such as infection, entrapment, or a compartment syndrome. A complicated case of tendinopathy is best supervised by a professional with advanced training.

It is essential for the treatment to be as relaxing as possible. Deep friction of a tendon can be somewhat painful and requires the client to allow you to reach the upper limit of his or her tolerance. Explain this to your client, and ask him or her to let you know when the amount of pressure you are applying causes him or her to tense up. In addition, because treatment to the affected tendon can be uncomfortable, it is best to alternate 30-60 seconds of treatment directly to the tendon with more general treatment to the muscles, stretches, and joint mobilizations. You are not likely to eliminate the symptoms associated with tendinopathies or any coexisting conditions in a single treatment. Do not attempt to do so by treating overly aggressively. Remember that you are working on tissue that is compromised. Ask the client to let you know if any part of your treatment reproduces symptoms, and always work within his or her tolerance. Deep palpation of a trigger point may cause pain at the upper end of the client's tolerance. Explain this to your client, describe a pain scale and what level of pain should not be exceeded, and ask him or her to breathe deeply during the application of the technique. As the trigger point is deactivated, the referral pain will also diminish.

The following suggestions are for treating pain, weakness, and limited ROM caused by a tendinopathy. This is generalized for any affected tendon. Refer to Chapters 4–11 for treatment suggestions pertaining to specific muscles.

- Positioning and bolstering depend on which tendon is to be treated.

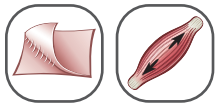
- If you find swelling, apply superficial draining strokes toward the nearest lymph nodes, and when possible, bolster the area to allow gravity to draw fluid toward the thorax.

- If swelling is minor or absent, apply brief moist heat to the affected area to soften adhesions and to increase circulation. Just a few minutes of moist heat is sufficient. If inflammation is present, do not use heat.

- Use your initial warming strokes to increase superficial circulation, soften tissues, and to assess the tissues broadly surrounding the site of injury and those that may be compensating for the injured musculotendinous unit. You should be able to initially assess tissues for adhesions, hypertonicity, protective muscle spasm, and tensile stress, which will help you determine how to focus your time.

- Before applying emollient, assess for and treat fascial restrictions around the injured area and compensating structures. Tissues that have shortened to prevent re-injury, particularly those closest to the joint, are most likely to develop fascial restrictions.

- Soften the tissues peripheral to the site of injury, beginning proximal. Pay special attention to the muscle of the affected tendon and its synergists. If the antagonists are accessible, treat these now, or return to this step when the client changes position.



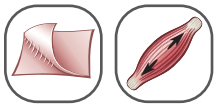
- Once the superficial tissues are pliable enough to allow for deeper work, apply transverse strokes to reduce the remaining adhesions and apply lengthening strokes to the peripheral tissues that are short and tight, beginning proximal. Muscles with fiber direction and actions in common with the muscle of the injured tendon are likely to have shortened, possibly in spasm, to protect the injured tendon and muscle from further injury.

Treatment icons: Increase circulation; Reduce adhesions; Reduce tension; Lengthen tissue; Treat trigger points; Passive stretch; Clear area

- Treat any trigger points found in the synergists of the affected muscle or in muscles compensating for the injury. Treat trigger points in antagonists if they are accessible, or return to this step when the client changes position. Follow trigger point treatment with lengthening strokes, but do not stretch the muscles until you have treated the injured tendon to avoid reflexive contractions.

- Assess and treat the muscle belly of the affected tendon for adhesions, tension, and trigger points. Follow trigger point treatment with lengthening strokes, but do not stretch the muscles until you have treated the injured tendon to avoid reflexive contractions.

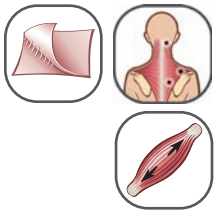
- Locate the injured tendon. With tendinosis and tendinitis, passively position the affected joint so that the tendon is lengthened but not overstretched. Reproducing symptoms may indicate overstretching. With tenosynovitis, the tendon should be fully lengthened and taut, within the client's tolerance.



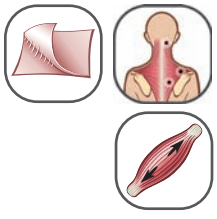
- Working slowly within the client's pain tolerance, apply short, deep transverse strokes to the full length of the injured tendon. Begin with strokes in one transverse direction, and continue with strokes in the opposite transverse direction. Transverse strokes both reduce adhesions and scar tissue, and encourage collagen repair. Follow this with longitudinal strokes to redirect tendon fibers, and mobilizations that lengthen the tendon. Alternate rounds of transverse strokes, longitudinal strokes, and mobilizations until you feel a change in texture. If the area gets hot or begins to swell, discontinue this step, and apply ice to the area for a few minutes to slow down the inflammatory process and cool the area.

- Apply longitudinal strokes to the full length of the injured tendon and muscle.

- Passively stretch the affected musculotendinous unit as fully as possible within the client's tolerance. This may require repositioning the client. Hold the stretch for 10-15 seconds. This step is essential for realigning the fibers and increasing the load on the tendon, which facilitates collagen remodeling.



- If you were unable to address the antagonists of the muscle with an injured tendon, reposition the client and address them now.



- If time permits, assess and treat any compensating patterns found.

The treatment overview diagram summarizes the flow of treatment (Fig. 14-5).

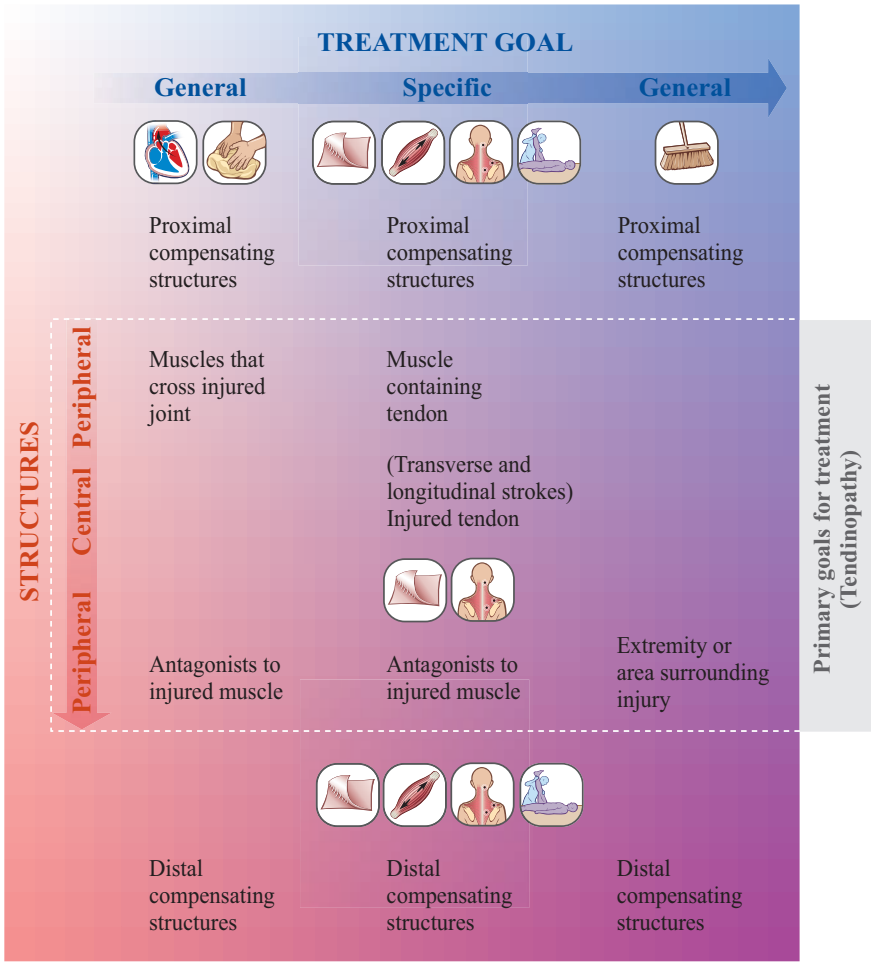


Figure 14-5 **Tendinopathy treatment overview diagram.** Follow the general principles from left to right or top to bottom when treating tendinopathies.

CLIENT SELF-CARE

Avoiding further injury is a primary concern when recommending self-care. While reducing aggravating activities and decreasing loads will help reduce friction, inflammation, and strain, activity is essential for collagen regeneration and to reduce adhesions. During the healing process, the client may choose to wear a brace or other protective device while performing activities that aggravate symptoms. It is best to wear these only when participating in aggravating activities and to allow the joint to be mobile otherwise. Arch supports may be helpful with tendinopathies of the lower extremity and if prescribed, should always be worn. Proper biomechanics are crucial to avoid reinjury. Ask your client to show you the repetitive activity that he or she performs or the action that initiated pain, and suggest ways of moving that will minimize aggravating factors.

The following are intended as general recommendations for stretching and strengthening muscles involved in the client's condition. The objective is to create distance between the attachment sites of musculotendinous units that have shortened and to perform repetitions of movements that decrease the distance between the attachments of units that have weakened. If you have had no training in remedial exercises and do not feel that you have a functional understanding of stretching and strengthening, refer the client to a professional with training in this area.

Clients often neglect self-care due to time constraints. Encourage them to follow these guidelines:

- Instruct the client to perform self-care throughout the day, such as while talking on the phone, reading e-mail, washing dishes, or watching television instead of setting aside extra time.
- Encourage the client to take regular breaks from stationary postures or repetitive actions. If the client's daily activities include hours of inactivity, suggest moving for at least a few

minutes every hour to prevent adhesions and reduced circulation. If the client's daily activities require repetitive actions that contribute to a tendinopathy, suggest resting for at least a few minutes every hour or reducing the aggravating activity as much as possible.

- Demonstrate gentle self-massage of the tissues surrounding the injury to keep adhesions and hypertonicity at bay between treatments.
- Demonstrate all strengthening exercises and stretches to your client and have him or her perform these in your presence before leaving to ensure that he or she is performing them properly and will not cause harm when practicing alone. Stretches should be held for 15–30 seconds and performed frequently throughout the day within the client's limits. The client should not force the stretch or bounce. The stretch should be slow, gentle, and steady, trying to keep every other joint as relaxed as possible.
- Stretching and strengthening exercises should be recommended according to your findings in ROM testing and palpation.

Stretching

Maintaining proper length and tone of the musculotendinous unit, its synergists, and its antagonists is essential to reduce the risk of re-injury. Stretches should be performed throughout the day, particularly before and after activity. The results of ROM testing and palpation will determine which muscles have shortened and need to be stretched. In general, stretching occurs when the distance between the attachment sites of the muscle is increased. Refer to Chapters 4–11 for stretches to specific muscles or groups of muscles. Take care to instruct the client to stretch slowly and to limit stretches to the comfortable range, beginning slowly, and gradually increasing the stretch as symptoms diminish and the risk of re-injury is reduced. Stretching an injured muscle too quickly or too deeply may initiate a reflex response, which may result in spasm. In addition, when the affected muscle is lengthened, its antagonists are shortened. If the antagonists are involved in protective splinting, contracting them too quickly or too deeply may also result in spasm.

Strengthening

Eccentric exercise has been shown to improve recovery from tendinopathies since increasing the load on the tendon encourages collagen proliferation. Eccentric exercises are those that lengthen the injured muscle. For example, if the long head of the biceps brachii is affected by tendinosis, extension of the shoulder increases eccentric loading to the biceps tendon and encourages healing. Eccentric exercise also strengthens the antagonists of the injured muscle, which helps to balance strength on either side of the joint. These exercises should be introduced slowly and increased in intensity only within the client's tolerance.

Strengthening weakened or atrophied muscles is equally important for restoring proper function of the affected joint. The results of ROM testing and palpation will determine which muscles have weakened and need to be strengthened. In general, active or resisted concentric contractions strengthen muscles. As with stretching, a strengthening program should progress gradually. Pain-free, active ROM is effective for gradually restoring strength to weakened muscles. As healing progresses and the risk of re-injury diminishes, add resistance to active ROM. Refer to Chapters 4–11 for exercises to strengthen specific muscles or muscle groups.

SUGGESTIONS FOR FURTHER TREATMENT

Ideally, a client with a tendinopathy will have treatments two or three times a week until the client can perform activities of daily living with minimal or no pain for at least 4 days. Once this has been achieved, reduce frequency to once per week until symptoms are absent for at least 7 days. When the client reports that he or she has been pain-free for more than 7 days, treatment can be reduced to twice per month. If the client is pain-free for 3 or more consecutive weeks, he or she can then schedule appointments once per month or as necessary.

There should be some improvement with each session. If this is not happening, consider the following possibilities:

- There is too much time between treatments. It is always best to give the newly treated tissues 24–48 hours to adapt, but if too much time passes between treatments in the beginning, the client's activities of daily living may reverse any progress.

- The client is not adjusting activities of daily living or is not keeping up with self-care. As much as we want to fix the problem, we cannot force a client to make the adjustments we suggest. Explain the importance of his or her participation in the healing process, and encourage the client to follow your recommendations, but be careful not to judge or reprimand a client who does not.
- The condition is advanced or has other musculoskeletal complications that are beyond your basic training. Refer this client to a massage therapist with advanced training. Continuing to treat a client whose case is beyond your training could hinder healing and turn the client away from massage therapy altogether.
- The client has an undiagnosed, underlying condition. Discontinue treatment until the client sees a health care provider for medical assessment.

If you are not treating the client in a clinical setting or private practice, you may not be able to take this client through the full program of healing. Still, if you can bring some relief in just one treatment, it may encourage the client to discuss this change with a health care provider and seek manual therapy rather than more aggressive treatment options. If the client agrees to return for regular treatments, the symptoms are likely to change each time, so it is important to perform an assessment before each session. Once you have addressed symptoms specific to the tendinopathy, you may be able to pay closer attention to compensating structures and coexisting conditions.

PROFESSIONAL GROWTH

CASE STUDY

Elisa is a 25-year-old student studying fashion design. She has pain in her thumb and palm that began while sewing a piece for her final project. She uses her computer daily, draws sketches of fashion designs with fine detail, and frequently sends text messages and plays games on her cell phone.

Subjective

Elisa stated that she has had episodes of pain in her right hand for the past year, particularly when sewing and sending text messages. She also feels some pain when carrying groceries or other heavy items in bags with handles instead of in a backpack. The worst of the pain is between her thumb and index finger. She does not feel pain in the left hand regularly but has noted that lately it seems weaker than usual. She explained that in the past year, the aching in her right hand has become more frequent and more intense and that, at least a couple of times per week, her thumb and index finger lock and she feels pain in her forearm. She also started feeling general aching in her shoulders. She bought a brace to support her hand but has a hard time performing tasks while wearing it, so she has not used it much. She has tried ibuprofen and felt some relief, but only when she was not using her hands. When she used ibuprofen and continued to work, the pain persisted. When she first felt the symptoms, she had a manicure that included a forearm and hand massage. She said that for that day and the next she had some relief. She hopes that focused massage will have even better, long-term results. She has no known underlying conditions. Her mother, who was a seamstress before retiring, had received a diagnosis of DeQuervain's tenosynovitis. Elisa wants to avoid developing the same condition. When asked, she stated that she has felt no unusual fatigue or malaise and has had no fever, sharp pain, or other unusual symptoms other than the pain in her hand. When asked, she stated that the pain does not wake her from her sleep but that she occasionally feels weakness in the morning when picking up her coffee cup.

Objective

Elisa appears healthy and vibrant. Her handshake was firm with no signs of pain. She had no difficulty turning the doorknob and seemed comfortable using a pen to fill out her intake forms. The right hand is slightly swollen compared to the left. Swelling is general, not specific to any finger. The skin is slightly dry and chapped bilaterally. There is no difference in temperature between the hands. When asked to fully extend the thumb

and fingers of both hands, extension on the right side was visibly reduced compared to the left, and Elisa felt aching in her thumb and along the anterior forearm. Passive extension of each individual finger revealed reduced ROM in the thumb and forefingers of both hands with pain on full passive extension of the right thumb. Palpation of the flexor tendons resulted in a level 5 pain on the right flexor pollicis longus, level 2 pain on the right first digit tendon of the flexor digitorum, level 2 pain on the left flexor pollicis. No remarkable results were seen from the passive stretch or palpation of other fingers. Palpation revealed tenderness and hypertonicity in the adductor pollicis and opponens pollicis. Palpation of the forearms revealed adhesions and hypertonicity in the flexors, particularly on the right, and taut bands in the extensors, which were also more pronounced on the right. Palpation of the common flexor tendon produced no pain, and Elisa stated that it felt good. No trigger points were found. Signs and symptoms suggest right flexor pollicis longus tendinosis with short, tight wrist flexors and taut wrist extensors. Shoulder aches may be the result of compensation.

Action

I began in the supine position, bolstering the right arm and applying drainage strokes to reduce minor fluid accumulation in the right hand. I applied general Swedish massage to the pectorals, shoulders, neck, and arms. I proceeded with treatment to the bilateral forearms and hands, beginning on the right with myofascial release using wringing to the forearms and deep fascial techniques to reduce adhesions among flexors and extensors. Adhesions were most significant in the right distal flexors. I applied kneading and stripping to the adductor and opponens pollicis and transverse friction to the forearm muscles, followed by lengthening the flexors and applying broad pressure and circular strokes to the extensors. No trigger points were found. With the forearm supinated, the wrist slightly extended with a bolster, and the fingers held in extension with one hand, I applied transverse friction to the tendons of the flexor pollicis longus and the flexor digitorum. I applied stripping to the same tendons followed by deep effleurage to the same muscles. I performed four rounds of treatment, alternating between friction and the lengthening of tendons with the lengthening of muscles. I applied a full deep stretch to the thumb and fingers, followed by clearing strokes toward the axilla, and 3 minutes of icing to frictioned tendons.

Plan

Following treatment, Elisa stated that she felt much less discomfort in her hands. She continued to feel discomfort on passive extension of the R. thumb and first finger, though less than before treatment. Elisa rescheduled for another treatment in 3 days. I recommended full stretches to the fingers and wrist several times throughout the day. I suggested that she ask her roommate to apply wringing to her forearms occasionally to keep adhesions at bay and demonstrated self-massage to continue reducing adhesions and hypertonicity in the forearms and between the thumb and first digit. I also suggested reducing activities that are least necessary (e.g., texting less during times when she is sewing a lot). I explained that her simple tendinosis could develop into a more serious case. I explained DeQuervain's tenosynovitis, so she can monitor for symptoms. Currently, there is no tenderness in the extensor pollicis, no pain or crepitus with passive flexion of the thumb, and no heat or swelling in the radial aspect of the wrist.

CRITICAL THINKING EXERCISES

1. Your client mentions feeling pain in the left shoulder and points to the anterior aspect, near the head of the humerus. Active extension of the left shoulder is limited compared to extension of the right shoulder, but causes little pain. Full passive extension of the left shoulder causes pain at the very spot the client originally pointed to. Write a SOAP note for this client. Is tendinopathy a possibility? Which tendon might be affected? How will you determine if it is tendinosis, tendinitis, or tenosynovitis? Which muscles may be compensating? Create a scenario that describes how this pattern developed, the signs and symptoms, possible coexisting conditions, a postural assessment, testing, precautions or contraindications, and specific treatment. Use a reference that describes the actions of the muscles to help you correlate the signs and symptoms. There is no single, correct SOAP note for this exercise. Be creative, as the possibilities are virtually endless.

2. This chapter contains references to the coinciding of tendinopathy with one of the conditions described in Chapters 4–11. Choose one of the conditions described in those chapters and discern which tendon could be injured or at risk for tendinopathy based on the client's posture or activities. How will you incorporate tendinopathy into the treatment description for that condition?
3. Conduct a short literature review to learn about the relationship between tendinopathies and the following:
   - Statin medication
   - Fluoroquinolone antibiotics
   - Mesenchymal syndrome
   - Genetic collagen variations

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