Chapter 3

Thermal modalities as treatment aids

CHAPTER CONTENTS

Applied appropriately, thermal modalities can be helpful adjuncts to soft-tissue manipulation. To use thermal modalities effectively, however, requires the practitioner understand a few fundamental principles of physics and physiology in the body, such as the nature of pain, methods of heat transfer, and physiological responses to temperature change. Thermal agents such as ice bags, hot packs, or ultrasound units are used to increase circulation and soft-tissue extensibility, increase or decrease the local tissue metabolic rate, and to decrease inflammation. In addition, a primary purpose for using thermal modalities in the rehabilitation environment is pain management.

UNDERSTANDING PAIN

Pain is generally defined as an unpleasant sensory and emotional experience due to actual or possible damage to tissues.[1] Because of the soft-tissues' extensive innervations they are a primary source of pain when injured or dysfunctional. Musculoskeletal dysfunction, inflammation or neurological excitation caused by injury, trauma and or degenerative disease are the primary causes of most soft tissue pain.[2,3] The effectiveness of thermal modalities at interrupting pain signals becomes clear when the nature of pain transmission is understood.

Nociceptors, also called free nerve endings, are the key sensory cells (neurons) that report pain to the central nervous system (CNS). They are present in varying quantities in most types of soft tissues, including skin, joints, muscle, and organs. As a response to mechanical, chemical, or thermal stress that could cause the body damage the nociceptors send signals to the CNS that are interpreted by the brain as pain. The number of nociceptors influences the level of pain. For example, due to the high number of nociceptors in muscles and joint capsules considerable pain can result when these tissues are injured. In contrast, the intervertebral discs can withstand high levels of compression and significant damage without the individual feeling pain due to the discs having few nociceptors.[4,5]

Signals are sent from nociceptors to the central nervous system by two types of small diameter afferent fibers called C and A-delta fibers.[6] Due to the small diameter of these fibers they do not transmit signals as fast as the other non-pain receptors, the mechanoreceptors and proprioceptors. The difference in signal transmission rate between nociceptors and the mechanoreceptors or proprioceptors plays an important role in pain management and is explained more thoroughly further in the chapter.

A-delta fibers have a myelin sheath which functions to speed up the transmission rate of signals. A-delta fibers are most sensitive to high levels of mechanical stress and produce sensations generally described as sharp, pricking, or stabbing.[2,7,8] C fibers are slower than A-delta fibers because they are unmyelinated (Fig. 3.1). Pain from C fibers has a slower onset but lasts longer and produces dull, throbbing, aching, or burning sensations.[7,8]

The A-delta and C fibers work in conjunction with each other in reporting pain sensations, but have different timing. For instance, imagine what happens when one stumbles and falls, hitting the knee on a rock. There is an immediate sharp pain sensation in the knee which is then transmitted primarily by A-delta fibers. A day later a more pervasive dull and throbbing pain, transmitted by the C fibers, replaces the initial sharp pain. Interestingly, a person's immediate reaction with such an accident is to rub the stricken area and to move the knee. The stimulation of mechanoreceptors and proprioceptors (associated with movement and touch) sends signals to the CNS that outpace the nociceptors, thus overriding some of the pain signals.

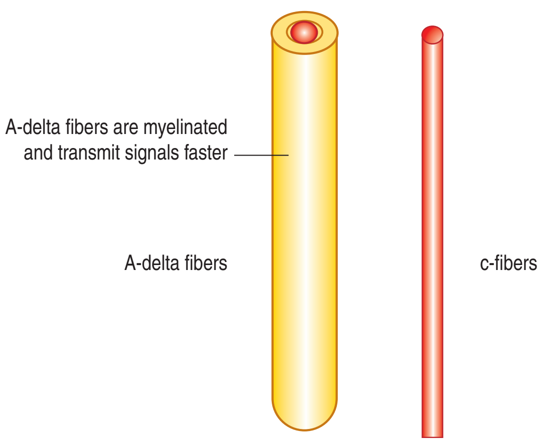

Figure 3.1 Myelinated and unmyelinated nerve fibers.

There are three primary categories of pain – acute, chronic and referred. Acute pain occurs as an immediate result of a causative event (ex: injury) and resolves within a relatively short period of time. Pain that lasts less than 6 months and where an identifiable pathology is found is called acute by some.[9] Chronic pain continues past what would be considered the normal time period for healing of a particular condition. Some references put a time frame on chronic pain and say it is any pain that has persisted for longer than 3–6 months.[2] When pain is referred, the sensations are experienced elsewhere from the location of dysfunction.[10] A site of referred pain can be either nearby the dysfunction or remote from it.

Minimizing a client's pain sensations with thermal modalities is an important rehabilitative goal. Not only is continual pain uncomfortable and indicative of tissue dysfunction, but it slows down the healing process as well. Chronic pain produces increased muscle hypertonicity which causes further pain and biomechanical dysfunction.[10] While attempting to correct a soft-tissue disorder, the more the pain can be reduced the better chance there is to make positive changes.

There are several theories that work to explain the means by which thermal modalities address pain. The most prominent is the gate control theory, originally proposed by Melzack and Wall in the 1960s.[11] According to the gate theory, only a limited amount of sensory information can make it through to the central nervous system. This limitation keeps the body from being totally overwhelmed with the massive amount of sensory information that it processes. Thermal modalities produce strong sensory impulses that shut off, or at least reduce the pain signals that reach the CNS. Signals from the C and A-delta fibers are

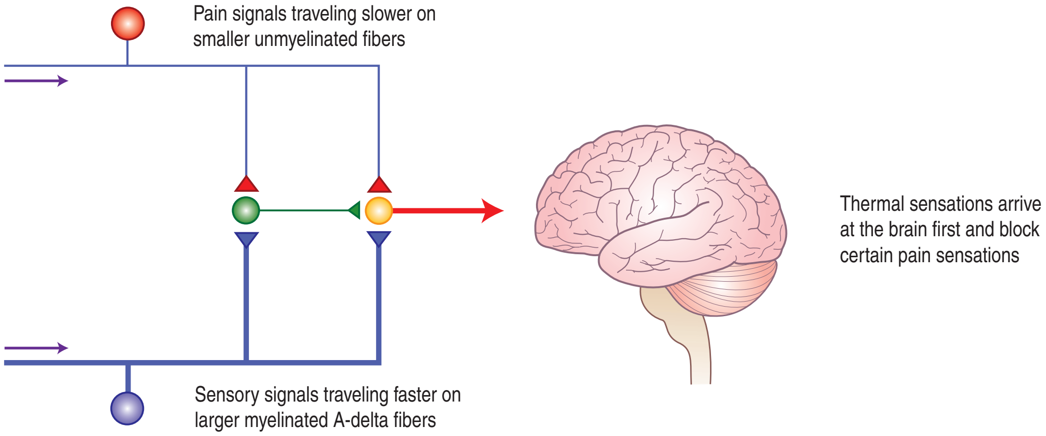

Figure 3.2 Schematic representation of the gate control theory.

slower than many of the other non-nociceptive afferent fibers. Thermal applications produce additional signals from afferent fibers which arrive at the central nervous system first and essentially override some of the pain signals from the injury or condition (Fig. 3.2).

The gate theory of pain has been dominant in pain research for decades. However, one of its founders has expanded the theory to be more inclusive of phenomena that were not adequately explained in the original theory. Ronald Melzack now suggests pain perception is a more complex process than initially envisioned. Melzack's current *neuromatrix theory* argues that pain "is a multidimensional experience produced by characteristic neurosignature patterns of nerve impulses generated by a widely distributed neural network – the 'body-self neuromatrix' – in the brain. These neurosignature patterns may be triggered by sensory inputs, but they may also be generated independently of them."[12,13] The neuromatrix concept includes aspects of cognitive and emotional experience that were not originally part of the gate theory. There is still validity to the gate control concepts, and there is much to learn about how various therapeutic interventions interact with Melzack's neuromatrix model.

HEAT TRANSFER

Thermal modalities work by taking advantage of temperature variances between the body and a physical agent. The laws of thermodynamics instruct that the production of heat or cold occurs as a result of the movement of heat from a warmer to a colder object. Heat is transferred in an attempt to reach equilibrium. There are four methods of heat transfer: conduction, convection, radiation, and conversion. Heat applications can employ any of the four methods of heat transfer, while cold applications require either conduction or convection to produce their results.

Conduction is a common method of heat transfer in thermal modalities. In conduction there are two objects in contact with each other. Heat is transferred from the object with the higher temperature to the object with the lower temperature. In hot applications, heat moves from the warmer modality to the cooler body part. Cold is produced in the same way but instead of the heat moving toward the body it moves away and toward the cooler modality (such as an ice bag). In essence, cold is created by the removal of heat. Conduction modalities include heat packs and ice bags.

Some thermal modalities employ convection. Conduction still occurs in convection but the medium of transfer – air or water – is moving. The constant movement of the heated medium, for example water, allows heat transfer to occur quicker and more efficiently than if the heated medium was static. Movement allows new areas of the warm medium to come into contact with the body part, thus allowing the body part to remain in contact with the warmest part of the heated medium. Thermal modalities employing convection include Jacuzzi tubs or foot baths of moving water.

Radiation is a third method of heat transfer. Radiation is the movement of electromagnetic energy through space. This type of heat is emitted as thermal radiation (there are other types of radiation). Infrared heat lamps and saunas are examples of thermal modalities utilizing heat radiation.

Some therapeutic modalities use a fourth type of heat transfer called conversion. It is usually out of the scope of practice for massage therapists to use these modalities but they may be part of the client's treatment protocol with another health care practitioner. Conversion is a transformation of non-thermal energy into heat. Ultrasound and pulsed short-wave diathermy are examples. Diathermy is not used much anymore. With pulsed ultrasound, high-frequency sound waves convert into heat as different tissues in the body selectively absorb them. Devices which use conversion do not get hot themselves generally; heat is not produced until the tissues absorb the ultrasonic energy.

HEAT APPLICATIONS

Integrating thermal modalities effectively into the clinical practice requires understanding how they function and of their benefits and disadvantages. In general, heat therapies are soothing and the soft-tissue practitioner can take advantage of their effects to enhance relaxation and decrease excessive sensory activity in the nervous system. However, there are situations where the effects of heat are not desired, and even contraindicated.

The following are the most commonly used types of heat modalities in the massage therapy clinic. There may be other forms of heat applications the client may have available to them if the therapist works alongside other health care practitioners, such as physical therapists and chiropractors. Understanding the nature of the client's complaint is paramount to knowing how and when heat modalities are beneficial and appropriate. Assessment should always be performed prior to treatment in order for the therapy to be most effective and not further complicate a condition.

An important factor to consider when selecting a heat modality is the depth of penetration. Most thermal applications are superficial as they are placed directly on the skin. A superficial application of either heat or cold can have a number of beneficial effects. Yet the depth of penetration of superficial thermal modalities is only about 1 cm below the skin.[14–16] Therefore, if the intention is to heat a deep soft-tissue structure such as the joint capsule, a superficial heat application will not be effective. In this situation a form of heat application that has the capability to produce heat in the deeper tissues, such as ultrasound or diathermy, would be required.

Heat modalities

Localized applications

The following are heat modalities that work by conduction. Increasing local heat in the superficial tissues is accomplished by applying a source of heat to the body that is warmer than the body's temperature. For example, if a hot pack is placed on the body and the hot pack is above 98°F, there will be a transfer of heat from the hot pack to the body. This type of heat will not penetrate deeper tissues, such as the muscles lying underneath layers of other muscles.

It is important to monitor the client's response because all the applications below can cause burns. Additional towels may be needed to protect the client with the hot pads or wet packs, which may be removed once the pack is tolerable level. Always test the heat of the item before applying to confirm it is not too hot. No heat source should be left on the body for long periods (15–20 minutes is standard) and they should be frequently monitored. Stones have caused burns because it is harder to control their heat. Always check in with the client as to heat tolerance, some people cannot stand heat well.

Box 3.1 Heat Modalities

- Local applications:
  - Moist heat pack
  - Dry heating pads
  - 'Moist heat' heating pads
  - Chemical gel packs
  - Heated gel packs
  - Rice/buckwheat pillows
  - Hot stones
  - Melted paraffin wax
  - Whirlpool tubs
- Whole-body applications:
  - Whirlpool tubs
  - Steam room
  - Sauna

The moist heat pack is one of the most effective superficial heat applications. Wet packs are cloth packs of silica gel in various shapes and sizes that are submerged in hot water. After removing from the water they are wrapped in a fitting terry cloth cover and placed on the body. Moisture in these heat packs improves the conduction of heat from the hot pack to the body. Additional towels are sometimes needed, and removed as the pack cools. A moist heat pack is usually applied for about 20 minutes. Dry heat should never be left on the body for extended periods; frequently check in with the client on temperature and location.

Dry heating pads are probably the most commonly used commercial form of heat application. The conduction of heat is not as good as with moist heat because the water molecules in a moist heat application aid the heat transfer. Dry heating pads are usually electric and have a switch that allows different heat settings from low to high. There are several forms of 'moist heat' electric heating pads that aren't a true moist heat application. A special cloth covering over the heating pad draws moisture out of the air and creates more moisture than the dry heating pad alone. These units are a convenient alternative to full moist heat packs, and usually more effective than the traditional dry heating pad.

There are a host of heat bags and pillows designed for heating in a microwave. These usually contain buckwheat, rice or some other fill that heats up without cooking. These are handy to have in the clinic for specific local applications and for keeping the client warm. These can be used, as can the dry heating pad, with moist washcloths for a moist heat effect.

Certain types of chemical gel packs may be heated for use as a heat pack. These packs contain a chemical compound that gets either hot or cold. Some gel packs may be heated in the microwave. They are usually designed to fit a certain region of the body, and may have Velcro fasteners or straps that hold them in place. Chemical gel packs are commercially popular and convenient.

Hot stones are primarily used in the spa environment. The stones are heated in water-filled tubs and then placed directly on the body. The density of rock allows it to retain heat for a longer time than some other heat modalities. Some practitioners use the heated stone as a soft-tissue manipulation tool with effective results. It can be challenging to monitor and control the temperature of the stone. To prevent burns, the practitioner must closely monitor the client, frequently checking in for comfort levels.

Melted paraffin is applied, usually to the hands or feet, as a local heat treatment. The hand or foot is dipped into melted paraffin and then remains covered as the paraffin solidifies and cools. The paraffin acts as an insulator that keeps heat applied to the application area. Wrapping the paraffin-covered body part in a towel or plastic wrap helps prolong the heat application. The paraffin bath is helpful to apply heat to areas, such as the hands or feet, that are harder to reach with other topical heat applications due to their shape. Monitoring the heat of the wax is important to prevent burns; practitioners should always test the heat of the wax on their own skin before applying to client.

The whirlpool is an effective method of applying localized moist heat to a particular area. In a rehabilitation environment, such as a physical therapy clinic or athletic training facility, the smaller whirlpools, which treat distal limb injuries, are more common.

Whole-body applications

These modalities work through either conduction if the water or air is non-moving or convection if the water or air is moving. In a whirlpool, movement allows the water molecules that have transferred their heat to the cooler body to be moved away, while warmer molecules of water move in to replace them. Thus, there is a continual renewal of the warmer elements as they come in contact with the body.[2] The medium's movement allows a more efficient transfer of heat. The steam room works by convection as steam moves across the body. A sauna works by radiation as there is a static heat source (wood fire or electrical element) that is radiating heat toward the body. Whole-body applications are effective at enhancing circulation throughout the body as opposed to just a small area as in local heat applications.

However, the benefits of heat come from the neurological reactions not an increase in temperature in the deep tissues. Although some whole-body applications do raise the temperature in the deeper tissues, this increase is not considered therapeutic.

The whirlpool uses jets of air that continuously circulate to move the water, stimulate circulation and provide an analgesic (pain relieving) response. Hot tubs with moving water accomplish the same effects as smaller whirlpool baths.

A steam room is a form of moist heat. The contact of steam with the body surface produces a whole-body moist heat application. The moist heat of the steam room prevents the evaporation of moisture from the skin, so it is easy to become overheated. Client time in a steam room should be monitored to make sure the body is not overheating.

A sauna is a form of dry heat. Sauna treatments are in a small enclosed room or cabinet that the person sits in for the length of the treatment. The sauna's heat source is usually electric in a clinic environment. The sauna is desirable in situations where flushing of the body's toxins through sweating is desired. Some people will prefer the sauna over a steam room or whirlpool as well.

The rehabilitation clinic

In a clinic with other health care practitioners such as physical therapists, chiropractors, or sports medicine doctors, clients may have access to other modalities. Ultrasound is the most frequently used conversion heat modality. Although its use is usually out of the scope of practice for massage therapists, therapists should be familiar with how ultrasound works.

Ultrasound is the most effective method to heat the deep tissues. With continuous wave ultrasound, high frequency sound waves are transmitted into the body through the head of the ultrasound device. Various tissues in the body absorb the ultrasonic energy at different rates. The denser is the tissue, the faster it absorbs ultrasound energy. Consequently, the denser tissues, such as bone, absorb ultrasonic energy at the greatest rate while thinner tissues are harder to heat. Therefore, heating dense and deep tissues that connect to bone, such as ligament or joint capsule, is most effective with ultrasound.

Heat benefits and contraindications

Heat applications have a number of physiological effects. Heat can be an effective compliment to the soft-tissue therapist's efforts to promote tissue healing and pain relief. Heat has general overall effects as well as those that are localized to a treated body part or region. Heat's effects also depend on the type of heat and its depth of penetration (the more adipose a client has the less penetration in those areas; and the reverse for those particularly thin).

As with all modalities, thermal and non, there are instances in which the therapy can produce effects opposite or even harmful to the goal of recovery. There are instances where there are both positive and potentially negative results with the use of heat, such as using heat on acute injuries which may increase lymphatic fluid movement but also swelling. The practitioner must evaluate the situation and make an educated decision. Consulting with a client's other health care practitioners may be beneficial. Knowing the effects of heat will help with these therapeutic choices.

Box 3.2 Benefits of Heat

- Increases local tissue metabolism
- Increases local circulation bringing nutrition and removing waste
- Viscosity of blood is reduced improving blood flow
- Increases lymphatic fluid movement, removing damaged cellular debris
- Increases the extensibility and elasticity of various connective tissues
- Relaxes neurological cells within fascia that govern fascial contractility
- Increases elasticity in superficial connective tissues and reduces fascial tension
- Relaxes deeper muscles through neurological effects
- Assists therapeutic stretching procedures
- Decreases excess neurological activity and hypertonicity
- Improves motor nerve conduction so reduces biomechanical dysfunction
- Increases nerve conduction velocity so reduces muscle tightness
- Breaks the pain–spasm–pain cycle and reduces pain

Benefits

Metabolism Heat increases local tissue metabolism as it speeds up various chemical and metabolic processes. In many cases, such as hypertonic muscle that is ischemic, this effect is desirable. In other situations, an increase in local tissue metabolism could cause problems (see precautions below).

Circulation Some of the most beneficial effects of thermotherapy involve increases to local circulation.

Superficial heat applications cause a reflex vasodilation of the blood vessels and a corresponding increase in local tissue circulation. Circulation is also increased because the viscosity of blood is reduced which allows for easier movement of blood through the vessels.[2] Increased circulation is of vital importance in the healing of most injuries. Increasing circulation helps injuries and other conditions because the blood brings in nutrients and oxygen, while removing waste products.

Increased lymphatic fluid movement Lymphatic fluids remove damaged cellular tissue debris. There is an increase in the movement of lymphatic fluid with heat applications and stimulating this effect with heat modalities is important for injuries.[17] Acute injuries can sometimes benefit from this treatment (see precautions below).

Increased connective tissue pliability Heat applications increase the extensibility and elasticity of various connective tissues. In muscles and tissues closest to the skin, using superficial heat modalities works to raise the tissue temperature and thus increase tissue pliability. Current research in fascial physiology shows that there are neurological cells within fascia that govern fascial contractility.[18,19]

While significant thermal change from a heat application does not penetrate to the depth of many muscle tissues, topical thermal applications can still reduce tension in deeper muscles. The reason for this is that heat increases elasticity in superficial connective tissues and reduces fascial tension. There is a neurological integration of superficial fascia with that which permeates deeper muscles. Consequently a reduction in superficial fascial tension from the heat application produces neurological responses that are followed in the deeper fascia producing a similar muscular relaxation response.

Because muscles have such a large percentage of connective tissue in them, it is helpful to use a heat modality before performing therapeutic stretching procedures. Stretching the connective tissues is more effective when they are warmer and the neurological response of the heat is transmitted to deeper muscles, making them easier to stretch as well.

A superficial heating modality provides little increase in connective tissue pliability for connective tissues around deep joints such as the joint capsule of the shoulder or ligaments of the hip. These joints are too deep for any significant thermal effects to reach. Heating these tissues requires a thermal modality other than topical applications. To cause a temperature change in these deeper muscle tissues, a qualified practitioner would have to use a deep heating modality such as ultrasound or diathermy.

Decreased muscle tightness Heat has a soothing effect which decreases excess neurological activity and reduces muscular hypertonicity. Heat is thought to reduce the firing rate of muscle spindle cells and decrease activity in the gamma efferent system of the spindles. The reduction in muscle spindle activity reduces muscle tightness. Heat may also increase the firing rate of Golgi tendon organs, also a factor that will lead to the reduction in muscle tension.[20]

Increase in nerve conduction velocity Reductions in muscle tightness that result from increased heat sensations are likely related to the increase in nerve conduction velocity of various sensory impulses.[21] Increased tissue temperature may also improve coordination in muscular activities and reduce biomechanical dysfunction because of improved conduction of motor nerve impulses.

Increased pain threshold A reduction in pain sensations helps break the pain–spasm–pain cycle, so a reduction in pain has lasting effects for many soft-tissue disorders. Thermal applications produce additional signals from afferent fibers which arrive at the central nervous system first and essentially override some of pain signals. Nerve conduction can also be reduced by raising the skin temperature and thus change the perception of pain. Any reduction in hypertonicity or spasm would also reduce pain.

Precautions and contraindications for heat

Heat, whilst usually and generally a positive modality for treating pain and injury, can cause further injury or delay healing in some situations. Taking precautions in using heat modalities overall and knowing when not to use them is important for the soft-tissue therapists. A proper assessment is necessary to ascertain the appropriateness of heat.

Acute injury or inflammation Heat applications can aggravate an acute injury or inflammatory condition. Heating the tissues speeds up metabolic processes and increases the inflammatory response. The acute inflammatory phase of most acute injuries is mostly complete after about 72 hours. After

Box 3.3 Precautions and Contraindications for Heat

- Acute injury or inflammation
- Recent or potential hemorrhage
- Increased formation of edema
- Impaired sensation
- Modalities that are too hot
- Impaired mental ability
- Thrombophlebitis
- Malignancy
- Pregnancy
- Broken or irritated skin
- Topical analgesics

this time, heat modalities are safer to use; however, one should use caution. In systemic inflammation, such as rheumatoid arthritis, heat can be contraindicated as it furthers damage.

Recent or potential hemorrhage Because heat applications stimulate circulation heat modalities should not be used if there is any suspicion of uncontrolled bleeding in the area. By decreasing the viscosity of the blood, the heat could aggravate this type of problem.

Increased formation of edema Edema (swelling) develops in response to traumatic tissue damage in the region of the injury. Heat applications increase the movement of fluids to the area. The clinician should be judicious in the use of heat modalities when swelling is present.

Impaired sensation If an individual has some form of sensory nerve impairment and is not able to feel sensations on the skin, heat applications should be used with great caution. Individuals can receive burns from heat applications because they do not perceive the pain sensations from the excess heat. Local nerve damage or systemic neurological disorders could also cause nerve damage severe enough to impair the perception of excess heat.

Modalities that are too hot Certain modalities, such as moist heat packs or hot stones that are heated in hot water, can be very hot. The client can be burned if the heat modality is placed directly on the skin without proper insulation. A general guideline is that if you can't comfortably leave your hand in the hot water that the modality was heated in, you need some level of insulation before placing it on the client's body. Always test the temperature of the modality prior to placing it upon the client.

Impaired mental ability An individual with impaired sensation or cognitive function is not able to determine if there is an excess of temperature applied to the body. Impaired mental abilities may result from genetic disorders, trauma, disease, medications, or other substances the client may have taken.

Thrombophlebitis An increase in circulation and/or reduction in viscosity of the blood from the heat application can dislodge the clot and cause a cerebro-vascular accident (stroke) or even death. Local swelling, particularly in the lower extremity, could involve clotting. Always ask the client if they have a blood clot.

Malignancy If the individual has malignant tumors, thermotherapy in the region is contraindicated. There is a possibility that growth of the tumor could be encouraged through an increase in circulation or an increase in local cellular metabolic activity.

Pregnancy Local applications of heat are generally not a problem for pregnant women. What is of concern is any form of heat that could increase the temperature which the fetus is exposed to. For example, therapeutic ultrasound that produces heat effects could be detrimental if aimed in the direction of the fetus. The density of the bones in the fetus could selectively absorb the ultrasonic injury and cause injury. The frequency level of diagnostic ultrasound (which is used frequently during pregnancy) is much different, and does not produce heat changes in the tissue. Full body immersions in hot water, especially for longer than 15 minutes, could cause adverse effects because the body temperature could be raised to a level that is harmful to the fetus.

Broken or irritated skin When the skin is broken there is an increased chance of infections being started. Any broken skin should be kept clear of thermotherapy to prevent risk of infection or transmission of infection to another individual. In most instances, the client is going to be aware of any broken or irritated skin and their pain is most likely to discourage the application of any thermal modality on the broken skin.

Topical analgesics Some advise against applying heat over topical analgesics that cause the skin to vasodilate, such as menthol or capsaicin due to a concern over burns possibly resulting.

COLD APPLICATIONS

Cold applications, or cryotherapy, have effects that are, for the most part, opposite to those of heat. Cryotherapy is the ideal treatment modality for acute injuries because of its effect on arresting inflammation and slowing local tissue metabolism. They are used extensively in the athletic environment as cold helps injured athletes to return to activity sooner.[22]

There are no deep, penetrating cold modalities as there are with heat; all cold modalities are superficial applications. In order for a cold application to be effective, the target tissue must cool by transferring heat out of itself. There is little significant temperature change at depths greater than about 1 cm below the skin.[14,16,23] Consequently, cryotherapy is impractical for deep anatomical structures. Practitioners must also consider the insulating capabilities of adipose tissue as its presence reduces the impact of cold applications on deeper tissues.[24] Monitoring cold applications is just as important as with heat. Frequently check in with the client for comfort and tolerance levels.

Box 3.4 Cold Modalities

- Ice bag
- Chemical gel packs
- Ice massage
- Cold immersion
- Whirlpool tub
- Vapo-coolant sprays

Cold modalities

An ice bag is applied to the body using a plastic or rubber bag that holds the ice and helps it mold to the shape of the body. The plastic bag acts as a partial insulator and keeps the ice from causing tissue damage from prolonged direct exposure to cold. Since the ice bag treatment uses conduction as a means of heat transfer, the bag (plastic) will never get as cold as ice placed directly on the skin. Therefore, the plastic provides a degree of insulation to keep the ice application from causing damage.

Although suggestions for treatment times vary, a generally accepted period of application is about 10–20 minutes.[25–27] One study found that repeated applications of 10 minutes was the most effective cryotherapy application for generating beneficial tissue temperature changes and avoiding adverse affects.[28]

In many situations, an ice bag is the preferred treatment because it can effectively mold to a body part that has an odd shape. Bags of frozen vegetables like peas or corn are used for this purpose as well, and make a great home treatment. The benefit of frozen vegetables, peas for example, is that they are much smaller than ice cubes, and will often provide a more effective contour to the body part. However, they are not as effective as crushed ice. Bags of crushed ice or ice water immersion appear to be the most effective cryotherapy methods.[29,30]

Chemical gel packs contain a chemical compound that gets very cold when frozen. Gel packs are frozen in a freezer and can be reused. They are usually designed to fit a certain region of the body, and may have Velcro fasteners or straps that hold them in place. The approximate length of time for a chemical ice pack application is 20 minutes. However, the client should be monitored when using a chemical cold pack (or tell them to pay close attention to signs and symptoms if using them alone). Some of chemical cold packs freeze at a lower temperature than water, and may be colder than initially apparent.

Chemical gel packs are commercially popular and convenient. Ice that melts in a plastic bag when you apply it can sometimes be messy. There is no similar mess with the chemical gel packs. However, comparative studies of different cryotherapeutic modalities have found gel packs to be some of the least effective at achieving beneficial therapeutic results.[29,30] Gel packs are not as effective as ice applications.

Ice massage allows the beneficial effects of cold to be combined with tissue manipulation. Ice massage is also an effective way to produce a cryotherapy treatment in a short duration of time.[31] This cold application begins with forming ice in a shape that is easy to handle. The most common method is freezing a paper cup filled with water. Once the water in the cup is frozen, the top of the cup is peeled away to reveal the ice. The cup provides an insulated handle for the practitioner to use when applying the ice treatment. The ice is rubbed over the area until the client experiences the four stages of cryotherapy treatment (see below). Ice application times vary, but they are usually no longer than 5 minutes in any one area because the ice is directly touching the skin. Ice massage is effective when performed in conjunction with massage treatments such as deep transverse friction.

Cold immersion is an effective cryotherapy treatment for regions such as the distal extremities. In this application the extremity is submerged in ice water. Because cold is applied directly to the skin, this treatment should not last longer than 5 minutes. Closely monitor the client in ice immersion treatments because the area being treated (such as an ankle) will cool faster than connected areas left out of the water (like the toes). Extensive ice immersion treatments can cause tissue damage to distal extremities where circulation is poor, and should therefore be used with caution.

Cold immersion is also done in whirlpools where the cold water is continuously circulated around the affected area. The water temperature in any of these ice immersion treatments can be adjusted so it is not too cold for the length of treatment. Ice water immersion is one of the most effective methods of cryotherapy application.[25]

Vapo-coolant sprays, such as fluori-methane, are another superficial cold application.[32] Fluori-methane and other vapo-coolants are substances kept in a pressurized bottle and then sprayed onto the skin surface. When exposed to air, these liquids evaporate rapidly, causing the underlying tissue to be chilled. Vapo-coolant sprays have become less popular in recent years because their use is linked to environmental damage such as ozone depletion.[33,34]

Cold benefits and contraindications

As with heat applications, selection of the proper cryotherapy method is dependent on the physiological goals of treatment. These goals arise from an understanding of the physiological effects of cold applications. The length of time for a cryotherapy treatment is dependent on a number of variables. For most cryotherapy treatments there are four distinct stages of cryotherapy treatment, which indicate stages of the body's response to the cold. These stages generally occur in the following order:

- Appreciation or strong sensation of the cold
- Burning sensations in the skin
- Deep aching sensations
- Numbness (lack of sensation).

When the stage of numbness is achieved, the cryotherapy application can be terminated. Decrease of sensory input (numbness) is the end goal of most cryotherapy treatment. Continued use of a cryotherapy treatment past the point of numbness can be dangerous, especially if the source of the cold, such as ice, is put directly on the skin without any insulating barrier. Prolonged application of cryotherapy can lead to frostbite or nerve damage. It is important to closely monitor the client during cryotherapy treatment.

While there are general guidelines for cryotherapy application, several factors can alter those guidelines and should be considered. The effect of

Box 3.5 Benefits of Cold

- Cellular metabolism is slowed, shortening healing time
- Swelling from acute injuries is reduced
- Blood flow is inhibited, also reducing inflammation
- Heat from inflammation is reduced
- Sensory signals are slowed, reducing pain
- Pain tolerance is heightened
- Acute spasm may be inhibited
- Reduces muscle soreness
- Decreases muscle tightness
- Helps break the pain–spasm–pain cycle

any thermal application can vary among individuals so the length of treatment for one person may be different than for another. The subcutaneous body fat is a highly effective insulating layer so the discrepancy in body fat percentage makes a difference in how two different people respond to any thermal modality.[24] Differences in adipose tissue in different body regions in one person also affect how long cryotherapy applications should be applied.

Benefits

Metabolism Cold applications slow down the cellular metabolic activity in the region where the cold is applied. Reduced metabolism is a primary benefit of cold applications, especially in acute injuries. The excess cellular metabolic activity in acute injuries is one factor that prolongs the healing process. Using cryotherapy immediately after the injury brings this metabolic activity under control and shortens the recovery period from the injury. Compression is usually applied to an acute injury along with ice applications. Reducing metabolic activity at the injury site is more effectively done when using ice in combination with compression.[35]

Circulation In response to cold sensations, the smooth muscle cells in the walls of the superficial blood vessels contract and produce vasoconstriction. Vasoconstriction is more pronounced with cold applications in some regions of the body, the distal extremities in particular. Blood flow is reduced with cold application in order to keep the overall body from becoming too cold. Circulation is usually decreased initially with cold applications, but a reaction called 'the hunting response' can occur after about 15 minutes, especially in the distal extremities. This response may repeat as a cycle of vasoconstriction and vasodilation during the entire application of the cryotherapy.[36] Attempting to incite vasodilation with cold is not recommended as a therapy. (The physiological effects on circulation can be either a benefit or a contraindication depending on the circumstances.)

Decreased edema Swelling and inflammation from an acute injury can be reduced with cryotherapy. Accumulation of excess fluids in the tissues around an injury is a primary cause of pain with injuries in the acute stage. By reducing the temperature in the tissues, heat is reduced. Cold also reduces blood viscosity and capillary permeability, which along with vasoconstriction inhibits blood flow and thus, the movement of fluids to the inflamed area.

The use of cryotherapy for the reduction of edema should be limited to acute injuries. Chronic edema due to poor circulation or immobility benefits more from heat applications that increase connective tissue pliability and encourage greater tissue fluid movement.

Decreased nerve conduction velocity and pain Cryotherapy slows the rate at which nerve impulses are propagated along a peripheral nerve. The slowing of this impulse affects both sensory and motor signals in the nerve. Slowing of motor signal transmission is evident by the lack of muscular coordination in an area that has had cryotherapy application. Sensory signals are slowed as well. The reduction of sensory signals is beneficial in reducing pain sensations following an injury. Pain reduction helps break the pain–spasm–pain cycle and contributes to a decrease in muscular hypertonicity.

If the cold application is of short duration (about 15 minutes), nerve conduction velocity returns to normal relatively soon. In cold applications that are 20 minutes or longer, it may take close to 30 minutes for nerve conduction velocity to return to baseline levels.[2] With a decrease in nerve conduction velocity, there is a decrease in the reporting of pain sensations. This nerve signal reduction gives the individual a heightened level of pain tolerance. However, the higher pain tolerance is limited to the tissues that are chilled with the cryotherapy application.

Decreased stretch reflex A corresponding part of the reduction in nerve conduction velocity is a reduction in the myotatic or stretch reflex. This reflex is activated by the muscle spindles when they are stretched either too far or too fast (as in whiplash). Overstretching a hypertonic muscle can also activate the muscle spindles, causing increased muscle tension. Cryotherapy is one avenue to decrease the activation of the muscle spindles so that stretching procedures can be more effective. This physiological effect will be most useful in acute muscle spasm where there is significant muscle tension that is difficult to reduce. However, cold applications decrease the pliability of connective tissues so attempting to aid stretching with cryotherapy may be limited. The practitioner will need to weigh the benefits of decreased neurological activity vs decreased connective tissue pliability.

Reduction in muscle soreness Cryotherapy helps reduce certain types of muscle soreness, especially the delayed onset muscle soreness (DOMS) associated with increased levels of unaccustomed exercise.[37,38] In addition, cryotherapy is used to reduce post-treatment soreness after certain methods of soft-tissue manipulation.

Decreased muscle tightness A reduction in muscle tightness occurs as a result of the reduction in motor nerve conduction velocity. By reducing motor signals and concurrently reducing pain sensations, cold application helps break the pain–spasm–pain cycle.

Contrast treatments In some instances, the beneficial effects of both heat and cold are desired. Alternating heat and cold modalities is called a contrast treatment. The use of heat and cold in quick succession is theorized to produce a flushing of the blood and tissue fluids. While contrast treatments are used routinely in rehabilitation settings, the research does not support many of the ideas behind contrast treatments. There are claims that contrast therapy enhances circulation though cyclical temperature fluctuations. However, in several studies contrast therapy did not appear to produce many of these purported temperature fluctuations.[16,39]

While contrast therapy may not produce the significant tissue temperature changes once thought, it still has benefits. There are valuable neurological responses to the alternating heat and cold, which are the most likely reason for clinical successes with contrast therapy. Recommendations for how long heat is used compared to how long the cold is used are variable. Time constraints of the two treatments often depend upon the situation and the individual. A general guideline is a 3:1 ratio of heat to cold. For every 3 minutes of heat there will be 1 minute of cold.[14] Consider the physiological effects of both the heat and cold applications when designing a contrast treatment.

Precautions and contraindications to cold

Many of the precautions for heat applications are the same as for cold. The following list of contraindications is relative – meaning a modality may be contraindicated in some cases, but not in all. Apply thoughtful clinical reasoning to determine if the physiology of the condition and treatment goals warrant one of the different cold applications mentioned. In some cases certain physiological effects of cold are desirable, but not others. If that is the case, then it is best to estimate if the benefits of using the cold application outweigh the drawbacks. Evaluation should always assess the client for the conditions listed below.

Box 3.6 Precautions for Cold

- Broken or irritated skin
- Cold intolerance or cold allergy
- Raynaud's disease
- Conditions of circulatory compromise
- Decreased connective tissue pliability
- Areas of superficial nerves
- Sensory nerve impairment
- Impaired mental ability

Broken or irritated skin Keep cryotherapy applications clear of broken skin to prevent the risk of infection or transmission of infection to another individual.

Cold intolerance or cold allergy Some individuals are not able to tolerate cryotherapy, and may have allergic reactions that are visible on the skin. They may break out in hives or rashes immediately or within a few minutes of placing a cold application on them. In many cases, the person does not know they have a cold allergy, so it is important to monitor the client when the cold application is first applied.

Raynaud's disease This is a condition involving arterial spasm that most commonly affects females between the ages of 18 and 30. The condition involves abnormal vasoconstriction in the extremities when they are exposed to cold. Emotional stress can also play a role in setting off the reaction.[40] The individual does not need to be exposed to extremes of cold for symptoms of Raynaud's to be evident. Most people who have this problem are aware of it because they have experienced the symptoms before.

Conditions of circulatory compromise Cryotherapy could further aggravate any condition that involves an undesirable reduction in circulation.

Decreased connective tissue pliability Heat increases the pliability in connective tissues and cold does just the opposite. In most instances, the goal of therapeutic procedures is to increase connective tissue pliability, so this physiological effect is usually undesirable. The practitioner should weigh the benefits of using cold application if an increase in connective tissue pliability is a primary goal of the treatment procedure.

Over regions where nerves are superficial Nerve damage can occur from cryotherapy if the nerve is close to the skin, and does not have adequate insulating protection from the cold. Two common examples where nerves can be injured from superficial cold applications are the ulnar nerve on the posterior aspect of the elbow and the peroneal nerve on the lateral aspect of the knee near the fibular head.

Impaired sensation If an individual has sensory nerve impairment and is not able to feel sensations on the skin, use caution or don't use cryotherapy at all. Always ask the client whether the client has a condition that impairs their sensations. Frostbite or nerve damage could occur because an individual does not feel the skin go through the various stages of cold application.[38]

Impaired mental ability As with impaired sensation if an individual does not have full and normally functioning cognitive powers, they might not be able to determine if there is an excess of temperature applied to the body. Impaired mental abilities can result from genetic disorders, trauma, disease, medications, or other substances they might have taken.

TOPICAL ANALGESICS AS THERMAL AGENTS

Analgesics are substances or agents that relieve pain without causing a loss of consciousness.[41] Most of us are familiar with oral analgesics such as aspirin or ibuprofen. Topical analgesics (TAs) are pain-relieving substances placed or rubbed directly on the skin in order to relieve pain and are popular forms of pain relief. A 1987 survey indicated that 34% of adults in the United States use TAs for some form of pain relief.[42]

Advertisements for topical analgesics sometimes tout their benefits in producing heat or cooling effects on the body. However, these claims can be misleading because topical analgesics are not true thermal modalities. Yet, there are therapeutic benefits to their use in certain conditions. The practitioner should understand how topical analgesics work in order to evaluate their physiological effects and if they are appropriate for specific clients.

Categories of topical analgesics

There are several categories of topical analgesics, depending upon their active ingredients. Some analgesics contain medications that are not legally dispensed in over-the-counter preparations, so they are not used by most massage practitioners.[43] The more common TAs that massage practitioners use fall into a category sometimes called rubefacients. A rubefacient is an agent that reddens the skin by producing active or passive hyperemia.[41] The majority of rubefacient TAs fall into one of three categories: counterirritants, salicylates, and capsaicin. The physiological properties of each category are described below. Several brand names are mentioned so it is clear which category various products fall into. All brand names listed are considered trademarked names.

Counterirritants

The majority of TAs used by massage practitioners is counterirritant. A counterirritant is an agent that produces a superficial irritation in one part of the body that is intended to relieve irritation in another part. The irritation produced by these substances is most commonly a chemical stimulation of thermal receptors in the skin, which produce a sensation of heat or cold. Popular brand names for counterirritants include: ArthriCare, Eucalyptamint, Atomic Balm, Icy Hot, Prossage Heat, Tiger Balm, Nature's Chemist, Biofreeze, and Therapeutic Mineral Ice.

The brand names for these various products reflect the emphasis on the sensation of heat or cold experienced from their use. For example, you would probably expect to have a sensation of heat from Prossage Heat or Atomic Balm. Likewise you would expect to have a sensation of cold from Therapeutic Mineral Ice. But what about Icy Hot? Each person's physiology may respond a little differently to the formula of the analgesic. Therefore some people may have a sensation of heat from Tiger Balm while others have a sensation of cold.

Salicylates

The salicylates are a group of related compounds derived from salicylic acid. They contain similar pharmacological agents as aspirin. Salicylates have several beneficial physiological effects. They are known to inhibit prostaglandin synthesis, reduce inflammatory activity, and aid in fever reduction and pain management. A review of salicylates show that in some cases they are beneficial, while in others they are only moderately helpful and in some cases not helpful at all (as in chronic arthritic and rheumatic pain).[44] Popular brand names for salicylates include: Aspercreme, Ben Gay, Flexall, Mobisyl, and Sportscreme.

Capsaicin

Many people are familiar with a sensation of heat felt on the skin when it is exposed to cayenne pepper. In cold weather climates or winter sports activities, people put cayenne pepper in their socks to keep their toes warm. The active ingredient in cayenne pepper that produces this warming sensation is capsaicin. It is an alkaloid irritation to the skin and mucous membranes that produces pain-relieving sensations. Capsaicin binds to the nociceptors of the skin where it produces an initial excitation of neurons (often felt as burning, itching, or prickling). After the initial sensation (sometimes as long as 2 weeks) there is some desensitization that leads to the analgesic effects. There are adverse effects with some forms of topical capsaicin because it can produce a burning sensation at the site of application.[43] Therefore it is not as popular as other TAs, such as the counterirritants. Brand names for analgesics containing capsaicin include: Zostrix, Zoxtrix HP, and Capzasin-P. Some sources suggest not using heat modalities over TAs such as capsaicin. Gloves should be worn for application in order to prevent it getting into sensitive skin areas.

Therapeutic effects of topical analgesics

Counterirritants are members of the primary group of TAs that is used in thermal application (correctly or incorrectly), so this discussion of physiological effects emphasizes that group. The effects of the counterirritants can be grouped into three primary categories: neurological, circulatory, and thermal.

Neurological

Interestingly, the neurological responses are the most significant benefits of TAs. Counterirritants work by chemically stimulating (irritating) sensory receptors in the skin, especially those associated with thermal sensations. The irritation of receptors in the skin may also inhibit pain signals reported from the nociceptors (pain receptors), thereby blocking pain sensations sent to the brain. This description is based on the gate theory of pain described earlier in the chapter.

While the receptors that are activated by the TA are located in the skin, the neurological effects are not limited to the skin. For example, a reduction of muscle tension often results from the chemical stimulation of sensory receptors in the skin.[45] Muscular pain reduction is a goal in most soft-tissue treatments so these substances can be helpful. Note, however, that the other physiological effects of true heat or cold applications, such as changes in connective tissue pliability or nerve conduction velocity, are not necessarily present with TA application.

Circulatory

The chemical stimulation of receptors in the skin produces a superficial vasodilation. Cutaneous vasodilation produces local hyperemia and accounts for the redness that can result from certain analgesics. The increase in circulation is local and only in the superficial tissues, so TAs shouldn't be considered a means of increasing circulation to damaged tissues at deeper levels. The increase in circulation can produce a slight temperature increase due to the increased circulation in the skin. However, this temperature increase is relatively small and it is questionable whether the small increase can produce any therapeutic benefits from the heat increase alone. The thermal results of TAs are discussed in greater detail below.

Thermal

There is a difference between a sensation of heat or cold and an actual temperature change within the tissues. The primary effects of counterirritants result from chemically stimulating the thermal receptors in the skin. The stimulation of these receptors causes the brain to perceive sensations of heat or cold. Yet there is no ingredient in TAs capable of producing a therapeutically relevant temperature change in the tissues. The therapeutic benefits of heat for soft tissues, especially the deeper tissues do not occur until the tissues reach a temperature of between 104°F and 113°F.[46]

As mentioned above under circulatory effects, local circulation increases from TAs may create a small temperature increase in the skin. One study that evaluated Eucalyptamint found the local circulation increase caused a skin temperature rise of approximately 1.5°F.[47] This slight temperature increase was limited to the skin and did not penetrate to deeper tissues.

When a TA is applied it is likely at room temperature (about 70°F). Of the four methods of heat transfer (conduction, convection, conversion, and radiation) the only one that is feasible for a topically applied cream to heat tissues is conduction. Therefore, to reach the temperature level considered necessary for therapeutic change in deeper tissues, the TA would have to be at least 30°F–40°F warmer than room temperature. Without being at this temperature there may be a sensation of heat but no significant thermal change in the tissues.

Precautions

As with heat or cold modalities, there are contraindications for the use of TAs. Practitioners should not assume the therapy will make deeper tissues more pliable, as that assumption could lead the practitioner to be overzealous in their soft-tissue treatment. Likewise, a person who applies a cold sensation TA to an acute injury with the idea of reducing inflammation may, in fact, use it inappropriately by increasing local circulation to the injury site in the acute phase. Finally, some argue that one should never use a TA with a heat application, as burns can result due to the skin possibly reaching the limit of vasodilation.[2]

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Chapter 4

Introduction to specific massage techniques

CHAPTER CONTENTS

Chapter 1 described orthopedic massage as a comprehensive rehabilitation system and not a particular technique. Consequently, an orthopedic massage treatment plan is capable of integrating a variety of massage techniques. Practitioner's who have a diversity of treatment techniques in their massage 'tool belt' are allowed a wider range of treatment options. Yet, the fundamental lesson of orthopedic massage is not 'how many', but how well one applies their knowledge and critical thinking skills. Thus, a really astute therapist with only the basic number of techniques in their tool belt is likely to be a more effective therapist than someone who has a host of techniques but is not yet skilled enough in evaluation and application.

This chapter presents the most common techniques that have been shown to be clinically effective in treating the soft-tissue pathologies described in Section 2. There is no single technique that is ideal for every condition. The hallmark of an excellent clinician is one who can determine the nature of each client's complaint and choose the most appropriate methods for each unique client. The techniques presented in this chapter should be viewed as a foundation upon which one builds a clinical treatment approach. The following provide practitioners with a basic set of tools that they may expand upon.

While there are innumerable treatment techniques available, the following basic set have defendable physiological rationales for their employment. The crucial factor is to match the physiological effects of the technique used (physiological effects are discussed in Chapter 5) with the physiology of the client's injury condition. Creative clinical thinking will allow the practitioner to use tried and tested techniques or consider new ways to apply familiar techniques with an innovative approach. No technique in and of itself is either good or bad; its effectiveness is directly related to the situation in which it is used by the clinician. Exceptional clinical results are a combination of effective manual techniques, correctly applied by the practitioner, and sound clinical judgment about the most effective treatment approach.

The discussion below begins with some of the traditional massage methods and progresses to several newer techniques that have evolved from the classical methods. I have found the following valuable in treating a wide array of soft-tissue disorders. Exclusion of any particular technique does not necessarily imply that the technique is not valuable or helpful; only, perhaps that it is not widely used in treating most soft-tissue disorders. These techniques may be applied to virtually any region of the body.

MASSAGE TECHNIQUES

Massage techniques go by a wide variety of names. What one practitioner calls trigger point therapy, another calls pressure point release, acupressure, or shiatsu. In describing these techniques, I have attempted to use simple and/or the most common names whenever possible to avoid confusion. In some cases treatment techniques are identified with the individual that made the technique popular, e.g. Rolfing, Graston technique, or Bowen Therapy. These 'named' techniques are often modifications or elaborations of the basic methods presented in this chapter.

Sound palpatory skills and an awareness of the client's response to a technique are prerequisites for effective massage. Most massage techniques have a range of pressure levels understood to be more or less effective. Understanding what the average pressure level is for a particular technique is only half of the equation. The other half is the knowledge of what the client's tolerance level is. Adequate pressure is usually defined as the point of the pain/pleasure threshold for that particular client. The importance of a quality communicative environment for the client to express him/herself cannot be understated, particularly with pain and injury treatment.

In addition to the client's feedback, the practitioner must be skilled in reading the client's tissue response to gauge the appropriate pressure level. If the client is tightening up with reactive muscle splinting in the treatment area, then the pressure is too much. The practitioner must gauge how the client's tissues react and not rely solely on the client's feedback for pain or pressure levels. Developed palpation skills will provide the practitioner with much information about their client's responses and the effectiveness of the treatment.

Effleurage (gliding)

The most common massage technique is the gliding stroke and is commonly referred to within the Swedish system as effleurage. Many massage treatments begin with this stroke. It is beneficial for spreading lubricant, warming the tissues, reducing muscular tension, and enhancing tissue fluid movement. In this technique the hands mold to the body part being treated and a smooth gliding stroke is applied (Fig. 4.1). Effleurage is performed parallel to the primary fiber direction.

This technique significantly affects the circulatory system and produces mechanical pressure on the veins so it should always be performed toward the heart, especially in the lower extremities.[1,2,3] Performing effleurage toward the heart will reduce the likelihood of dislodging a thrombus.[4] Effleurage strokes can be performed with a variety of contact surfaces. The broad surface of the hand is

Figure 4.1 Effleurage applied to the hamstring muscles.

used most often. In less accessible or smaller body regions, the fingers or thumb can be used. In larger body regions, such as the back or posterior lower extremity, the gliding stroke can be applied with a broad contact surface such as the back of the hand or forearm.

Unfortunately, too many practitioners consider effleurage to be only a means of starting treatment and spreading lubricant. Effleurage is a versatile treatment method and one of the most effective massage strokes. You can alter the pressure level, speed of application, and angle of pressure to create many different variations of this simple technique. Several of the techniques described later in this chapter are based on effleurage strokes.

Box 4.1 Foundational Techniques

- Effleurage (gliding)
- Sweeping cross fiber
- Compression broadening
- Friction massage
- Deep longitudinal stripping
- Static compression
- Massage with passive engagement
- Massage with active engagement
- Myofascial approaches
- Stretching methods

Sweeping cross fiber

Sweeping cross fiber is similar to effleurage in that it is primarily a gliding stroke, but there is a superficial cross fiber component. While the strokes of effleurage are parallel to the primary fiber direction, in the sweeping cross fiber technique the stroke moves diagonally across fibers of the muscle being treated. A common method of performing this movement is with a sweeping motion of the thumb and wrist. During the sweeping motion flex the thumb toward the palm and move the wrist in ulnar deviation (Fig. 4.2). These combined movements of the hand and thumb produce the stroke that diagonally sweeps across the fiber direction. The primary pressure of the stroke is underneath the moving thumb.

Figure 4.2 Sweeping cross fiber to the wrist extensor muscles.

This technique is similar to the method called *Deep Muscle Therapy* developed by Therese Pfrimmer in Canada in the 1940s. The pressure level of the stroke is usually moderate, but could be more or less depending on the physiological effects desired and the client's pressure level tolerance. Sweeping cross fiber techniques encourage tissue fluid flow, warm the soft tissues, enhance pliability, and reduce tension in the muscular fibers. The sweeping motion that moves diagonally across the fiber direction is believed to enhance pliability through broadening and separating muscular fibers.

Compression broadening

To be healthy and fully functional a muscle must be able to fully contract and elongate. When a muscle contracts, it also broadens due to the overlapping sarcomeres within the fiber.[5] *Compression broadening techniques* are designed to mimic this natural broadening action of the whole muscle, although they do not actually broaden individual muscle fibers. The technique enhances elasticity and pliability in the muscle by using deep pressure perpendicular to the muscle fiber direction. Pliability is improved through the reduction of intramuscular adhesion among parallel fibers.[6] This stroke is particularly effective when used as part of the active engagement methods described later.

To perform compression broadening you must apply pressure to the target muscle whilst performing a broad cross fiber stroke (perpendicular to the muscle fiber direction) (Fig. 4.3). In areas of large muscle mass, apply the compression

Figure 4.3 Compression broadening to the posterior calf muscles.

with a broad contact surface, such as the palm of the hand. On small muscle groups, such as the wrist flexors or extensors, the region to be treated is much smaller so use the thenar aspect of the hand or thumb.

Friction

Friction treatments move adjacent tissues in relation to each other (usually superficial over deeper tissues). There are several variations of friction but all emphasize moderate to deep pressure and mobilizing adjacent tissues. Circular friction is performed with a broad contact surface such as the heel of the hand for more general applications or a small contact surface, such as the fingertips for treating a specific area. The hand, fingers, or thumb do not glide over the skin but retain contact with the skin and move with it during treatment (Fig. 4.4).

Figure 4.4 Circular friction around the patellar retinaculum.

Circular friction can start with light pressure to address the superficial tissues and then increase to more significant pressure to decrease tension in the deeper tissues.

Many soft-tissue injuries, especially those involving fibrous scar tissue, are treated with friction that is transverse (perpendicular) to the fiber direction, instead of circular.[7–10] Deep transverse friction (DTF), originally described by James Cyriax, is the primary technique used for this approach.[11] Transverse friction is used for separating adhesions between damaged fibers.[10,12–14]

Transverse movement is important for conditions where there is a disruption or tearing of the tissue fiber, such as in muscle strains or ligament sprains. In these conditions a back-and-forth friction movement is valuable because of its ability to break the cross linking bonds of fibrous scar tissue that have bound adjacent muscle, tendon or ligament fibers together.[6,10] Transverse friction is also helpful in tenosynovitis, in which the transverse movement helps break up the fibrous adhesions that have developed between the tendon and its surrounding synovial sheath.

Deep friction treatment is also used to treat tendinitis/tendinosis, with the idea that the transverse movement helps decrease fibrous adhesions between torn tendon fibers.[15] However, recent studies into the nature of tendinitis indicate that common overuse tendon disorders do not involve fiber tearing or an inflammatory reaction, but a degeneration of collagen fiber within the tendon instead. For this reason, the term tendinosis is preferred over tendonitis (see Tendinosis, Chapter 2).[16–18] Despite the lack of torn fibers and inflammatory activity in tendinosis, DTF is effective in treating these complaints.

The primary benefit of DTF in treating tendinosis appears to be stimulation of fibroblast activity in the degenerated tendon and not reducing adhesions between torn tendon fibers.[19] Thus, friction massage does not need to be transverse to the primary fibers to be effective when treating tendinosis. Longitudinal friction (applied parallel to the tendon fiber direction) can achieve the same results as transverse movement. The fibroblast mobilization in damaged tendon fibers that is stimulated by friction appears to result from the combination of pressure and movement and not from the direction in which pressure is applied.[20]

Figure 4.5 Deep transverse friction to the wrist extensor tendons.

The practitioner performs DTF by placing the fingers on the skin and then applying a back and forth motion that is perpendicular to the fiber direction (Fig. 4.5). The friction technique is applied directly to the site of the soft-tissue lesion. DTF applications use a significant amount of pressure. However, too much pressure can cause reactive muscle splinting or further tissue injury. Deep friction is most effective when the client reports the sensation as uncomfortable, even mildly painful, but bearable. If the pressure is within tolerable limits a sensation of analgesia can develop after a few minutes of treatment, decreasing the discomfort and making the treatment more tolerable.[10] The analgesia effect is likely due to stimulation of non-pain sensory receptors and nociceptor inhibition as described in the gate theory of pain.[21–23]

There are different views on how long DTF should be applied. Cyriax advocated treatments of 20-minutes' duration given every other day in an ideal treatment setting.[24] Some recommend shorter treatments, such as 10 minutes.[10] The author has found it effective to apply much shorter durations of friction treatment and to intersperse the friction with other techniques. For example, apply deep friction for 20–30 seconds and then follow with other techniques, such as compressive effleurage, sweeping cross fiber, or compression broadening. Active and passive range of motion and stretching procedures can then be performed to encourage proper tissue remodeling. This combination of techniques is repeated several times during the treatment session.

Incorporating a variety of techniques along with the friction treatment gives maximum opportunity to mobilize the affected tissues and prevents the client from having to withstand long durations of DTF that can be uncomfortable. More specific guidelines for how to incorporate DTF with other treatments are given in the specific treatment suggestions for each condition in Section 2.

Deep longitudinal stripping

Deep longitudinal stripping technique involves a slow longitudinal gliding stroke applied to muscle or other soft tissue with the intent of encouraging tissue elongation and elasticity. *Deep tissue massage* is another common name for this technique, although this term can be misleading because many different techniques access deep tissues of the body. It is an excellent method for reducing hypertonicity and increasing pliability in muscles and connective tissues. When deep longitudinal stripping technique is applied to muscle fibers, it helps encourage lengthening and elasticity in those fibers leading to a reduction in hypertonicity (muscle tightness) and increased flexibility.

The deep, long gliding strokes create tangential pulling forces on superficial and deep connective tissues. These tangential forces stimulate Ruffini endings (a specialized sensory receptor cell in the skin) in the connective tissue creating a neurological response that leads to increased tissue relaxation.[25] Deep longitudinal striping is also the most effective way to inactivate myofascial trigger points when using a direct manual approach.[26] Deep longitudinal stripping techniques are parallel to the direction of the muscle fibers being treated. The stroke usually extends from one tendinous attachment of the muscle to the other. In some cases short segments of muscle or other soft tissue are treated without covering the entire length of the tissue.

The technique can be applied with varying levels of pressure, although it is most effective when the pressure level is moderately deep. Adequate pressure is usually when the client perceives it as right on the pain/pleasure threshold. In addition to the client's feedback, the practitioner must be skilled in reading the client's tissue response to gauge the appropriate pressure level. If the client is tightening up with reactive muscle splinting in the treatment area, then the pressure is too much. The practitioner must gauge how the client's tissues react and not rely solely on the client's feedback for pain or pressure levels. A detailed knowledge of anatomy and muscle fiber direction is also required to perform this technique correctly.

Stripping techniques are performed slowly due to the depth of pressure. If the practitioner is moving too fast across the tissue while applying significant pressure, the sensation can be very abrupt and uncomfortable for the client. Moving too fast across tissues also causes the practitioner to miss valuable tissue consistency changes perceived with palpation. Deep stripping techniques are particularly valuable for their diagnostic as well as treatment capabilities.

Longitudinal stripping can be performed with a broad contact surface, such as the palm, fist, or forearm (Fig. 4.6). With a broad contact surface the pressure is spread over a larger surface area so the pressure is not as intense for the client. Applying stripping techniques with a broad contact surface first is helpful to reduce tension in superficial tissues before treating deeper tissues. Muscles or other soft tissues can be treated more precisely with longitudinal stripping using a small contact surface. In these techniques pressure is delivered over a smaller surface area, so pressure is more concentrated on those tissues directly under contact. Examples of small contact pressure surfaces include thumbs, fingertips, knuckles,

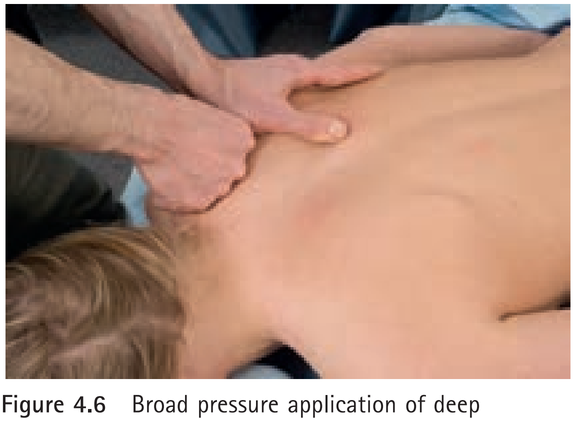

Figure 4.6 Broad pressure application of deep stripping with the back side of the right hand.

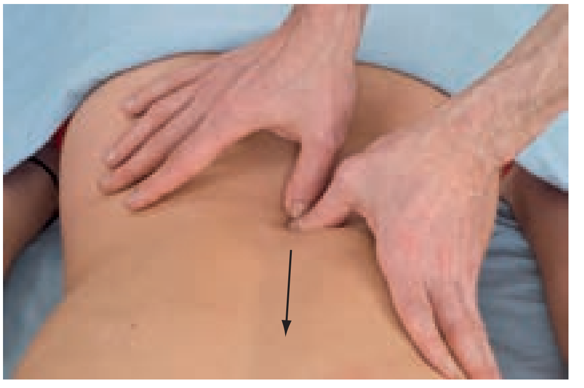

Figure 4.7 Small contact surface deep stripping on the intrinsic spinal muscles.

elbow, or pressure tools (Fig. 4.7). As with the broad contact surface treatments, the stroke should be slow, deep, and preferably close to the client's pain tolerance. All longitudinal stripping techniques should follow circulatory guidelines and move toward the heart when working on the extremities.

Static compression

Static compression is a technique of pressing directly on soft tissue in one location without moving the treatment hand. Numerous systems and techniques use static compression as a primary method of treatment. These systems differ mostly in their theoretical models and not in the way pressure is applied to the client's body. Examples of these systems include shiatsu, acupressure, myotherapy, and neuromuscular therapy. Static compression on pain points in the body can produce several physiological effects.[27] In this text attention focuses on static compression for its neuromuscular effects of reducing hypertonicity and deactivating myofascial trigger points in muscle tissue.

The amount of pressure used in static compression techniques varies depending on the practitioner's intended results. In their original discussions of myofascial trigger point treatment, Travell & Simons called their static compression technique ischemic compression, emphasizing a pressure level that would produce local tissue ischemia of the irritable trigger point.[28] However, later research developments led to a change in perspective for the most effective method to treat myofascial trigger points with static compression.

Myofascial trigger points appear to result from dysfunctional activity at the motor-end plate. In addition the hypertonic muscles compress local sensory nerves and lead to greater pain generation.[29] Pressure that is strong enough to produce local tissue ischemia could aggravate these sites in the muscle. Therefore, a gentler pressure on the trigger point appears to produce better treatment results, especially when combined with tissue stretching. This newer static compression technique for trigger points is called trigger point pressure release.[26,30]

As with deep stripping techniques, static compression is an important technique for identifying areas of hypertonicity or restriction in the tissues as well as the tissue's response to treatment. Palpation and static compression techniques have proven to be one of the most reliable methods of identifying myofascial trigger points in muscle tissue. However, the practitioner must have well-developed skills of palpation to identify these dysfunctional regions of muscle tissue.[31–33]

Another use of static compression is its integration with a technique called positional release. In positional release the practitioner uses static compression to identify a tender point in the target tissue. Pressure is maintained on the tender point while moving the body region in a variety of different positions. The client is asked to monitor the pain sensations in the tender point during the movement. Using these different positions, the practitioner attempts to find the position with the least discomfort and to hold the static compression along with the position.[34,35] After holding the compression and position for anywhere from a few seconds to more than a minute there is a reduction in local neurological activity that decreases muscle tightness.

Static compression can be performed with a broad base of pressure such as the palm, fist, or forearm (Fig. 4.8). Hold the pressure until you feel the tissues relax. If you have identified myofascial trigger points or regions of muscle tissue that appear hypertonic these regions can be treated with small contact applications of static compression, such as the thumbs, fingers, elbow, knuckles, or pressure tools (Fig. 4.9). Pressure is held for varying lengths of time, but you can usually achieve a therapeutic response in about 8–10 seconds. The therapeutic response is a reduction in tissue tightness or the client's report of reduced local or referred pain from pressure applied to the region.

Figure 4.8 Broad contact surface static compression to the lateral thigh region.

Figure 4.9 Small contact surface static compression to the tibialis posterior.

MASSAGE WITH ACTIVE AND PASSIVE MOVEMENT

This next section introduces a number of techniques that combine some of the methods described above along with either active or passive movement. Proper application of these techniques requires a sound knowledge of *kinesiology* (the study of human movement) due to the use of movements along with the soft-tissue manipulation. Different variations and positions can be used to access each muscle making a wide variety of treatment options.

Not every technique is appropriate for every client. For example, the techniques involving active engagement can be more uncomfortable than passive techniques for a client at the early stages of a soft-tissue injury because more muscle fibers are engaged in the active technique. In those cases it is best to keep the active techniques for the later stages of the rehabilitation process. More specific guidelines about active and passive engagement techniques are discussed with the injury treatment recommendations for each condition in Section 2.

Massage with passive engagement

Massage with passive engagement uses static compression, compression broadening, or deep longitudinal stripping in combination with passive joint movement. Joint movements are used that produce either shortening or lengthening of the target tissue being treated. Performing movement with specific soft-tissue manipulation magnifies some of the physiological effects of the technique.

Compression broadening, static compression, and deep longitudinal stripping techniques use a variety of contact surfaces both broad and small for different effects. The choice of contact surface and pressure level as well as the use of shortening or lengthening strokes creates a wide variety of technique variations.

Shortening strokes

In a shortening stroke the practitioner applies static compression to an area of the muscle that has a heightened neurological response, such as a myofascial trigger point, an area of restricted fascial movement, or muscle tightness. Once static pressure is applied over the area, the tissues underneath the pressure are shortened by moving the affected joint passively (Fig. 4.10). Most clients will feel a decrease in painful sensations as the tissue is brought into a shortened position.

The idea behind this technique is that decreasing the sensation of pain and restriction in the muscle tissue by moving it to a shortened position instead of forcibly trying to stretch it, may help decrease tension, trigger point activity, and neuromuscular dysfunction in that muscle. This procedure is particularly helpful in situations of severe muscle spasm, such as those which occur following an acute injury.

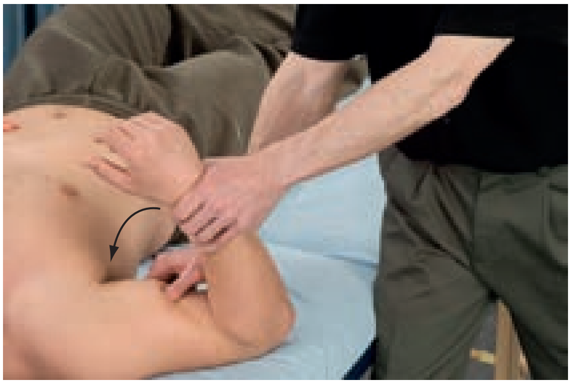

Figure 4.10 Passive engagement/shortening applied to the elbow flexors.

The final shortened position of the muscle may be held for longer periods to achieve a better neurological release. There are different theories about how long is a beneficial time to hold this position ranging from about 20 to 90 seconds.[35]

The primary effect of the shortening strokes is a reduction in neurological activity in the muscle. By applying pressure to a muscle and then decreasing the intensity of the pressure through passively shortening the muscle, there is less tension on the muscle fibers while they are being compressed. There may also be some myofascial effects of moving the muscle while pressure is maintained on it. This technique is very similar to procedures that go by the name of positional release or strain/counterstrain.[34,35]

Lengthening strokes

Lengthening strokes are most effective for mobilizing connective tissue, decreasing muscle tension, and increasing elongation in the myofascial tissues. Lengthening strokes are particularly effective for helping to encourage elongation and flexibility in tight muscles. The pressure applied to the tissue while it is being elongated helps in the stretching of both connective tissue and contractile elements within the muscle. There are two ways to perform lengthening strokes:

1. Static compression is applied to a particular area of the muscle while it is in the shortened position. The target muscle (the one being treated) is placed in a shortened position (for

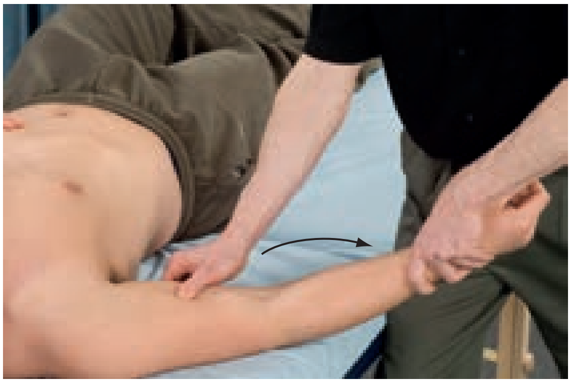

Figure 4.11 Passive engagement/lengthening with static compression applied to the elbow flexors.

Figure 4.12 Passive engagement/lengthening with longitudinal stripping applied to the wrist flexors.

example, elbow flexion is a shortened position for the biceps brachii). With static compression continually applied, the client's related joint or limb is moved so the target tissues are elongated. This technique is also called *pin and stretch* (Fig. 4.11). The static compression can be applied with a broad base of contact, such as the palm or back side of the hand initially. Using a broad base of contact allows the technique to feel a little less intense for the client. A broader contact surface also allows a greater expanse of connective tissue to be pulled and stretched. If a more specific application is desired or the area being treated is not large, a small contact surface such as thumbs, finger tips, elbows, or pressure tools can be used.

2. Another lengthening stroke is to use deep longitudinal stripping on the target muscle while moving the related joint or limb passively to lengthen the muscle (Fig. 4.12). Place the target muscle in a shortened position. Perform the deep stripping technique with a broad contact surface for more general applications or a small contact surface for more specific ones. The stripping technique can be repeated several times, working in parallel strips on the muscle, until the entire area is treated.

Massage with active engagement

The following techniques use static compression, compression broadening, or deep longitudinal stripping in combination with active movements of a muscle. The primary effects of active engagement techniques are both neurological and mechanical. In both variations, shortening (broadening) and lengthening, the pressure applied while the muscle is under contraction helps to reduce excessive muscle spindle activity and decrease overall muscle tension, just as any static compression technique would do. These techniques also help increase connective tissue mobility. In the shortening techniques the cross fiber movement performed with pressure helps to spread and broaden muscle fibers thereby decreasing any intramuscular adhesions and enhancing pliability. In the lengthening techniques, pressure applied while the muscle is increasing in length helps to pull and stretch the myofascial tissues and decrease overall muscle tension.

Massage with active engagement is effective for magnifying the muscle's neurological and mechanical responses to the techniques. For example, with muscles that are tight and also deep, it is hard to apply effective pressure when doing a longitudinal stripping technique without using a great deal of force. By having the client actively engage the area, the cumulative effect of the pressure is magnified because the density of the tissue is increased when the muscle is engaged in active contraction. Pressure during active contraction also helps mobilize some of the deep fascia surrounding these muscles.

A benefit to this approach is that practitioners don't have to exert as much effort in treating large or deep muscles. With the deeper muscles it can be hard to apply effective pressure when doing a longitudinal stripping technique without using a great deal of force. Working deep or large muscles is advantageous with this technique, but it is just as effective in treating small or easily accessible tissues as well. Compression can be performed with the palm, knuckles, thumb, fingers, elbow, or a pressure tool.

Shortening strokes

The primary purpose of the shortening strokes is to enhance the broadening effect of the muscle during concentric contractions. Efforts to enhance muscle broadening with various cross-fiber techniques help reduce inter-fiber adhesions within muscle tissue.[15] The amount of muscle contraction can be varied with either of the following methods by adding additional resistance. The additional resistance will recruit a greater number of muscle fibers and make the pressure level more effective. The practitioner can increase muscular recruitment with resistance bands, weights, or manual resistance (Fig 4.13).

There are two ways to perform the shortening strokes:

1. Static compression is applied to an area in the muscle that is hypertonic, contains myofascial trigger points, or appears restricted or tender due to excess tension. Once static compression is applied (only a moderate amount of force is needed), the client is instructed to concentrically contract the affected muscle. Pressure is maintained during the concentric (shortening) phase of the contraction. Pressure can be maintained or released as the client returns the affected area to the original position. The static compression technique can be applied with a broad base of pressure like the palm or a small area of pressure like a thumb, knuckle, or pressure tool (Fig. 4.14).
2. A more effective method of enhancing the broadening of a muscle during concentric contraction is to use compression broadening strokes during the concentric contraction. The technique begins with the target muscle in a lengthened position. The client is instructed to actively contract (shorten) the affected muscle. During the client's concentric contraction the practitioner performs a compression broadening technique on the muscle (Fig. 4.15). The practitioner releases pressure as the client

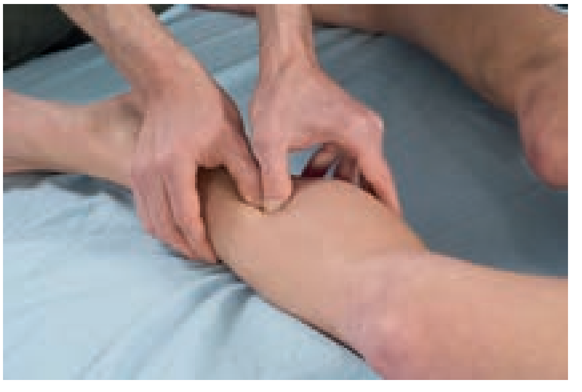

Figure 4.14 Active engagement/shortening with static compression applied to the tibialis posterior (client is actively plantar flexing the foot during compression).

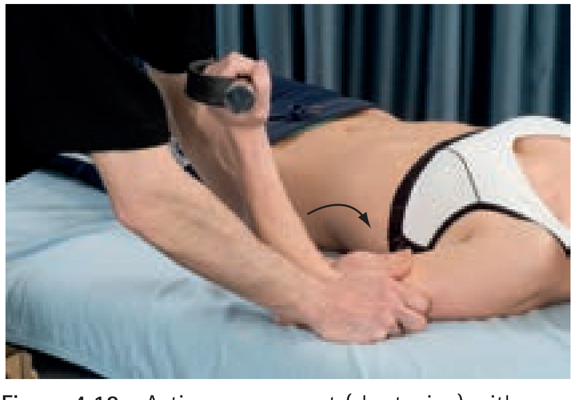

Figure 4.13 Active engagement (shortening) with additional resistance applied to the elbow flexors.

Figure 4.15 Active engagement/shortening with compression broadening applied to the wrist extensors.

returns to the starting position. Then the practitioner again performs a compression broadening technique as the client shortens the affected tissues actively once again. This process is repeated moving along the length of the muscle until the whole muscle has been treated adequately. It is important to make sure the practitioner's movement is coordinated with that of the client's movement so that when the client begins moving, the practitioner begins applying the stroke. When the client reaches the end of the movement, the practitioner should be reaching the end of the stroke.

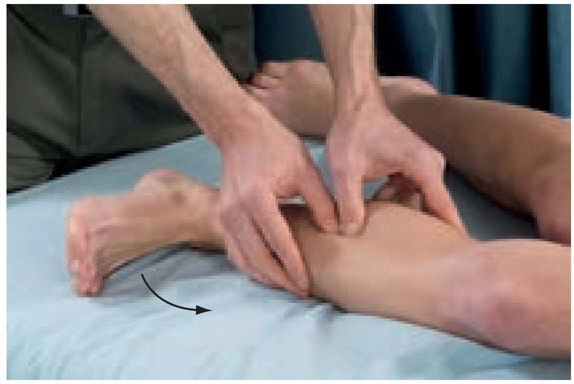

Figure 4.16 Active engagement/lengthening with static compression applied to the tibialis posterior (client is actively dorsiflexing the foot).

Lengthening strokes

Lengthening strokes during active engagement are an effective method of decreasing muscle tightness, reducing irritable myofascial trigger points, and encouraging tissue elongation. Applying simultaneous pressure and stretch to the target tissue helps to lengthen abnormally contracted sarcomeres in the muscle.[29] It is best to perform this technique in the later stages of the rehabilitative process or with individuals whose muscles are in moderately good tone to begin with. The technique is begun with the muscle in its shortest position, in an active muscle contraction. Some muscles, such as the hamstrings, are prone to cramping if contracted in their shortest position. Cramping in a shortened position is most common for multi-articulate muscles (those that cross more than one joint). For these muscles use a more lengthened position to engage the initial contraction. Lengthening strokes are performed in two ways:

1. The technique begins by establishing a moderate level of tension in the muscle with an isometric contraction. This isometric contraction should be engaged close to the shortest position of the muscle as long as that muscle is not prone to cramping in this short position. Static compression is applied to the muscle during the isometric contraction and held throughout the performance of this procedure. A broad contact surface is used initially or for more general applications as it causes less discomfort for the client. For more specific applications of pressure to the target tissue, use a small contact surface.

   The client is then instructed to create an eccentric contraction in the target muscle by slowly releasing, but not letting go of, the contraction. Simultaneously, the practitioner pulls the client's limb in a direction that lengthens the target muscle while applying the static compression (Fig. 4.16). This procedure is similar to the lengthening technique performed with passive movement (pin and stretch) with the only difference being the eccentric contraction in the muscle as opposed to the muscle passively elongating.

2. Reducing muscle tension and enhancing myofascial elongation can be encouraged even more with deep longitudinal stripping performed during the eccentric contraction instead of static compression. The practitioner has the client engage an isometric contraction of the affected muscle from a shortened position as in the procedure above. As with the previous variation, a different initial starting length is used for multi-articulate muscles or any others if muscle cramping is a possibility. The client is then instructed to create an eccentric contraction in the target muscle by slowly releasing, but not letting go of, the contraction. Simultaneously, the practitioner pulls the client's limb in a direction that lengthens the target muscle while applying deep longitudinal stripping on the target muscle (Fig. 4.17). This technique will greatly magnify the effect of deep stripping techniques.

Figure 4.17 Active engagement/lengthening with stripping applied to the gastrocnemius.

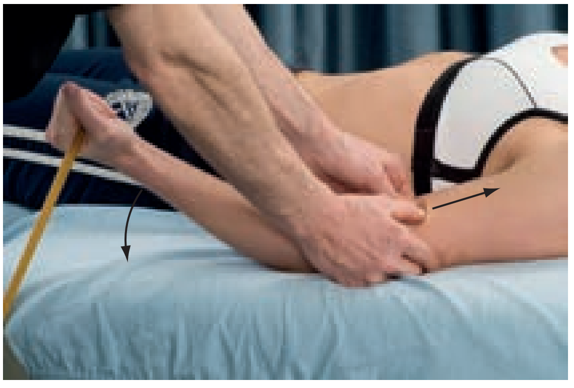

Figure 4.18 Active engagement/lengthening with additional resistance applied to the elbow flexors.

The intensity of muscle contraction can be altered with either of these methods by adding additional resistance. A greater number of muscle fibers are recruited with additional resistance and this makes the pressure level more effective due to increased tissue density. Increase muscular recruitment with resistance bands, weights, or manual resistance. If resistance bands or weights are used for the eccentric contraction, both hands are freed up to perform the longitudinal stripping methods (Fig. 4.18).

MYOFASCIAL APPROACHES

Fascia envelops every soft tissue in the body creating an intricate network of connective tissue that serves important structural and neurological functions. Originally considered by many to be a connective tissue of minor consequence, the importance of fascia in maintaining optimum function in the body has recently gained great interest. As a result, numerous soft-tissue manipulation techniques that focus on fascia have become key tools for soft-tissue clinicians. Much of the credit for the emphasis on therapeutic soft-tissue treatment directed at fascia is due to the pioneering efforts of Ida Rolf.[36] Many of her students have elaborated on her theories to develop new ideas and ways to encourage health in the fascial tissues of the body.[37] Treatment techniques that are specifically aimed at the fascia run from the deep and sometimes painful approaches that were used in the early days of structural integration (Rolfing), to the subtle and often puzzling effects of treatments such as myofascial release.[38]

The key component of all myofascial work is to increase its pliability by applying tensile force to the connective tissue. For many years descriptions of myofascial techniques focused on the mechanical response of the fascia to this pulling force. Proponents of these myofascial techniques emphasized the transformation of fascia from a thicker and gelatinous (gel) state to the more soluble or fluid (sol) state.[36,39] However, many found this explanation challenging because it seemed unlikely that tensile forces applied to fascia during therapeutic treatments could produce this kind of change.

Biomechanical studies have found that the amount of tensile force necessary to produce change in connective tissue would be too great and more likely cause tissue tearing and damage.[40] In addition, tensile force would have to be applied on the fascial tissue for close to 1 hour to make significant changes according to physiological models.[25] Yet numerous clinicians attest to the palpable change in tissue tension felt after only short durations of tensile force on superficial connective tissues. In most of these applications change is felt with tensile force loads much smaller than mechanical models dictate would be necessary for fascial elongation from mechanical stretch alone.[6,38]

New research shows that fascia contains smooth muscle cells and has its own contractile properties and an abundance of specialized sensory receptors.[41,42] These neurological receptors, especially the Ruffini endings, are particularly sensitive to tangential pulling forces applied to the fascia.[25] Tangential forces are those that offer only light pressure loads on the tissue and exert primarily tensile (pulling) force on the fascia. Even when exposed to very light tensile loads, these neural receptors in the fascia modulate activity in the nervous system which then produces a corresponding reduction in muscle tension. The function of fascia is so tightly integrated with muscle tissue that these two are most appropriately considered *myofascial tissues*.[43,44] Therefore when a relaxation is produced in the fascial tissues, there is tension reduction in muscular tissue as well, and thus the palpable change felt by soft-tissue practitioners (Fig. 4.19).

The primary purpose of myofascial techniques is to reduce tension in the fascial and muscular tissues. There are many different myofascial techniques, so this discussion focuses on the elements that are common to most of these methods. Once an area of muscular or fascial restriction is identified, a tangential or pulling force is applied to the connective tissues in the area. This technique is usually performed with minimal or no lubrication so that the practitioner's hands or fingers do not easily glide across the skin but instead pulls across the skin creating greater effect on the fascial layers under the skin.

In some techniques the treating hand glides slowly along the direction of the muscle and fascia being treated (Fig. 4.20). Slow movement is recommended because the lack of lubricant can produce discomfort due to the excess friction. As with the longitudinal stripping methods the practitioner can use a broad contact surface (palm, forearm, knuckles, etc.) for more general applications or a small contact surface (thumbs, fingers, or elbow) for a specific application.

In other myofascial techniques the tangential force applied to the fascia is performed without moving the treatment hand(s). This method is most commonly referred to as myofascial release.[38] To

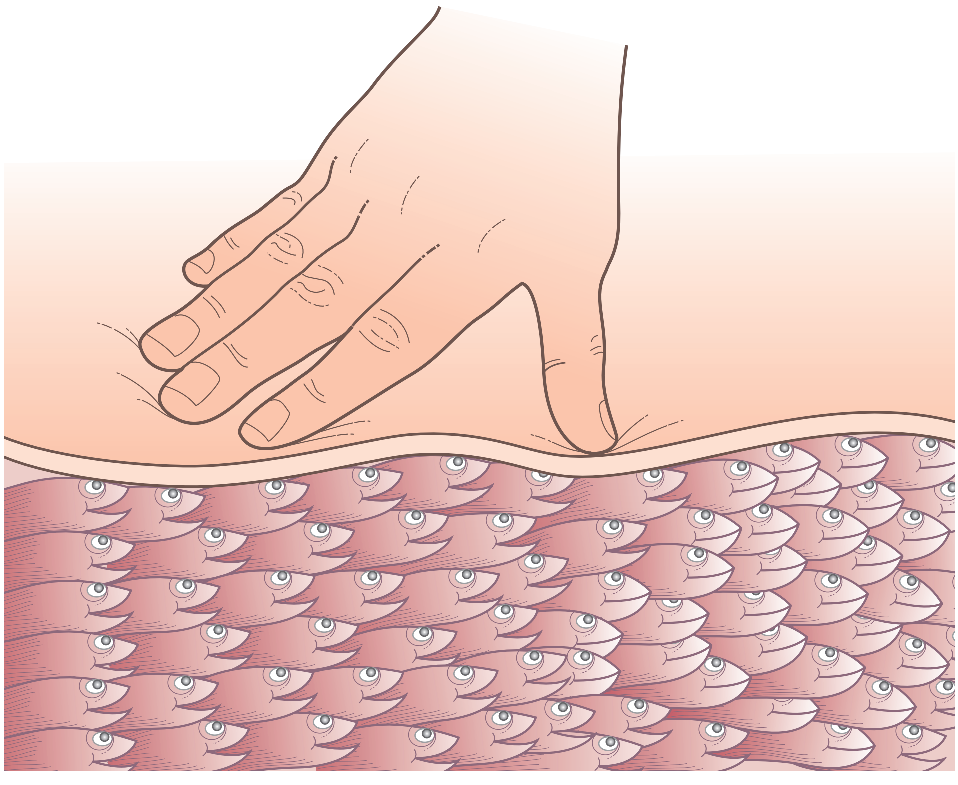

Figure 4.19 Feeling change in myofascial tissues. "Myofascial tissue as a school of fish. A practitioner working with myofascial tissue may feel several of the motor units responding to touch. If the practitioner then responds supportively to their new behavior, the working hand will soon feel other fish joining, and so forth. Figure by Twyla Weixl, Munich, Germany." Reprinted with permission from Schleip R. Fascial plasticity – a new neurobiological explanation. Journal of Bodywork and Movement Therapies. 2003;7(1):11–19.

Figure 4.20 Myofascial gliding technique applied with the back of the hand to the lateral neck muscles.

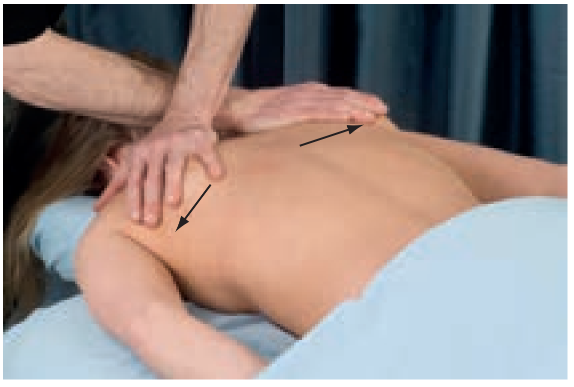

Figure 4.21 Non-gliding myofascial technique applied to the upper thoracic region.

perform this method, one or both hands are used to apply a light tensile load to the fascial tissue. The hands are pulled away from each other just enough to take the slack out and create a low tensile force on the tissue (Fig. 4.21). The force is often so light that it does not seem like anything could possibly be stretching the tissues of the body. Yet fascial elongation and a reduction in muscular hypertonicity result from these methods.[45] The amount of time to hold this tensile force varies, and may range from a few seconds to several minutes. Many practitioners advocate holding the tensile force until a sensation of tissue release is felt by the client or practitioner.[46]

STRETCHING METHODS

Stretching is used extensively as a soft-tissue treatment method. For years clinicians, athletes, and many other rehabilitation specialists have advocated it as a beneficial means for injury prevention and treatment. There seems to be little argument that stretching hypertonic or restricted tissues is a valuable part of injury treatment. However, recent studies into the effects of stretching have been unable to find a correlation between stretching and injury prevention.[47–51] There are likely benefits to stretching as a preventive measure in certain circumstances, but not in all. Stretching is routinely incorporated with massage in the treatment of pain and injury conditions so this discussion of stretching emphasizes its use as a rehabilitative practice more than a preventive one, although the two are closely related.

The primary purpose of any stretching technique is to enhance pliability and flexibility in the soft tissues. Stretching is generally aimed at muscle and fascial tissue, but there is evidence that stretching procedures can enhance elasticity in tendon tissue as well.[52] Stretching procedures can be divided into two separate, but equally important components: connective tissue effects and neurological effects.

Connective tissue effects

Every single muscle fiber is wrapped in fascia and there are fascial sheets enveloping bundles of fibers as well as the entire muscle. Consequently a key factor in the flexibility of any muscle is the pliability of its surrounding connective tissue. The discussion of fascial physiology in Chapter 2 and in the above section on myofascial approaches is also relevant when considering stretching procedures. Eliciting relaxation effects from the sensory receptors in fascial tissue is most effective when a prolonged tensile load is applied to the tissue.[53,54] Stretching produces a tensile load on connective tissues. Holding this tensile load for a certain period reduces tension in the connective tissue and subsequently aids overall myofascial extensibility. There is debate about the ideal length of time to hold a stretch. Several factors related to the ideal time of stretch are discussed below in the section on specific stretching techniques.

Neurological effects

The function of muscle tissue is to generate intramuscular contraction forces in order to create or limit movement in the body. The muscular system is a highly complex feedback system with an extensive array of sensory receptors including the Golgi tendon organs and muscle spindle cells. These two specialized proprioceptors are critically important in understanding various stretching techniques. Both proprioceptors play different roles in helping to manage tension in the muscle and also its ability to elongate during stretching.

The Golgi tendon organ (GTO) is located in the musculotendinous junction (Fig. 4.22). Its primary function is to relay information back to the central nervous system about the amount of contraction force in muscles. When muscle fibers contract, they pull on the tendon, which then transmits the contraction force to the bone. Due to its location in the musculotendinous junction, the GTO is ideally positioned to give the central nervous system information about the level of tension or pulling force that its muscle generates. Its predominant role is to help manage appropriate muscular contraction forces.

Tendons can be pulled either by a muscular contraction or a passive tensile force, such as a stretching procedure. During a strong muscular contraction the muscle pulls on the musculotendinous junction and the GTO is stimulated. It was once thought that the GTO prevented excessive muscular contraction (and subsequent overcontraction injury) by shutting off a muscle contraction if the contraction stimulus was too strong. However, we have now learned that the GTO does not function in this way and the reflex cessation of overly strong muscular contraction results more from excessive stimulation of free nerve endings (pain receptors).[55]

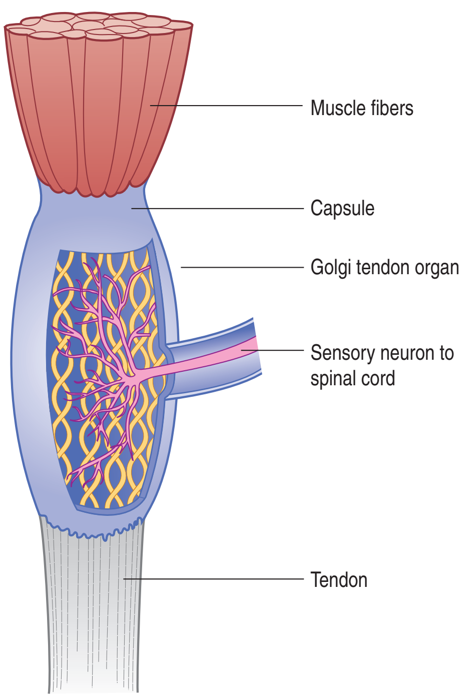

Figure 4.22 Structure of the Golgi tendon organ.

Another erroneous perception about GTO function that still persists suggests that passive muscle stretching pulls on the musculotendinous junction and stimulates the GTO, thereby causing a corresponding decrease in muscle tension. The GTO is activated by muscle contraction, but in many cases not activated at all by passive stretching.[55] Therefore stimulation of the GTO with passive stretching does not occur and is not a mechanism for increasing stretching effectiveness.

The other muscle proprioceptor that is essential for understanding stretching effectiveness is the muscle spindle cell. Muscle spindle cells are located throughout muscle tissue (Fig. 4.23). Their primary function is to help regulate levels of muscle tension and stretch. While the GTO is receptive to the level of contraction force in a muscle, the spindle cells primarily focus on the degree of muscle stretching. Spindle cell physiology is complex and involves both sensory cells in the spindle as well as motor fibers to the spindle itself that help manage appropriate muscle length. The spindle cell is primarily responsive to the muscle's change in length (how much a muscle lengthens) and the rate of change (how fast it lengthens).

If a muscle elongates either too far or too fast, the muscle spindles report that change to the central nervous system and an automatic reflex muscular contraction ensues to reduce the excess stretch. This reflex is called the myotatic (or stretch) reflex. Its primary function is to prevent muscle tearing that would result from overstretching. Practitioners should be careful with any stretching procedure not to elicit the stretch reflex by stretching the client too far or too fast because the reflex contraction directly reduces the benefit of any stretching procedure.

There is a wide variety of stretching procedures or systems used to increase myofascial flexibility. The most common stretching methods fall under one of three categories: static, ballistic, or active-assisted

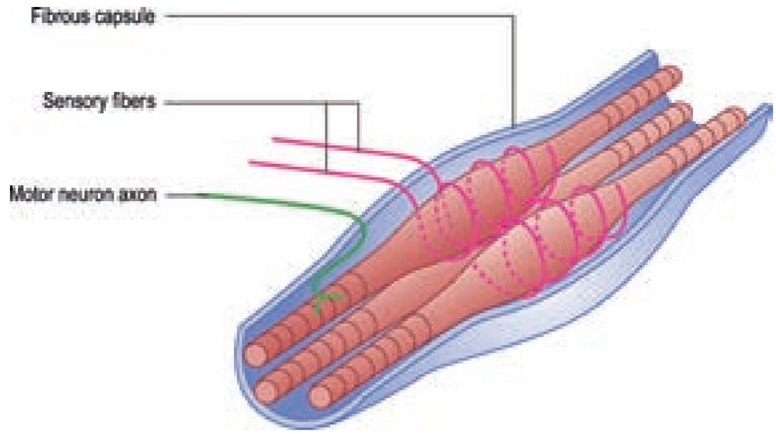

Figure 4.23 Simplified structure of a muscle spindle.

stretching. While there are numerous variations of stretching, most techniques are classified as one of these types.[56]

Static stretching

Static stretching is the most common type of stretching procedure. It involves bringing a tissue into a lengthened position and holding it there for some period of time. The ideal length of time to hold a static stretch is debated in the literature and the results still appear inconclusive. Somewhere around 15–20 seconds is a common time frame that achieves good clinical results.[57–60] However, practitioners of hatha yoga are accustomed to holding stretch positions for much longer and there is ample evidence that this centuries-old practice produces enhanced flexibility.

The ideal time frame for a static stretching procedure could be dependent on what muscles are being stretched. Certain muscles are more stretch resistant than others and would therefore benefit from a longer duration of stretch. In his ground-breaking work on muscle function and physiology Vladimir Janda described two categories for many of the major muscles in the body: postural and phasic muscles.[61] Postural muscles are those most associated with maintaining erect posture during locomotion, while phasic muscles have a more important role in large power movements of the body. Postural muscles contain a greater amount of perimysium (fascial connective tissue) and are therefore stiffer than phasic muscles.[54] Consequently, postural muscles could require a longer duration of static stretch than some phasic muscles to effectively elongate the connective tissue within the muscle.

Ballistic stretching

Ballistic stretching is a practice that has been used to enhance flexibility, especially in the athletic environment. This practice involves bobbing or bouncing into a stretch to encourage tissue elongation in the muscle. Ballistic stretching works by using the momentum of the moving limb to extend past the initial range of motion limitation. There are many who oppose the use of ballistic stretching because the rapid elongation of muscle tissue in the bouncing motion might activate the stretch reflex, which would be counterproductive to the purpose of stretching, potentially causing injury, or reducing the effect.

There are also arguments in favor of ballistic stretching. Many of the movements during athletic activity are sudden muscle lengthening movements and similar to those occurring in ballistic stretching. There is benefit to practicing a form of flexibility enhancement that prepares the body for these movements, especially in athletics. Ballistic stretching has been shown to increase muscle, fascial, and tendon elasticity.[52,62] It is also a very effective stretching method when combined with static stretching. The combination of static and ballistic stretching has been found more effective than either one of them performed alone.[56]

It is argued that ballistic stretching might be effective for people who are less inclined to comply with a stretching routine due to boredom with the activity. Because ballistic stretching involves constant movement, some might find it more interesting to perform and thus use it more often. Consequently, ballistic stretching performed correctly is better than no stretching at all.

Active-assisted methods

In active-assisted stretching the client actively engages specific muscle contractions prior to or during the stretching procedure. There is a variety of active-assisted techniques and they go by different names. There are slight variations in each of these methods, but they are all based on the neurological principles of post isometric relaxation (PIR) and reciprocal inhibition. Experiments that compare active-assisted methods with static or ballistic stretching routinely show the greatest range of motion gains with active-assisted methods.[63,64]

Immediately following an isometric contraction, there is an increased degree of relaxation in that muscle. This immediate reduction in neurological activity is called the PIR.[65] The methods of active-assisted stretching use the window of reduced neurological activity during the PIR to engage a stretch of the target muscle after it has isometrically contracted. Stretching during the PIR is more effective than stretching without the corresponding isometric contraction.[65,66]

The other neurological principle that is of prime importance in active-assisted stretching methods is reciprocal inhibition. When an agonist muscle contracts, there is a neurological inhibition of its antagonist (or opposite) muscle. This reduction in neurological activity in the antagonist muscle is called reciprocal inhibition. Because reciprocal inhibition decreases neurological activity in muscles opposite the ones being contracted, it is helpful to use during stretching procedures. Stretching of the target muscle is enhanced when its opposite muscle is contracted at the same time (Fig. 4.24).

The active-assisted techniques listed below rely on the following two basic stretching methods:

1. Contract–relax (CR): This is a stretching procedure that uses an isometric contraction immediately prior to the stretch. It is also sometimes called contract–relax–stretch or hold–relax. In a CR procedure the muscle being stretched is the one engaged in the contraction immediately prior to the stretch (Fig. 4.25). There are various lengths of time for holding the isometric contraction. Most recommendations find an isometric contraction between 3 and 7 seconds to be sufficient.[67,68] The length of time to hold the stretch also varies, but a similar amount of time (3 to 7 seconds) is common. Several repetitions of this cycle are more effective than performing the CR stretch just once.[69]

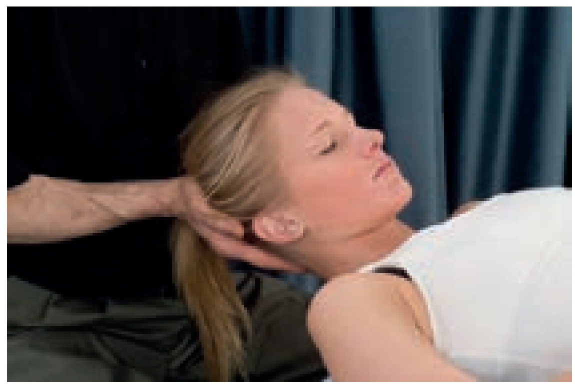

Figure 4.24 Reciprocal inhibition stretching of the anterior neck muscles. The client is using the neck extensors in a contraction first then stretching the neck flexors.

Figure 4.25 Contract–relax (CR) stretch to the right lateral rotator muscles. The client attempts to turn the head to the right while the practitioner resists. When the contraction is released, the practitioner turns the client's head to the left to stretch the right rotator muscles.

Figure 4.26 Contract–relax–antagonist–contract (CRAC) stretch to the neck flexors on the anterior side of the neck. The client first attempts to lift the head up by contracting the neck flexors. After holding the contraction for several seconds, the client relaxes and then eventually pushes the head into the practitioner's hands by using the neck extensors. The practitioner gradually allows the client to move into full head and neck extension thereby stretching the neck flexors.

2. Contract–relax–antagonist–contract (CRAC): This procedure uses both the PIR and reciprocal inhibition concepts. The target muscle (the one to be stretched) is contracted isometrically. When the contraction is released, the client engages the opposite muscle group to stretch the original target muscle (Fig. 4.26). Using the opposite (antagonist) muscle at the end of the stretch engages reciprocal inhibition to decrease neurological activity in the target muscle and enhance the stretch. CRAC stretching is perhaps the most effective of the various active-assisted methods. Studies that have compared different stretching methods have found the greatest motion gains when using the CRAC variation.[70,71]

A brief description of the various names and terms associated with active-assisted stretching are listed below:

- Proprioceptive neuromuscular facilitation (PNF): This is a system that was originally developed by physical therapists in the 1940s to enhance neurological rehabilitation. It included various movements, especially those involving spiral and diagonal movement patterns, which are more complex than the movement patterns used most often in static stretching.[67] The PNF rehabilitative system is a comprehensive rehabilitative exercise program and the stretching component is only one part of that system. However, the term PNF has become synonymous with just the stretching methods of this system. Some of the early advocates of PNF stretching methods used muscle contractions close to the maximal level. Recent variations have demonstrated stretching results that are just as effective with muscle contractions much lower than the maximum level.[72]
- Muscle energy technique (MET): The osteopathic profession's focus on manual methods of soft-tissue treatment expanded on some of the early concepts used in PNF stretching to promote a similar method, which was called MET. The term muscle energy technique emphasizes the importance of using the client's own muscle contraction energy to enhance the stretching procedure.[68]
- Facilitated stretching: Another name for stretching procedures using the client's energy is facilitated stretching. These methods are very similar to those used in the traditional PNF system with just a few variations.[73]
- Active isolated stretching (AIS): This is an active-assisted stretching procedure that was developed by Aaron Mattes, and is also known as the Mattes method.[74] The cornerstone of this technique is a short duration of stretch (only about 2 seconds). AIS stretching uses reciprocal inhibition, but does not generally use isometric contractions of the target muscle prior to the stretch.

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