2. **Iliac fascia and hip flexion:** Perform a hip flexion either by lifting your leg or by flexing the lower limb. Visualize the iliacus muscle located on the inside of the ilium of your pelvis. Now imagine the iliac fascia covering the iliacus from the whole length of the inner lip of the iliac crest to the linea terminalis of the lesser pelvis. Imagine the fascia resting on the muscle like a soft and silky covering that also has some weight. Perform another hip flexion and take note of any changes in sensation.
3. **Stretching with fascia in mind:** Focus on your connective tissue in a stretch. The fascia should not be rigid (figure 9.10*a*). Instead imagine the fascia providing length by being viscous and flowing (figure 9.10*b*).

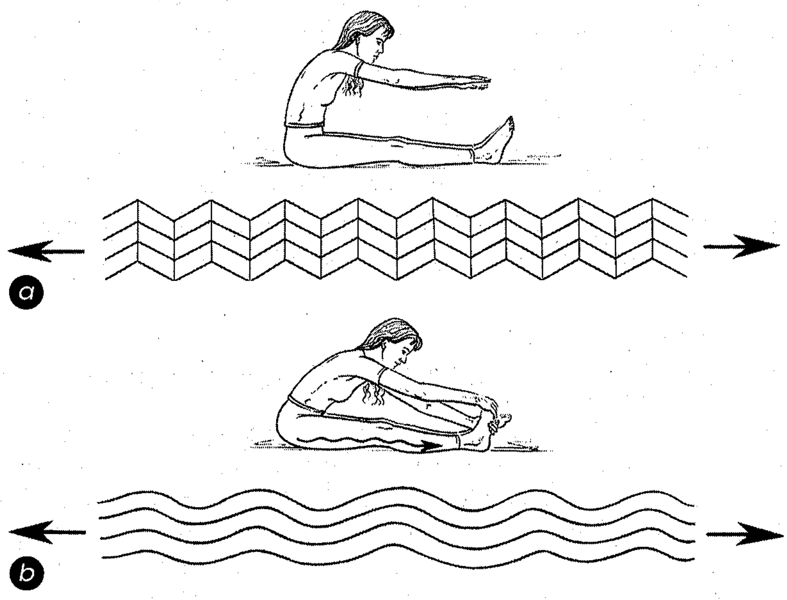

Figure 9.10 (*a*) Rigid connective tissue; (*b*) viscous connective tissue.

MUSCLES

A muscle is a large bundle of fibers held together by small sheets, which in turn are held together by a larger enveloping sheet. The functional unit of a skeletal muscle, a muscle designed to make you move through space, is a muscle fiber. Every fiber is basically a small contracting machine that can exert force on the bones to which it is attached by shortening itself. Often the function of strength and tone is emphasized in muscle training; however, another important function of muscles is force absorption (damping) to protect joints and other structures. A significant part of force absorption is mediated through the connective tissue.

Connective Tissue of Muscles

Muscles are covered by an interwoven wrapping of connective tissue called the epimysium. The epimysium dives into the muscle belly and forms the septae (separators) dividing it into individual bundles, or fasciculi, whose deeper wrappings are called the perimysium. The perimysium in turn dives yet deeper and surrounds the individual muscle fibers in the form of an endomysium. Tendons, fascia, and aponeuroses also have a connective tissue wrapping called the epitenon. Within a tendon are also fine connective tissue strands called the endotenon. The perimysium of muscle connects to the epitenon of a tendon, which in turn connects the periosteum of the bone. Sharpey's fibers, another form of connective tissue, anchor the periosteum into the bone, which is connective tissue as well. You can see that there is a relationship between each individual muscle fiber, connective tissues, and bones in your body through a near-endless web, or tensegrity grid, of interconnections.

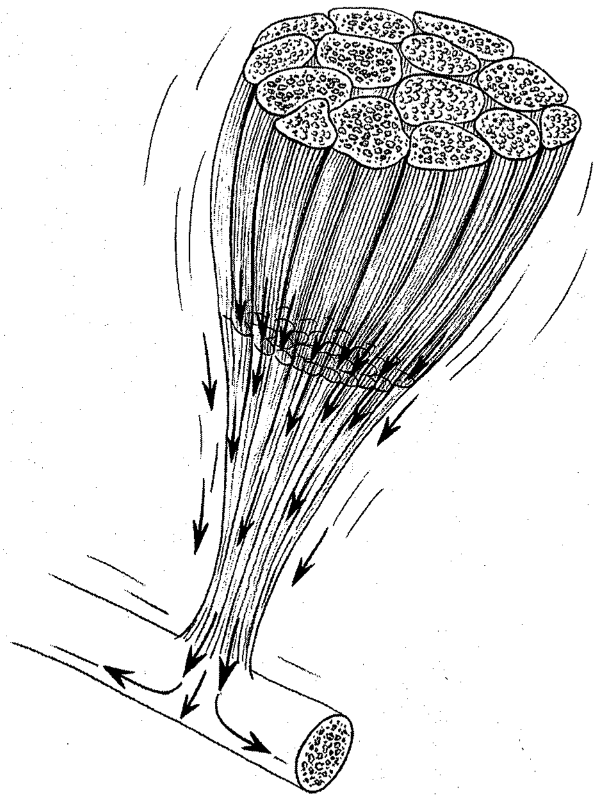

Figure 9.11 Muscle within its connective tissue connecting to the tendon and the bone.

Muscles move connective tissue before they move bone. No muscle fiber runs the whole length of a muscle; the force of a fiber is transferred through the connective tissue to adjoining fibers and finally to the tendon at the end of the muscle (figure 9.11). When you contract a muscle, it pulls on its surrounding connective tissue through many layers that then reach the tendon, which finally pulls on the bone. The reverse is also true. When gravity pulls on a bone, it does not stretch the muscle proteins directly. It first pulls on the tendon, which pulls on the connective tissue of the muscles, which then aids in lengthening the muscle itself.

Experiencing Relationships of Muscle-Connective Tissue

When you bend your elbow, imagine the biceps muscle tissue pulling on the surrounding connective tissue through many layers that then pull on the tendon, which pull on the bone. To extend your elbow, imagine gravity pulling on your lower arm, which pulls on your biceps tendon, which pulls on the connective tissue of the muscles, which finally lengthens the muscle. Compare this image to the image of the muscle pulling directly on the bone, without the connective tissue interface or gravity pulling directly on the muscle. You may notice that the image containing the muscle-connective tissue and tendon is more resilient and elastic. I refer to this as muscle-tendon-bone imagery (MTB).

Traditionally muscles are depicted as separate entities that run from bone to bone. This image has been perpetuated by anatomy books that illustrate muscles without their connective tissue wrappings. In reality, muscles are related to bone not only through tendons but also through fascia, aponeuroses, and sometimes ligaments (see chapter 10 on the pelvis and chapter 12 on the spine). The muscles of the rotator cuff of the shoulder, for example, have insertions into the connective-tissue joint capsule, the gluteal muscles are connected to the sacrotuberous ligament and the tensor fasciae latae, and the latissimus dorsi are connected to the thoracolumbar fascia. Muscles are related to bone and each other through a complex connective matrix. This system allows for three-dimensional force generation and force absorption through muscle-connective tissue dialogue. In figure 9.12, the connective tissue is depicted as coiled springs to which the muscles attach, providing tension.

When muscles contract along their length, they become wider because the same amount of muscle tissue is now concentrated over a smaller distance (figure 9.13). This increase in diameter pushes on the connective tissue, making the muscle more firm. The body uses this system to increase dynamic stability. The increased tension in the fascia is relayed to bones and joints to increase force closure (see "Thoracolumbar Fascia" in chapter 12).

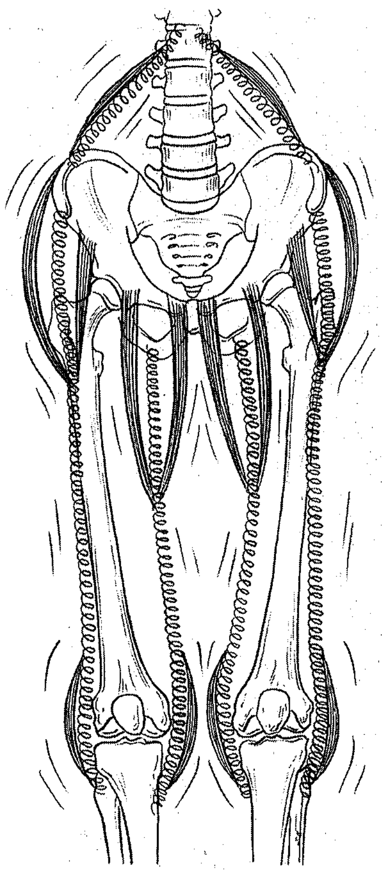

Figure 9.12 Muscles tensing the connective tissue.

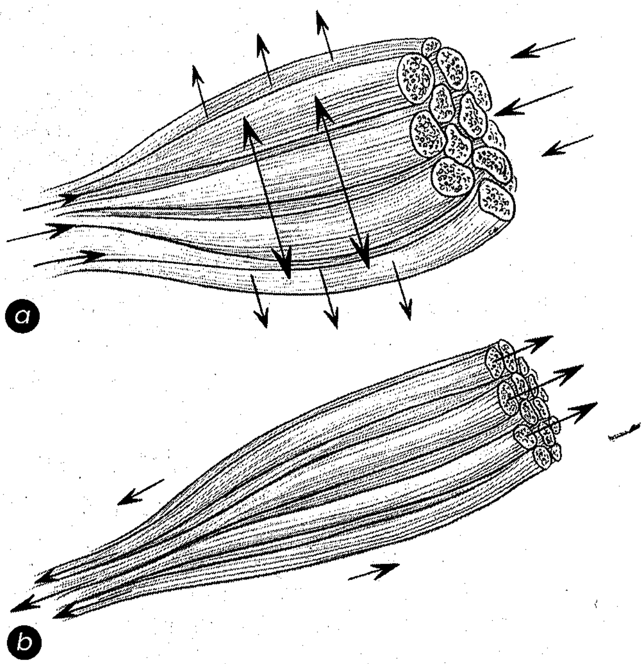

Figure 9.13 *(a)* As the muscle shortens, it becomes wider and pushes on the surrounding connective-tissue wrappings. *(b)* As the muscle lengthens, it becomes narrower and longer.

Widening and Narrowing of Muscle and Connective Tissue

Hold your right biceps and flex and extend your elbow. As the muscles shorten and widen, imagine them pushing against their connective-tissue wrappings. As you extend your elbow, imagine the muscles lengthening within their connective tissue. As you flex your elbow once again, imagine the connective tissue widening in anticipation of the muscle. As you extend your elbow, anticipate the lengthening of the connective tissue. Repeat the bending and stretching of the elbow several times while imagining the muscle action. Finally, compare the ease of motion in the right and left arms. Repeat with the other arm.

Sliding Filament Theory of Muscle Contraction

If you take a microscopic look at a muscle cell, the most obvious thing you can see is a regular arrangement of bands (figures 9.14 and 9.15). These bands are the proteins that cause muscle contraction. Muscles are made of elongated cells containing myofilaments. The myofilaments are arranged within compartments called sarcomeres. There are three types of myofilaments: actin, myosin, and titin.

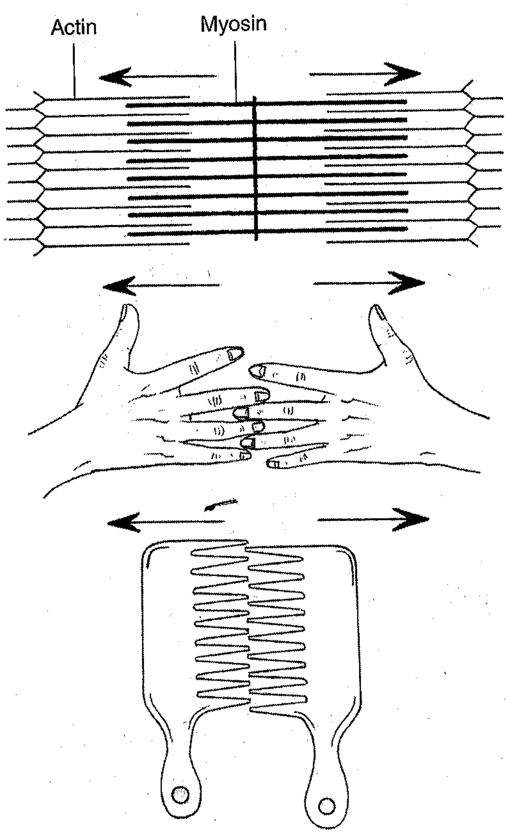

Figure 9.14 The sarcomere slid apart.

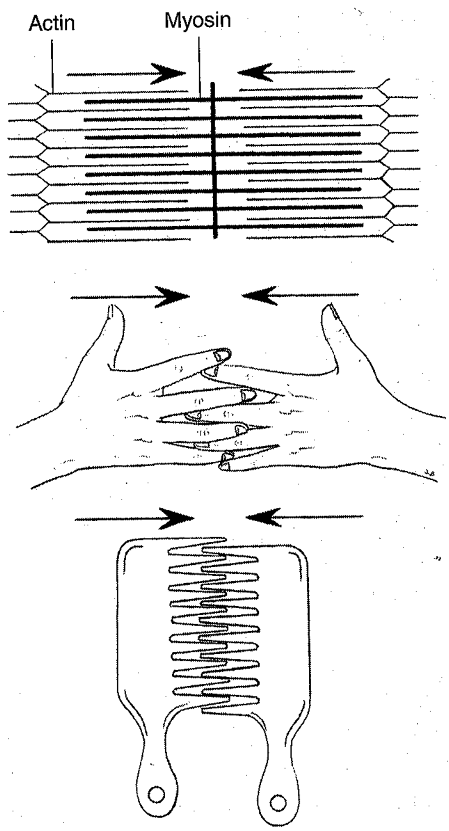

Figure 9.15 The sarcomere slid together.

You can see thicker lines and thinner lines. These are the myofilaments. In striated muscle they are arranged in transverse bands; in smooth muscle the filaments are arranged irregularly. The thicker ones are called the myosin filaments (figure 9.16). The thinner ones are called the actin filaments. The thin ones are attached to what are called the Z-lines and project toward and interlace with the thick ones. So-called titin filaments connect the myosin to the Z-lines functioning as molecular springs to provide passive elasticity. The area with only thin ones is the I-band; the area with thick ones is the A-band. The area with only myosin is the H-zone.

If you increase the magnification of your imaginary microscope, you see that the thicker filaments have little arms that look like the oars of a boat with thick paddles (see figure 9.17). When a muscle fiber (cell) shortens, the filaments slide past each and overlap even more. They remain essentially the same length. Tension in the muscle is produced by cross bridges, which are the myosin heads attaching and reattaching in new positions to the actin as if the oars were repeatedly dipping into

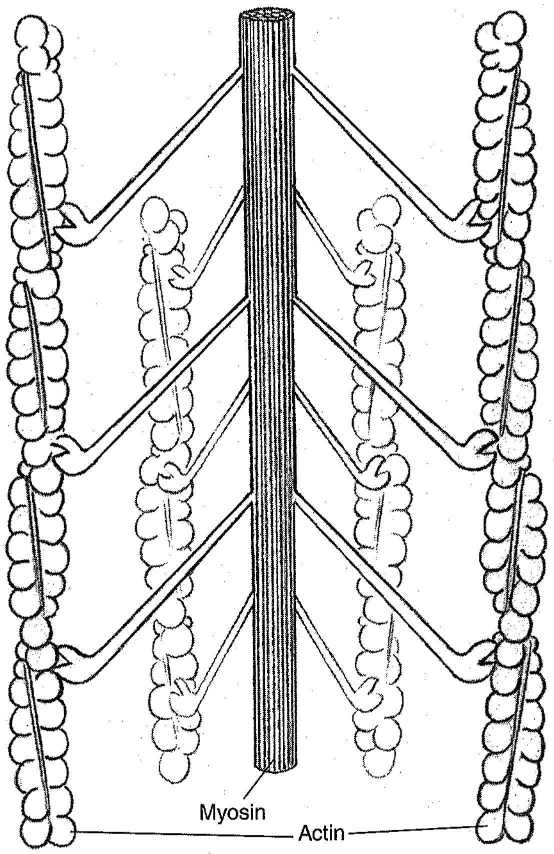

Figure 9.16 Myosin and actin close up.

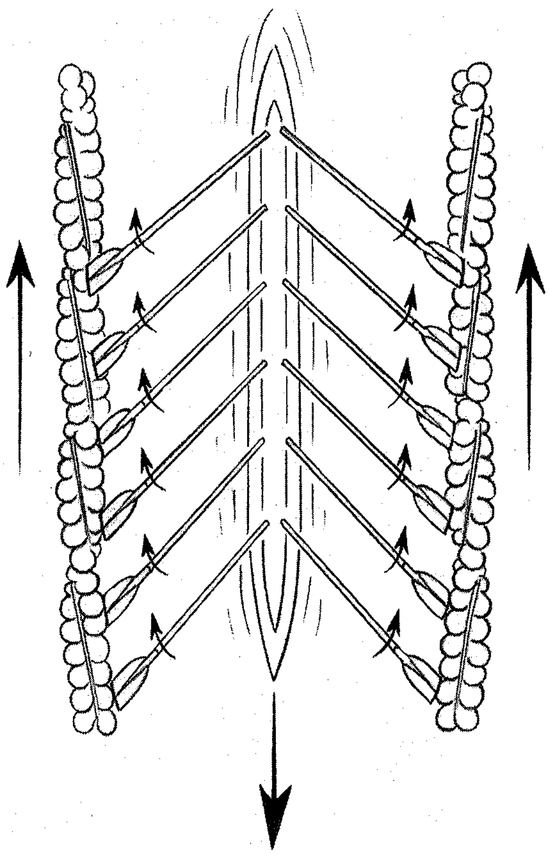

Figure 9.17 The rowing-boat image.

water to push the boat forward. (To be accurate, the rowing-boat image would need to be three-dimensional, with oars sticking out to all sides.) Also, the myosin filament pulls the actin toward itself from both sides like a double-sided tug of war. The valuable visual, kinesthetic, and perhaps even auditory imagery that evolves from this anatomical knowledge is that from the point of view of muscle proteins, muscles do not shorten; they slide.

Imagery Exercises for Sliding Filament

1. **Biceps muscle sliding:** Put your left hand on the biceps and slowly bend and stretch the elbow while visualizing the filaments sliding together and apart. Repeat the movement and image 12 times. Stay focused as you do this. When you are finished, drop your arms down at your sides and notice the difference between the two sides. Then also notice the kinesthetic difference between your muscles as you bend and stretch both elbows simultaneously. Commonly the side practiced with imagery feels smoother, more relaxed, and even more flexible.
2. **Pectoralis muscle sliding:** Put your left hand on the right pectoralis. Lift the right arm up until it is parallel to the floor and move it forward until your elbow is

in front of the breastbone. You have now slid the pectoralis filaments together. Move your elbow laterally and slide the pectoralis filaments apart. Move your arm slowly medially and laterally 12 times while imagining muscle sliding in the pectoralis. You may use self-talk such as *Slide together, slide apart* to support this action. Drop your arms down at your sides and notice the difference between the two sides. The practiced side will probably feel more open because the shoulder is more laterally placed and less slouched. Now move both arms at the same time and notice differences in flexibility in a variety of directions. This exercise provides the insight that you can achieve flexibility without forceful stretching of muscles but rather through the combination of touch (tactile proprioception), movement, and imagery.

Innervation

A special type of nerve cell, the alpha motor neuron, signals the muscle fibers to contract. All muscle fibers connect to a single alpha motor neuron, a motor unit, which is the smallest part of the muscle that can contract independently. When the fibers receive a command signal, they can do only one thing—shorten. This doesn't mean that the whole muscle shortens. If only a few muscle fibers receive the command to shorten, no perceptible movement occurs in the muscle. The few fibers that are working may not suffice for contracting the whole muscle. You can compare this situation to a team of husky dogs hooked up to a sled. If only one of the dozen or so dogs attempts to pull the sled while the others are sound asleep, the sled will not move forward. (Note that this is an example of imagery with an educational purpose.)

For a muscle to contract, motor units need to fire repeatedly. The more motor units activated, the stronger the movement. If you are thinking of a movement without doing it, or you are hesitant about doing it, you will activate some motor units but not enough to make you move.

Types of Contraction

Three types of contraction are commonly described: concentric, eccentric, and isometric. Concentric and eccentric contractions are dynamic, involving movement through space of the bony levers to which the muscles are attached. If you hold a weight in your hand and slowly bend your elbow to lift it upward, your biceps and other upper-arm muscles shorten and contract at the same time, as expected. This is a concentric, or shortening, contraction. If you lower the weight, the muscles are still contracting to keep the weight from falling out of control, but they are getting longer in breaking the fall of the weight. This is called an eccentric, or lengthening, contraction. If you simply hold a weight with your elbow bent, the muscles work without lengthening or shortening. This is an isometric, or constant-length, contraction. The term *contraction* can actually be confusing. Literally, an eccentric contraction means away from center, pulling together (in other words, a contradiction in terms). Some authors are therefore replacing the term *muscle contraction* with *muscle action*, which makes more sense.

Slowly Let Go

When your quadriceps muscle straightens your knee, it is performing a shortening, or concentric, contraction. In a squat, this same muscle must break your fall by eccentric action. As your knee bends, the quadriceps lengthens while contracting just enough to break your fall. Visualize the muscle slowly letting go. You can compare the sensation to the notion of carefully lowering a bucket into a deep well. You may also think of the muscle as slowly stretching taffy.

Prime Movers, Synergists, and Stabilizers

For every joint movement, there are muscles that produce this motion, called the movers, or agonists. If you want to bend your elbow, then certain elbow flexor muscles are the so-called prime movers because they are the most important movers. The muscles that oppose this movement are called the antagonists. When flexing your hip, the iliopsoas is the prime mover because it is the strongest hip flexor. Sometimes certain muscles join forces to produce a certain effect; they are called synergists.

The agonist sends an inhibiting signal to the antagonist so that it can perform its function. Just as a ship cannot pull out of the harbor if it is not released from its ropes, an agonist cannot move if it is not released by its antagonist. This process is called reciprocal inhibition, a mutual relaying of tension states so that the muscles can work in harmony.

If joint stability is needed, such as in the standing leg in the high leg kick, then co-contraction may occur, in which both agonist and antagonist contract simultaneously. These muscles are now acting as stabilizers to maintain posture and continuity of motion. Stabilization does not always mean that a part of the body is being fixed in a nonmoving position but may occur dynamically throughout a motion cycle.

Brushed Into Length

Aid the movers by seeing the antagonists as long and released. A dancer extending his arm and leg (or in a leg kick, battement, développé, or any extension) may imagine the underside of the arm and leg being brushed into length (figure 9.18).

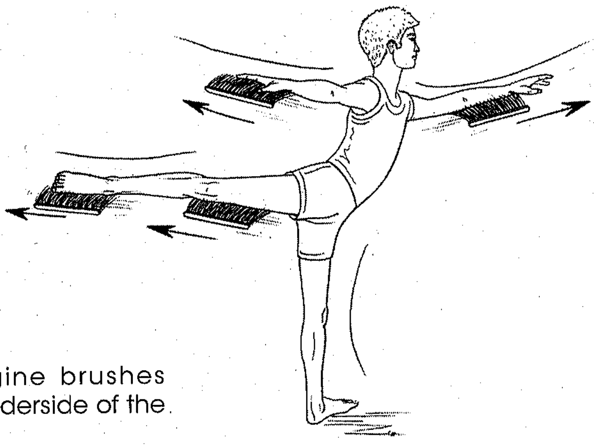

Figure 9.18 Imagine brushes moving along the underside of the arms and legs.

Stretch Reflex

Complex movement would not be possible without an automatic pilot constantly adjusting your posture. This automatic pilot consists of reflexes that underlie your consciously guided movement. Sherrington (1964) writes, "The reflex is independent of consciousness even at first occurrence. It does not emanate from the 'ego'" (p. 156). You have reflexively withdrawn your fingers from a hot plate or flame. The body acts before you can think about it, producing rapid movements to prevent you from injuring yourself. If the doctor's hammer taps the proper point, the knee straightens as the result of the stretch reflex. The so-called muscle spindles monitor the length of a muscle to keep it from being injured by overstretching. To permanently increase muscle length through stretching, this reflex must be circumvented. Reflexes, righting reactions, and equilibrium responses underlie all successful effortless movement. Primitive reflexes are with humans from birth; righting reactions that control alignment come into full bloom at about one year of age. Equilibrium responses maintain balance from the time you first walk (Cohen 1994).

Muscle Tone

Tone (from the Greek *tonos*, meaning tension), the basic level of muscle tension, determines the body's density. Your basic muscle tone is lower when you sleep and higher when you are very active. Without muscle tone, the body would collapse; conversely, excessive tone blocks movement. A baby's muscles feel soft, resilient, and rubbery to the touch because they are free of excessive tension. Some people seem to be in a constant state of high muscle tension, whereas others are in the opposite state—flaccidity. Often you find differing states of tension in the body, such as tense shoulders with high tone and midsection with low tone. Similarly, varying styles of movement require varying degrees of muscle tone. The pre-breakdance robot style of dancing, for example, was definitely a high-tone affair.

The more you can change the level of tone in your body at will, the richer your expressive possibilities. Improvisation is a way of practicing this ability. Balanced tone is one of the goals of dynamic alignment. Most people need to increase tone in the center front of the body, which includes the abdominal and deep pelvic muscles. This in turn helps create the foundation for reducing tension in the shoulder and upper-chest areas.

Exercising Muscle Tone

1. **Changes in tone:** Move like a robot and then like a flowing river. Imagine supporting a heavy weight and then gliding through a silk curtain. Become an oak tree resisting the wind and then a leaf being tossed by the wind. (See also *Dance Imagery for Technique and Performance*, the chapter on improvisation.)
2. **Lying on chestnuts:** Gather a bunch of chestnuts or marbles and spread them on a towel. Lie down with the back of your body on the chestnuts and imagine your back melting down over them. If this hurts, use smooth or plush balls.

Muscles Crossing Joints

Muscles affect only the joints they cross. Some muscles cross one joint, and others cross two joints, often creating opposing actions. Two-joint muscles are most efficient when they can shorten at one joint and lengthen at the other; otherwise they may develop what is called active insufficiency. The rectus femoris muscle, for example, originates at the hip and attaches below the knee. It flexes the hip and extends the knee, making it easier to lift your leg with the knee bent than with the leg straight. If the knee is stretched as you lift the leg, the rectus femoris needs to shorten both at the hip and at the knee, causing an active insufficiency. Simply stated, there is less shortening power left if the knee is extended as you lift the leg. If the knee is bent, the rectus femoris can concentrate its contractile power on the hip.

Extending the leg to the back in arabesque lengthens the rectus femoris at the hip and shortens it at the knee, lending optimal function to this two-joint muscle. When you extend your leg at the hip and bend the knee, the hamstring shortens both over the back of the hip and the knee. If you continue to bend the knee in this position, you will notice that the hamstrings become actively insufficient, sometimes even cramping.

Emphasis on Iliopsoas

In this exercise you will focus your imagery on the deep-lying iliopsoas in hip flexion. This will increase its activity enough to make a perceptible difference in lifting your leg. Lift and lower your knee and notice what this action feels like. To activate the prime mover for hip flexion, the iliopsoas, use an indirect approach, reducing your reliance on the secondary movers such as the rectus femoris. As you lift your knee, imagine the iliopsoas contracting. Visualize the place where you are creasing your hip to be very foldable, soft, and melting. Now lower your knee. Perform the action once again in your mind's eye only, focusing on a very malleable, soft creasing at the hip. Lift your knee again and notice any changes in sensation. Lift your other knee and notice the difference between your legs.

Control Over Individual Muscles

Learning how to control individual muscles is difficult; it can usually be done only with much practice, if at all. Humans would have been extinct long ago if they had to constantly instruct every individual muscle to move (figure 9.19). Body therapies would not exist if you had such control because everyone could optimally adjust every muscle. You would never need massages, but you would spend most of the day organizing your muscles.

Muscle Balance and Posture

Ideally, muscles not required to perform a movement should not be involved. But are there any such isolated movements? Just lifting your arm to the side causes subtle changes throughout the body. Your breathing pattern changes slightly, and even the muscles of the legs need to adjust. Muscles stabilize one part of the body against the movement of another and constantly perform midmovement corrections to maintain balance. All of these actions should happen efficiently without excess strain.

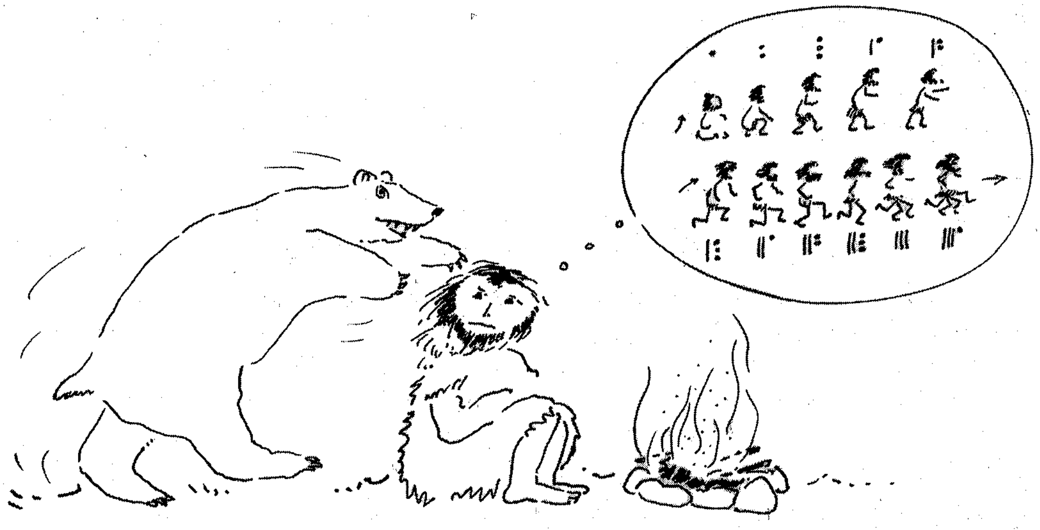

Figure 9.19 Trying to move one muscle at a time would have made us easy prey. Therefore, we have control over the goal of our movement, which subcortically organizes the individual muscles for action. In this case, escape would have been appropriate.

Dynamic alignment helps you achieve this goal by balancing the muscles in your neutral position (easier said than done). I have already pointed out the importance of well-balanced first-class levers for alignment. To simplify for clarity, muscles acting on a bone can be visualized as a tent or drape attached over a central pole. If the muscles are tight, the bone is held rigidly in place (figure 9.20*a*). If the muscles are flaccid, the bone sways and lacks control (figure 9.20*b*). If the muscles are imbalanced (tight on one side of the joint and flaccid on the other), the bone loses alignment (figure 9.20*c*). Ideally, the muscles should be neither too tight nor too flaccid.

Can alignment be corrected by strengthening some muscles and weakening others? To create balance, you could lengthen a habitually shortened muscle and strengthen a weak one. A good knowledge of muscle function is necessary for improving balance with such exercises, and even then success will be limited to creating a temporary and rough balance.

Unless you recognize and adjust your basic habits, body image, and movement patterns, you are going to reinforce your old imbalances indefinitely. You do not want your training to improve what you are trying to change. The Franklin method four-step process will help you to create steps in the right direction (see chapter 4).

Minimal Amount of Holding

Hold a ruler in one hand and lower it perpendicularly to the floor. If you grasp it tightly, it will stay in its position. Determine the minimum effort needed in order to keep the stick from falling. Do the same exercise with your left hand and compare the ease with which each hand accomplished the task.

Discovering Muscle Imbalances

There are several ways to begin noticing muscle imbalances in your body. One is simply to palpate an area on one side of the body and compare it in muscle thickness and density to the same area on the other side. The neck is a good place to start because you might hold your head slightly to one side. Put your fingers on both sides of your neck and see if you notice any differences between the muscles on the left and right sides. Compare your findings with your preferred motions of the head: Does it seem more normal to tilt the head slightly to the right or to the left? Does it seem more normal to turn the head to the right or to the left to look behind you? Usually, if you prefer to look to the right, that is also your better turning side in dance, influencing muscle chains all the way down to the feet.

Noticing Differences in Perceived Muscle Effort

Another way to detect muscle imbalances is to stand up from a chair and sit down again. Put your right leg in front and your left in back and stand up and sit down again. Repeat with your left leg in front and your right leg in back. Do this very slowly and notice the differences between the sides. Catch yourself during the day and watch how you stand up and sit down. Most likely you use similar patterns and reinforce them continuously. Also notice differences in muscle effort by altering the position of your legs. What is it like to stand up and sit down with your legs medially rotated, laterally rotated, and in parallel?

How Movement Habits Create Muscle Imbalances

In sports, dance, and exercise, it is important to be equally strong on both sides of the body. Balance of strength may be more important than overall strength when creating optimal movement technique and lifelong musculoskeletal health. You are usually aware of which is your better supporting leg and which leg is better in extension, and you sometimes try to correct the situation. But if your only action is to strengthen and stretch, and you don't attempt to change your movement habits, you will not be entirely successful. Don't work on your alignment only during training. I have observed that when students listen to a teacher's instruction during a movement class, their true alignment patterns often emerge, patterns that are surprisingly different from their exercise alignment. True improvement in alignment is not possible by focusing on and artificially maintaining alignment only during a specific situation.

Muscle Chains

Muscle chains are separate muscles with different origins and insertions but similar lines of action. The left internal oblique abdominal muscles and the right external oblique abdominal muscles form a muscle chain, as do the right internal obliques and the left external obliques. These particular muscle chains support complex rotary and spiral actions throughout the body. Although their connection is not otherwise obvious, muscle chains connect the arm to the pelvis. Anteriorly, the ascending fibers of the pectorals are in line with the internal obliques and the psoas of the opposite side. Posteriorly, the latissimus dorsi connects the arm to the spine and the lumbar fascia. Its fibers are generally in line with the external obliques and the gluteus maximus of the opposite side.

Imagining muscle chains creates strong kinesthetic connections throughout the body, which can manifest in feelings of envelopment, three-dimensionality, and general interconnectedness. This is helpful in spiral turns, but when visualized, these sensations are helpful in many actions, even in standing (see also chapters 10 and 12 on the pelvis and spine).

Muscle Chain

Lying on the floor with one arm overhead, visualize a diagonal muscle chain through the body from the biceps, ascending pectoral, and serratus anterior and crossing the midline of the body diagonally to the internal obliques and psoas (figure 9.21).

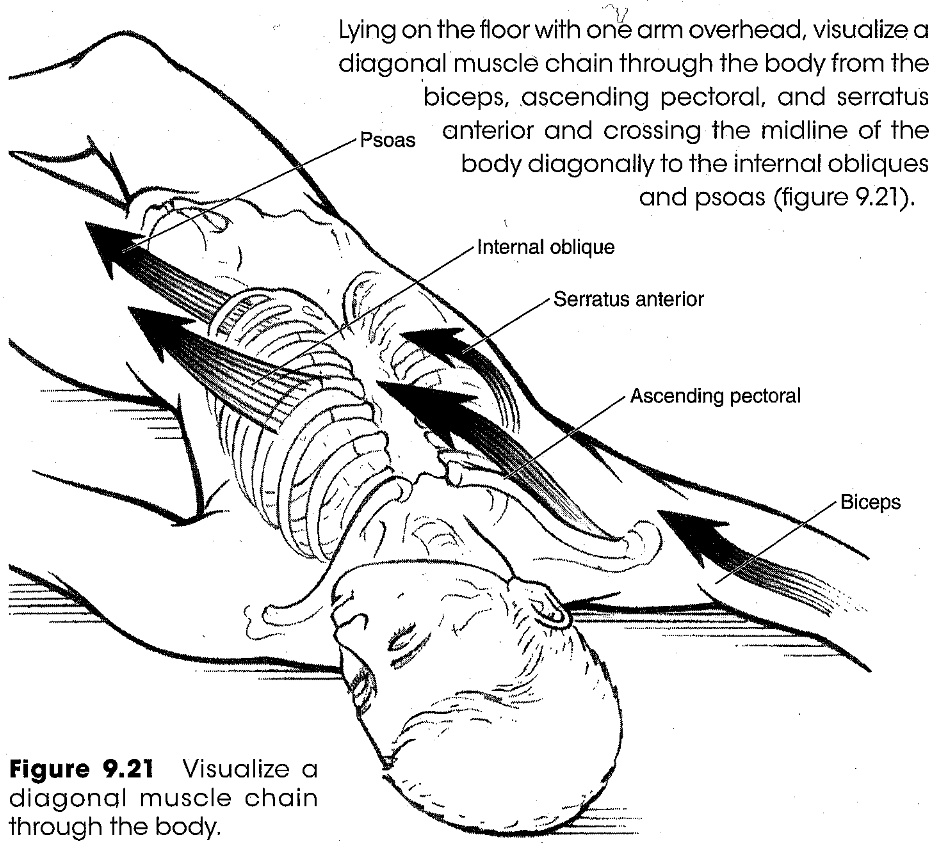

Figure 9.21 Visualize a diagonal muscle chain through the body.

From: Eric Franklin, Dynamic Alignment Through Imagery 2nd Ed.. Human Kinetics, 2012, Champaign: IL