Chapter 12

Spine and Body Wall

Thoughts are generators of being.

Spinal patterns reveal much about cultural heritage and stylistic preferences. In classical ballet, the spine is held in a very slight extension (arched); in classical Spanish dance, it is even more extended (arched); in Native American dance, it is fairly erect; and in traditional Japanese styles, it is slightly flexed (curved forward) (Barba and Savarese 1991). Modern dance employs a great variety of spinal patterns, lumbar initiations, thoracic over- and undercurves, side bends, spirals, and swings.

In typical mammals, the vertebral column is slung like a suspension bridge between the hind legs and forelegs. In humans, this orientation of the spine has been changed to an upright column with many consequences for optimal function. Good alignment is key because a small deviation from the ideal suffices to create constant bending and shearing stresses on the spine. To deal with upright posture, humans have strong abdominal walls, especially in the lower area; the organs are contained within a supportive visceral skeleton. The heart is firmly attached to the diaphragm and connected to the spine with ligaments, and the pelvic floor is reinforced with muscles and fascia. Surprisingly, spinal muscles are less developed in humans than in primates. A human spine is constructed as an upright wave-shaped spring and not configured to be constantly bending forward as may occur in the common desk-bound occupations. In this chapter you will understand how the spine and related muscles work optimally and discover imagery for furthering that functioning in dance, exercise, and sports.

FUNCTIONING SPINE

To fulfill its varied functions, the spine needs to be both stable and mobile. This stability must be dynamic because the spine needs to respond to ever-changing demands of movement and support. Attempts to use static ideas to explain its function will not succeed. The goal is stability during movement—not postural fixation, but dynamic adaptation.

The spine also supports various internal organs and protects the spinal cord while providing outlets for nerves fanning out into the entire body. Composed of many joints, the spine is designed for infinite combinations of movements. If the spine's potential is not fully explored regularly, its muscles, especially the short intrinsic ones, weaken.

As the intermediary between the upper and lower body, the spine carries the weight of the head, organs, and limbs and protects the spinal cord. It does this during complex positions and movements. The spine serves as an attachment site for a multitude of muscles, ligaments, and organs. Through its unique design features, it is able to absorb forces in all dimensions. The intervertebral discs are mostly fluid; the spinal cord is surrounded by the cerebrospinal fluid, and even bone, with its marrow core, is fluid-like at its center. Fluidity should not be equated with weakness, however. If you ever have been knocked down by a breaking wave at the beach, you can appreciate this.

The vertebral column consists of 24 separate vertebrae, composite vertebrae, the sacrum, and the coccyx. The cervical spine, the highest and most mobile part of the vertebral column, consists of seven vertebrae. The thoracic spine consists of 12 vertebrae that support the rib cage. The lumbar spine consists of five large vertebral bodies whose anterior aspects touch or even pass the midline of the body (figure 12.1). The base of the spine is called the sacrum and is composed of five fused vertebrae. The coccyx, the tail of the spine, consists of four vertebral remnants. From the back, the spine down to the lowest lumbar vertebrae looks like a long, slender pyramid, while the sacrum appears to be an inverted pyramid. The broad base of a long pyramid sits on the broad base of a short and wide pyramid, being the most stable static structure. From the side, the spine has four opposing curves in the sagittal plane, which add to its strength and resiliency.

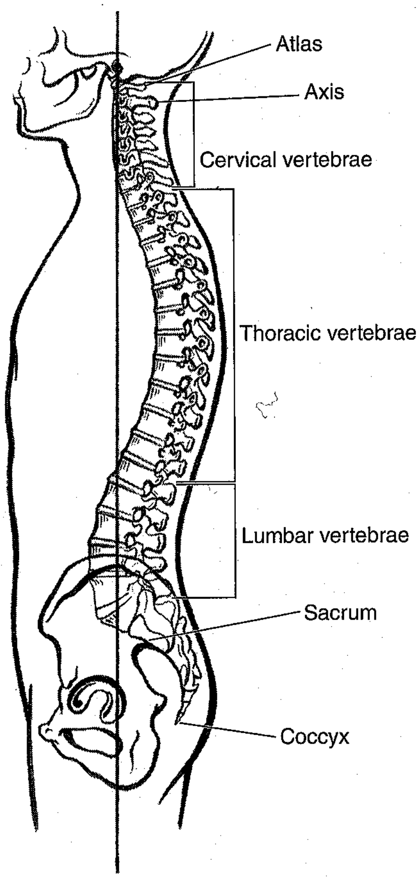

Figure 12.1 The vertebral column consists of 24 separate vertebrae, composite vertebrae, the sacrum, and the coccyx.

All humans are born with a basic convex curvature, the primary curve, of which the thoracic and the sacrococcygeal remain intact in adulthood. Opposing curves, necessary for sitting and walking, are developed by a baby's exemplary movement efforts. As a baby learns to lift her head, the cervical concavity develops. As she kicks, pushes, pulls, rolls, creeps, and crawls her way through babyhood, the lumbar concavity develops.

Fully understanding the unique spinal design with opposing spinal curves requires a review of human evolution and efficient biomechanical design. In quadrupeds, the spine has only one curve, supported by two pairs of legs in front and in back. Seen from the side, such a spine resembles a suspension bridge similar to the Golden Gate Bridge in San Francisco. In this design the cars are supported by a suspended roadway, just as the organs are supported by the abdominal wall and rib cage in the quadruped. If you were to position such a bridge upright, the singly curved spine would sag forward and buckle unless resisted by powerful posterior muscles. Such is the situation in gorillas or chimpanzees. These animals can walk upright but with much more effort than humans need to put forth.

An apparent solution would be to make the spine straight, like a slender pyramid or a Greek column. This is somewhat the shape of the spine when you look at it from the front.

However, two challenges arise if the spine were a straight column in the sagittal plane: Where do you place the organs and the baby during pregnancy, and how do you absorb forces through a straight spine? A flexible straight column would buckle under strain, and a rigid column would not be able to absorb force, causing shockwaves to reach the spinal cord and brain. The evolution of the two concavities of the spine allowed for a more axially centered structure. The cervical lordosis contributes the necessary dorsal movement of the head back over the sacral base, while the lumbar lordosis contributes a dorsal movement for the thorax. The curves enable the masses of the body, including the viscera (and baby during pregnancy), to be poised over their base of support. If you visualize the spine as a stack of four arches, each one inverted relative to the other, the line of gravity runs behind the apex of the convexity of the arches, thus maintaining the arches' ideal shape. The curves then contribute to force absorption by allowing axial compression to be turned into stretch in the muscles and connective tissue on the convex side of the curves (figure 12.2).

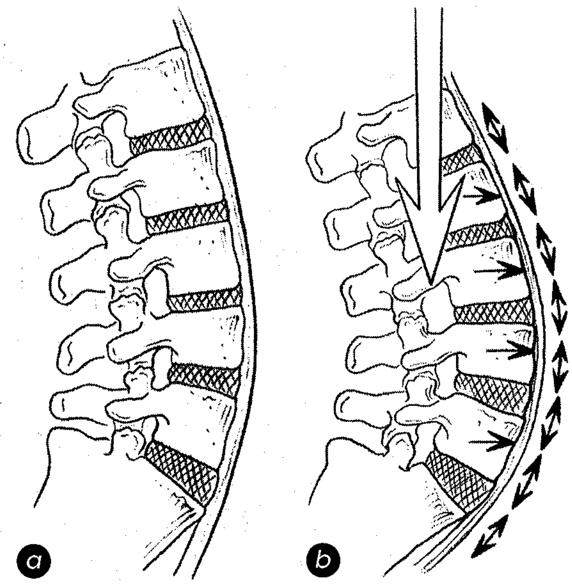

Figure 12.2 *(a)* Decompression and *(b)* compression forces in the lumbar spine being converted into stretch in the anterior longitudinal ligament.

If the spine were straight, the connective tissue and muscles would not be stretched but buckled and shortened. Muscles are much stronger, acting eccentrically; it is easier to support a load through stretch than through compression. The curves intelligently reduce impact on any individual part of the spine by shunting the energy from impact to stretch. Spinal curves need to be adaptive and resilient. In walking, dancing, or jumping, the spine subtly changes the degree of curvature to absorb and release force. An increase in the curve of the arch allows for compression forces to be transferred into stretch, where they can be stored and released to aid further movement. The spine can therefore be likened to a spring or an upright stack of trussed arches. Figure 12.3 exaggerates the changes in the spinal curvature for the purpose of clarity of the action.

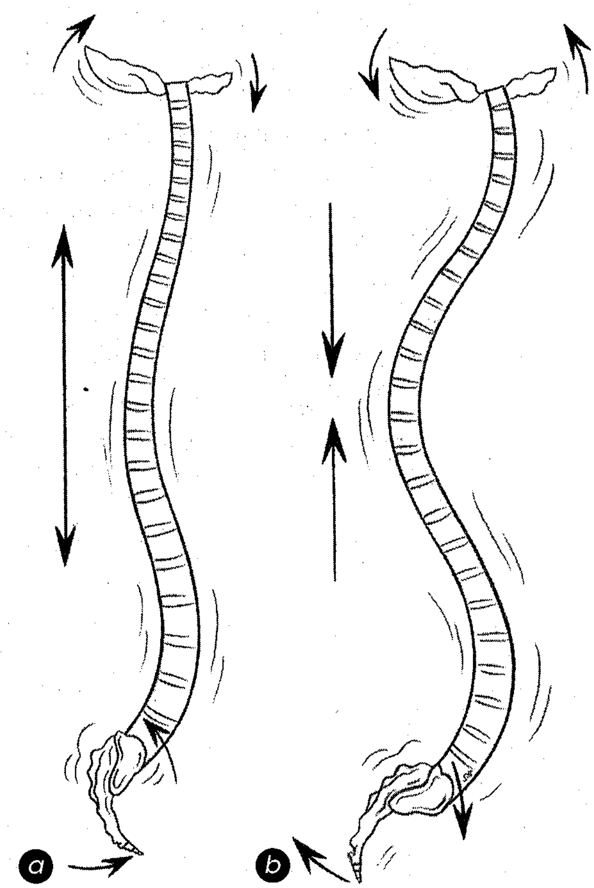

Figure 12.3 Spinal curves *(a)* lengthening and *(b)* deepening.

Due to differing angles of the spinous processes (projections of the spine), the spinal curves feel flatter to the touch than they actually are. The lumbar spinous processes are nearly horizontal where the spine is concave; in the thoracic concavity, they point downward. The gutters between the spinous processes and the ribs contain powerful

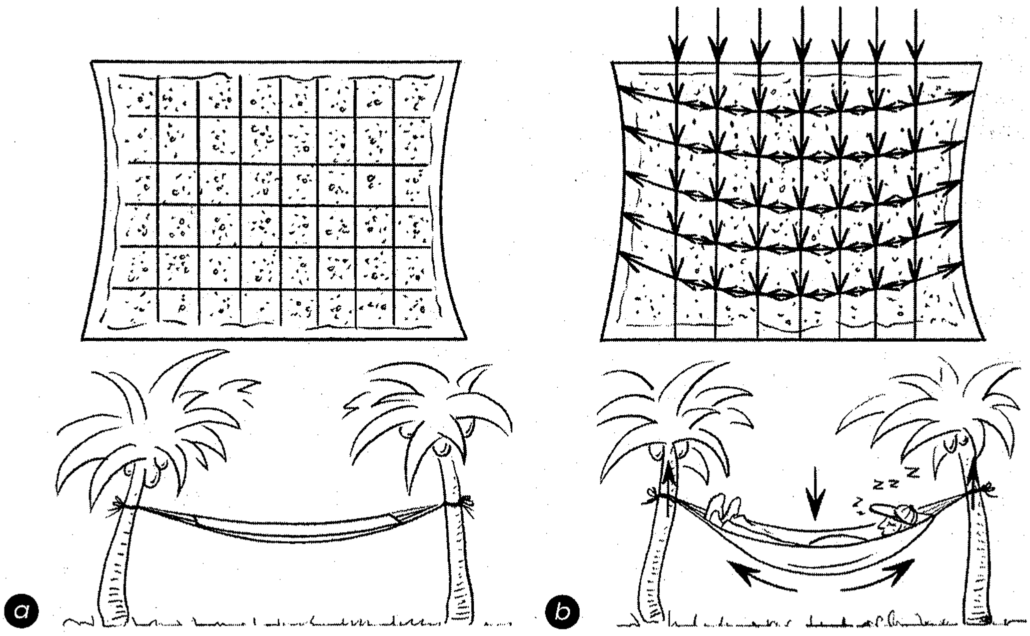

Figure 12.4 Force absorption in the vertebrae compared to stretching a hammock: *(a)* decompression; *(b)* compression.

strands of musculature, evening out the contour of the back so that it serves as a broad resting surface for the body.

As a further line of defense, the vertebrae contain trabeculae (Latin for "small beams"), a latticework of bone that directs forces through the interior of the bone and increases its ability to bear load. The trabeculae within each vertebra allow compression forces to be turned into tensile forces within the bony structure (Bogduk 1997). In this case, the vertically arranged trabeculae transfer the force to the horizontal system and from there to the cortical bone located at the rim of the vertebrae (figure 12.4).

The trabeculae can also be considered spokes of a wheel or a tensegrity system that transfers force away from the intervertebral disc with the help of the deep stabilizing muscles of the spine (Sohier 1991). In this case, the pull of the deep spinal muscles is able to decompress the vertebral end plates through the force lines of the trabeculae (figure 12.5).

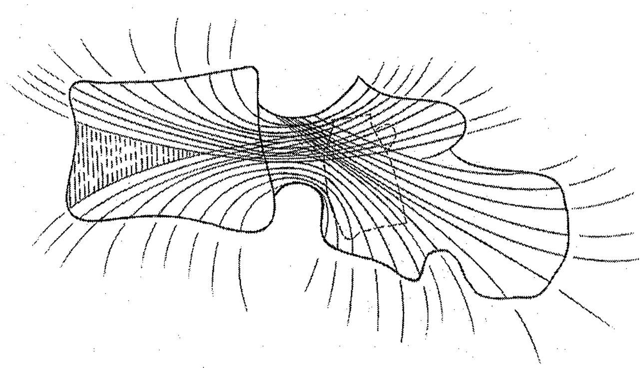

Figure 12.5 Trabecular lines of force relaying forces spokelike through the vertebrae.

Imagery Exercises for Spinal Design

1. **Visualizing the spine:** Visualize the design of your spine. In the sagittal plane, it resembles a tapering column; from the side, it resembles a vertical wave. Experience your spine as a motion-based structure. Imagine the curves as waves in water flowing upward.
2. **Painting your spine:** Using an imaginary paintbrush, color your spine in a variety of shades. Give each part of the spine an individual color: the bodies, discs, processes, and facet joints.
3. **Dynamic curves:** Stand in a comfortable position. Imagine the curves of the spine being perfectly counterbalanced. In your mind's senses travel up along the front of the spine and embody the four curves. Travel down the back of your spine and notice how the curves are slightly less pronounced. As you bend your legs, feel the curves of the spine deepen, which slightly shortens the overall length of the spine. The lumbar and cervical convexities will deepen forward; the thoracic and sacral curvature will deepen backward to counterbalance. As you bend your legs, imagine the spine lengthening and the curves becoming shallower. Repeat the action several times with the following self-talk: *Deeper curves* as you bend your legs and *longer curves* as you stretch them.
4. **Static curves:** Notice what happens if you think of the spinal curves as fixed. In other words, there is one position that is right, and the spine should remain in that position as you bend and stretch your legs. You may notice that the static image of the spine creates tension in your whole body and makes flexing and extending your limbs more difficult.
5. **Springy spine with self-touch:** Stand in a comfortable position. Place one hand on your neck and one hand on your lumbar spine (either the palm or the back of your hand). Bend your legs and experience a slight softening of the lumbar spine and neck as the curves deepen. This softening should not be equated with a sense of weakening; it is simply the fact that the spine is moving forward under your touch. Stretch your legs and feel the spinal curves moving back toward your hands and lengthening. Repeat this action 12 times, remove your hands, and notice the lengthened feeling in your spine. This is a prime example of how moving with an image that corresponds to function creates dynamic alignment. If you were to simply think, *Lengthen your spine*, the result could be static and reduce force absorption.
6. **Springy spine with arms:** Stand in a comfortable parallel position with your arms stretched out in front of you. At this point, your spinal curves are maximally lengthened. Bend your arms and legs and imagine the spinal curves deepening. Feel this as balanced movement forward and back of all the convexities of your spine. Stretch your arms and legs and feel the spinal curves lengthening. Repeat the action 10 times or until you can clearly feel the relationship of stretched limbs to longer curves and flexed limbs to deeper curves. Now relax your arms at your sides and enjoy the effortless lengthened and centered sense of your spine.
7. **Hammocking curves:** As you bend your spine, imagine the lumbar and cervical curves resting into the surrounding and supporting structures, muscle, ligaments, and connective tissue. Imagine the tissue to be like vertically oriented hammocks that support your spinal curves. Allow this image to create a resilient

feeling in your spine. Bend your legs and feel the stretch in the hammock; stretch your legs and feel it rebound again.

8. **Rebounding curves:** As you bend your spine, imagine the lumbar, thoracic, and cervical curves resting against springs located at their apexes. As you bend your legs, the springs are compressed; as you stretch your legs, the springs rebound and push the curves into length (figure 12.6).
9. **Moving with resilient curves:** As you move, imagine your spinal curves adjusting and rebounding off the ligaments and connective tissue surrounding them.
10. **Melting butter (supine position):** Imagine the back to be a chunk of butter. Watch as it melts and spreads. Depending on your personal preference, substitute ice cream, honey, soft snow, milk chocolate. . . .
11. **Smoothing sand (supine position):** Imagine your back to be made of chunky sand arranged in mounds. Visualize the wind blowing down your back, smoothing, leveling, and softening the sand.

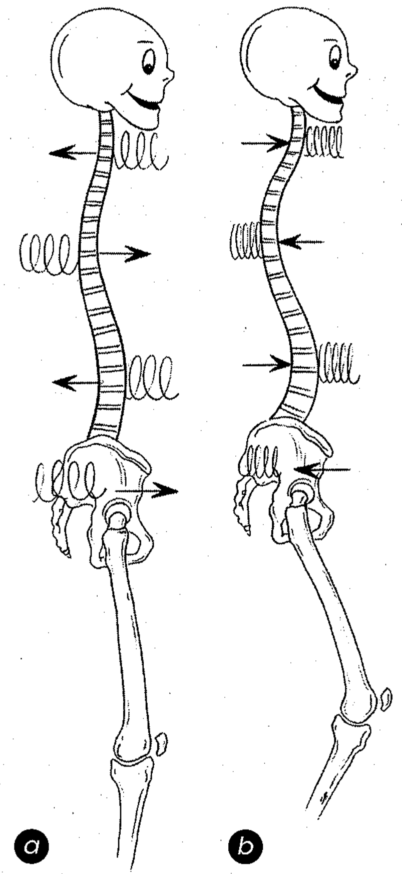

Figure 12.6 Spinal curves rebounding against springs: *(a)* lengthening curves compelled by springs; *(b)* deepening curves compressing springs.

PELVIS

The curves of the spine are influenced by the position of the pelvis. The fifth lumbar vertebra rests on the slanted sacral table, producing intrinsic shear forces in the lower lumbar area. These forces are counteracted by bony, ligamentous, and muscular restraints as well as by the hydrostatic pressure and tone of the abdominal organs and musculature. A line crossing the sacral table intersects with horizontal to determine the lumbosacral angle (figure 12.7*a*).

In the case of an anteriorly rotated pelvis, a plane defined by the ASIS and the PSIS will be slanted anteriorly (figure 12.8*b*). If the pelvis is rotated posteriorly, the plane defined by the ASIS and PSIS will be slanted posteriorly (figure 12.8*c*).

Excessive forward rotation of the top of the pelvis increases the lumbosacral angle, deepening the lumbar curves, which will tend to increase the other curvatures of the spine or cause compensatory reactions (figures 12.7*b* and 12.8*b*). Therefore, the COGs of the individual vertebrae will be less well aligned on top of each other, increasing the shear stresses at the lumbosacral joint and other joints of the spinal column. Anterior rotation also increases the stresses on the hip joint. Posterior rotation of the pelvis, commonly called lifting the pelvis, reduces these stresses but increases the stress on the lumbar discs and reduces the ability of the pelvis and spine to absorb force. In addition, the pelvic outlet is narrowed and the muscles of the pelvic floor shortened, reducing flexibility in the hip joint. Posterior rotation of the pelvis and sacrum (tucking the pelvis) tends to flatten the curves (figure 12.8*c*) and is not a beneficial approach to lengthening the spine. In addition, there are cultural differences. People of African origin generally have deeper spinal curves, which studies have shown decrease the incidence of back pain (Carey et al. 1996). It seems that not the degree of curvature but the dynamic balance and force-absorbing ability of the spinal curves are the key to spinal health.

Overemphasizing the posterior rotation of the pelvis is especially problematic in sports, dance, and certain forms of exercise. In the turned-out dance position, tucking the pelvis distorts the alignment of the legs by forcing the knees forward, increasing tension in the pelvic musculature, and straining the medial aspect of the knees. This reduces the efficiency of hip flexion and leg extension. If you try to eliminate an established tucking habit, you will feel as if your buttocks are protruding to the rear. Since this feels wrong, it is often challenging to repattern. A balanced pelvis is based on good

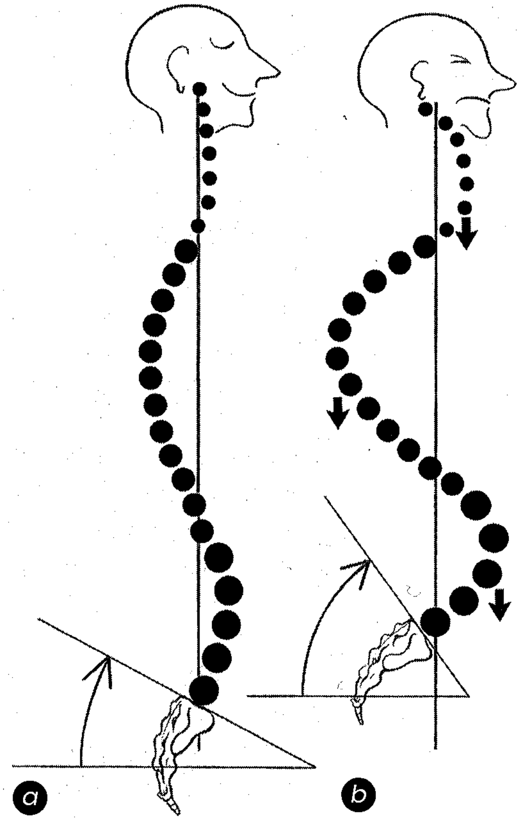

Figure 12.7 *(a)* The lumbosacral angle. *(b)* A larger lumbosacral angle means vertebrae will be less well aligned on top of each other, increasing shear stresses at joints throughout the spinal column.

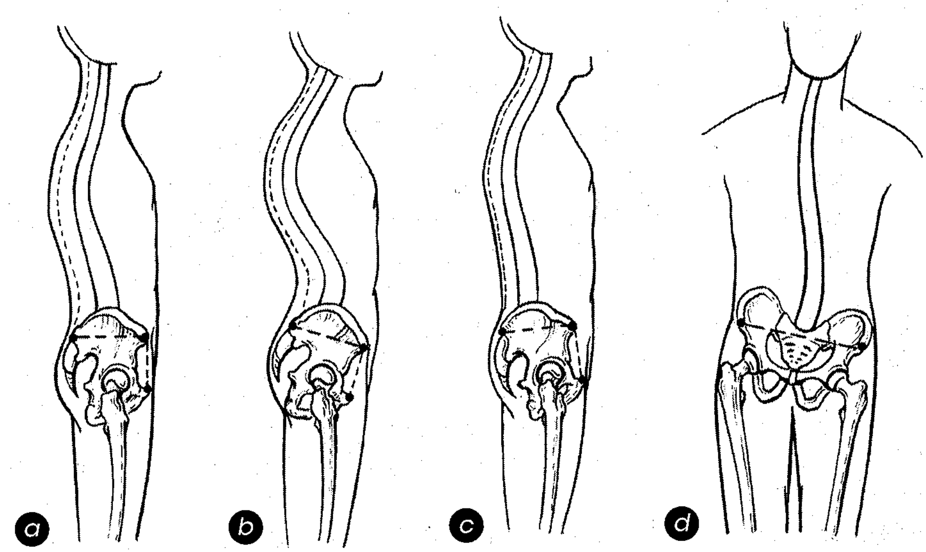

Figure 12.8 *(a)* The ASIS and PSIS in the same plane. *(b)* The PSIS higher than the ASIS. *(c)* The PSIS lower than the ASIS. *(d)* The ASIS not on the same horizontal plane.

movement patterns and dynamic stability, not on the constant tensing of certain muscle groups, which reduces the adaptability of the system.

If the pelvic crests and the ASIS are not level in the horizontal plane, the lumbar spine will deviate to the lower side of the pelvis. This forces the spine into a corrective bend to recapture its vertical alignment. Such curves of the spine in the frontal plane are called scoliotic (figure 12.8*d*). If the pelvic halves are twisted, the spine twists uncomfortably at its very base—certainly not the foundation of good spinal alignment.

If the pelvis is in good static alignment, three points delineated by the ASIS and the front of the pubic symphysis (the joint between the two pubic bones) form a vertical plane. In this case, the ASIS and the PSIS are approximately on the same horizontal plane (figure 12.8*a*). This has been called neutral pelvis. In dynamic alignment, your pelvis should oscillate around this neutral position and certainly not be held there by voluntary muscular contraction. The question is always about performance and well-being. If you place a person in the "correct" position and his ability to move suffers and he feels uncomfortable, this cannot be called a success. Other factors must be considered. (See "Motion of the Pelvic Halves" in chapter 10.)

Therefore, although achieving a visually ideal position may be an important element of efficient functioning, it is no guarantee. An improvement in spinal alignment must be dynamic and centered on motion interrelationships of bones, muscles, and organs, and it must include changes in the person's body image, in which the pelvis and head play a significant part.

The spine and pelvis interrelate in a complex manner. In bilateral hip flexion, the sacrum nutates, increasing the lumbar lordosis. The pelvic halves inflare and internally rotate and the sit bones move laterally. These movements are all small but need to be coordinated with the spinal adjustments. Since the body's intelligence is aiming to absorb and store force, any one part of the body that is held in tension will cause all the other areas to reduce their movement. (See "Motion of the Pelvic Halves" in chapter 10.)

Imagery Exercises for the Pelvis and Spine

1. **String lifting pubic symphysis (standing, walking):** Imagine a string attached to the pubic symphysis. Watch the string pulling up and forward on a slight diagonal to lift the front rim of the pelvis. Imagine this string pulling you into a walk.
2. **Lighting designer aligns the spine (supine, sitting, or standing):** Visualize the spine as a chain of spotlights. Turn on the lights and observe their focal directions. In a relaxed upright posture, they should be illuminating the median sagittal plane. If they shine in many confused directions, adjust them so that they all focus in the sagittal plane. Now adjust them so that they shine with equal brightness.
3. **Aligning your spinal lights (supine, sitting, or standing):** Concentrate on the spotlight at the center of the cervical spine. Its light should shine in the horizontal direction (perpendicular to the central axis). Focus on the spotlight at the center of the thoracic spine. Allow its light to become perpendicular to

the central axis. Finally, focus on the spotlight at the level of the fourth lumbar vertebra; adjust its light so that it too is directed perpendicularly to the central axis. Focus on these three spotlights simultaneously. Watch them become parallel, horizontally aligned in the sagittal plane (figure 12.9).

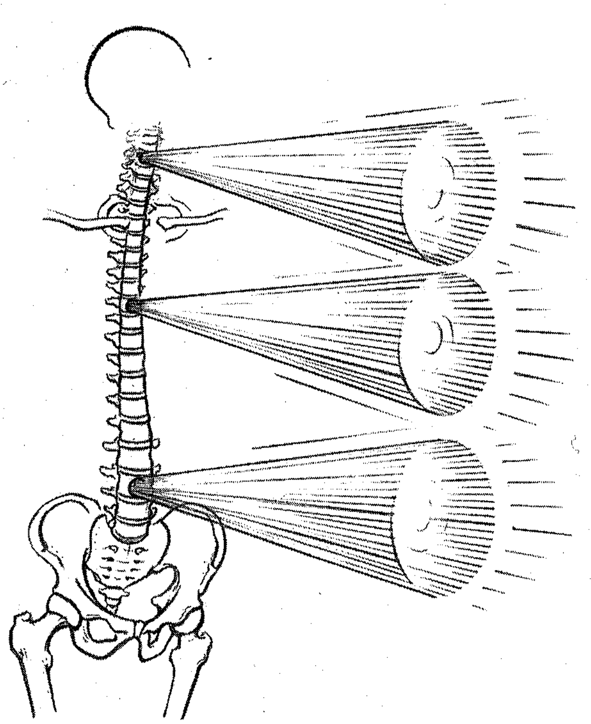

Figure 12.9 Visualize the spine as a chain of spotlights.

VERTEBRAE

Each vertebra consists of two main parts: a cylindrical body in front, mainly responsible for resisting compression forces, and a vertebral arch in back. The arch is formed by two pedicles and the laminae with four articular joint and three nonarticular projections; the nonarticular processes are the spinous and the transverse (figures 12.10 and 12.11). Only the spinous processes can be seen and palpated as the posterior part of the spine. These processes should form a line that divides the back into two equal halves. Because the spinous and transverse processes are interconnected by many short muscles, you have the ability to move the spine in a snakelike manner.

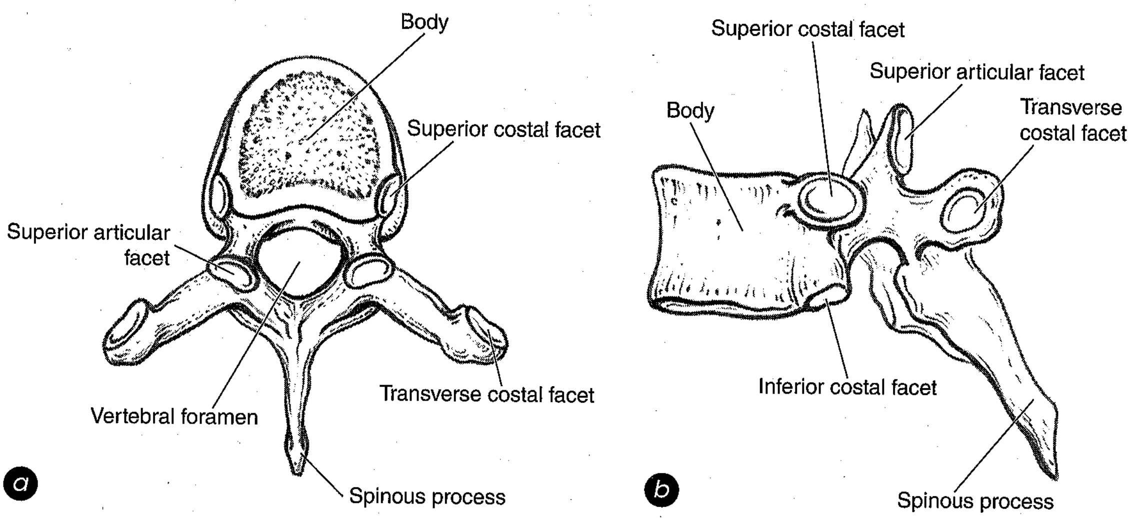

Figure 12.10 A thoracic vertebra: *(a)* top view; *(b)* side view.

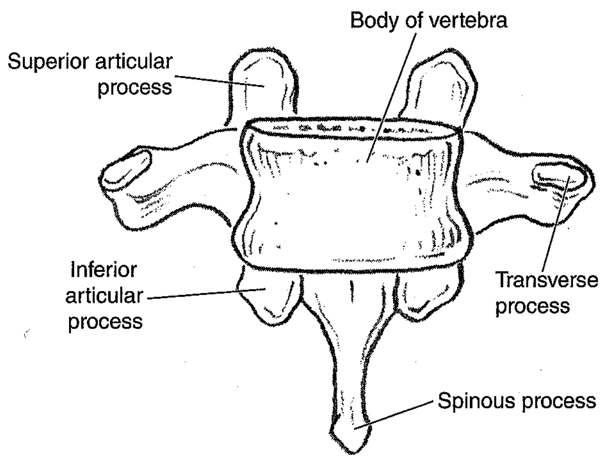

Figure 12.11 Thoracic vertebra from the front.

Because the spinous processes are the visible part of the spine, people tend to think of the spine as being far back, when in fact the weight-bearing bodies of the vertebrae, as well as the intervertebral discs, are more centrally located. The facets are estimated to carry 18 to 20 percent of the load, while the discs carry the remainder. Maintaining such balance is important for spinal health. The body and facets form a triangle, or tripod, which increases stability in balance.

The spine has more depth than you may imagine. If you place your finger in your navel, the bodies of the lumbar spine are only about two to four inches (5 to 10 cm) from the tip of your finger.

Imagery Exercises for the Vertebrae

1. **Weight bearing and articulating (standing, sitting):** Imagine the vertebrae and discs. This is the predominantly weight-bearing part of the spine. Now imagine the arch and the facet joints and processes. This is the more mobile part of the spine. Perform small movements with your spine and imagine the anterior part of the vertebrae carrying more weight while the posterior part guides and mobilizes.
2. **Releasing the spinous processes (standing, sitting, or supine):** Visualize the dorsal spinous processes as little flags or ribbons. Imagine the wind blowing through your body from front to back, unfurling these flags. Watch the flags fluttering in the wind. Picture all the flags aligned one above the other (figure 12.12).

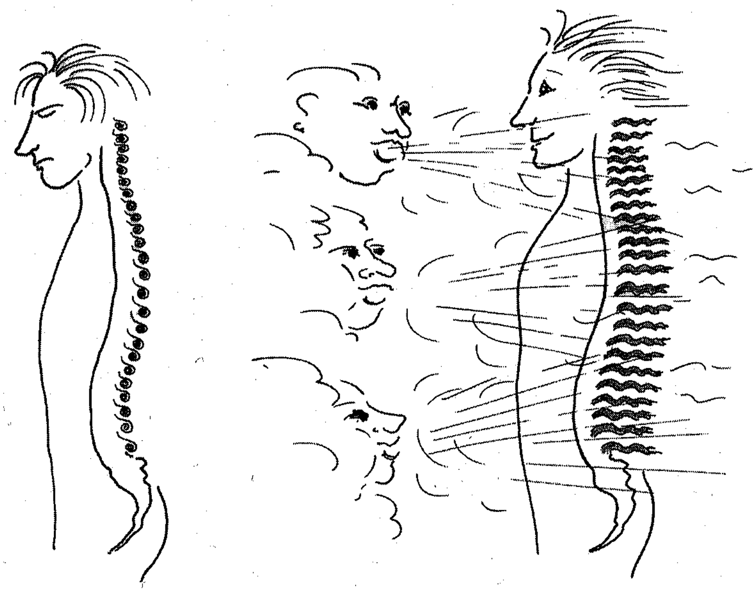

Figure 12.12 Visualize the dorsal spinous processes as little ribbons.

3. **Spinous process as an elephant's trunk:** Imagine the spinous process is the trunk of an elephant (figure 12.13). Allow this image to create a flexible feeling in the posterior spine.

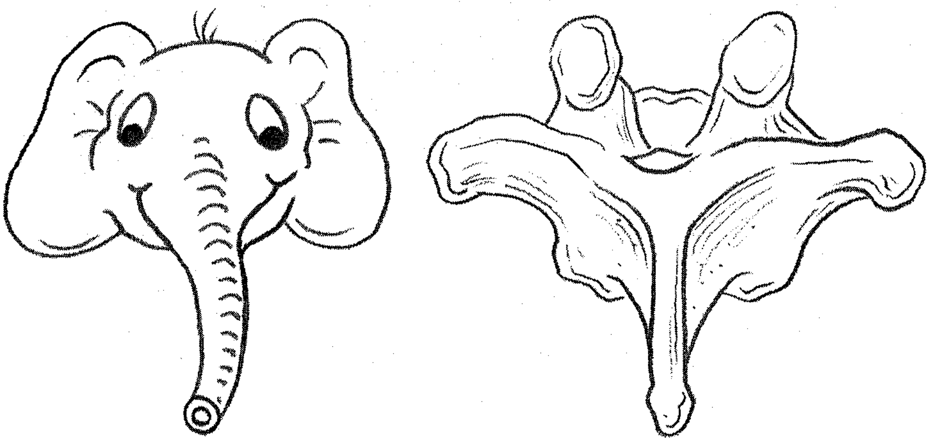

Figure 12.13 The spinous process as an elephant's trunk.

4. **A variety of images for the spinous process:** Imagine the spinous process to be a kite tail, or a shower head, or a paintbrush, or a pump handle (figure 12.14). Choose the image that works best for you in creating a sense of length and release in your back.

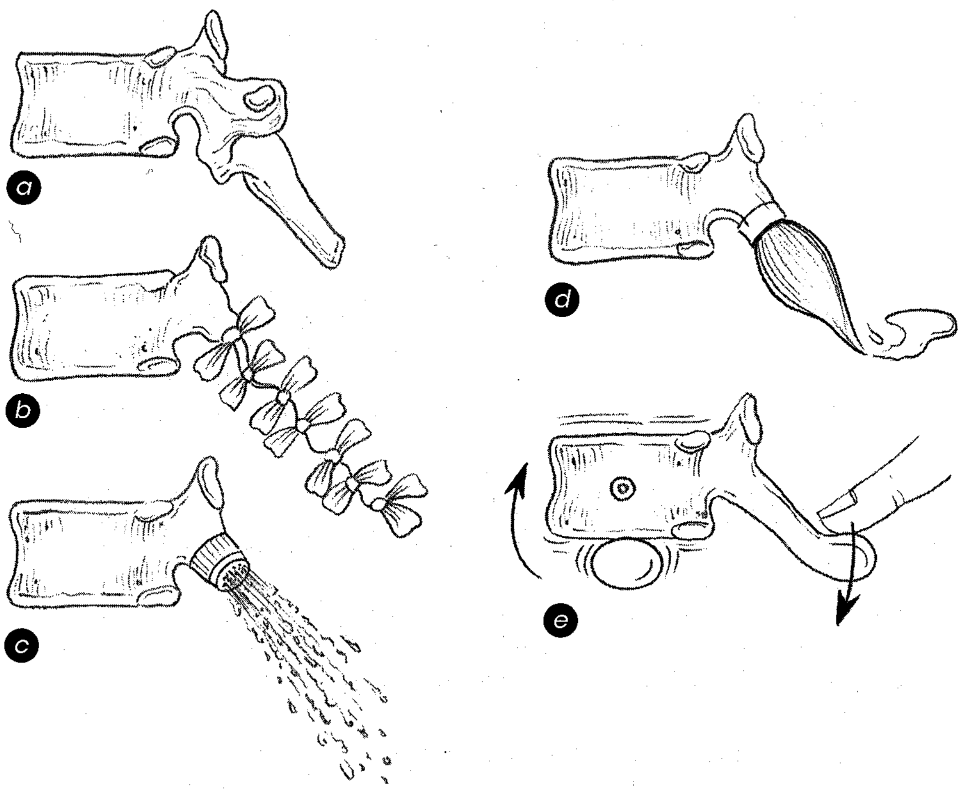

Figure 12.14 Imagery for the *(a)* spinous process: *(b)* kite tail, *(c)* shower head, *(d)* paint brush, *(e)* pump handle.

5. **Fluidity and subtlety of spinal movements (any position in improvisation; music optional):** Imagine the spinal processes as the tongues of a vibraphone. Each process creates its own distinct sound. Hear the spine-vibraphone playing. Feel the vibration of each vertebra (figure 12.15).
6. **Fluttering transverse processes:** Imagine the transverse processes of the spine stretching sideways. Now watch as they begin to move gently, creating a downward current along the sides of the spine. This motion is similar to that of the soft, tiny hairs called cilia used by one-celled animals to move through the water (figure 12.16).

Figure 12.15 Imagine the spinal processes as the tongues of a vibraphone.

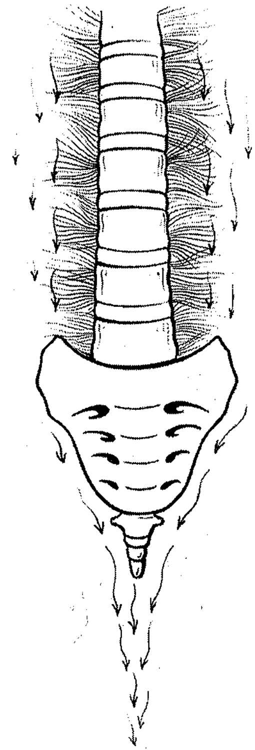

Figure 12.16 Imagine the transverse processes of the spine stretching sideways; the movement is similar to that of cilia, used by one-celled animals to move through the water.

7. **Spine as a chain of spheres or pearls:**
   a. **Awakening chain (supine, improvisation):** Lie on the floor and imagine the spine to be an interconnected chain of spheres. Watch as a single sphere comes alive with motion. At first, there is only a gentle stirring, a small rocking motion. The movement of the vertebra intensifies until it inspires its neighbors to move as well. The inspiration spreads along the entire spine until the whole chain is in motion.
   b. **Releasing pearls (supine, sitting, standing, walking):** Imagine the spine to be a string of pearls fastened by a knot at the bottom end. Visualize the knot opening and the pearls gliding off the string. As the pearls drop, watch the space between adjacent pearls widen.

c. **Pearl dance (improvisation):** Visualize the spine as a polished, glistening chain of pearls. Watch how the pearls catch the myriad colors of light. Hear the sounds the pearls make as they roll against each other.

8. **Imagining the tripod:** Imagine the tripod nature of the vertebrae and facet joints. Visualize balanced tripods throughout the spine (figure 12.17).

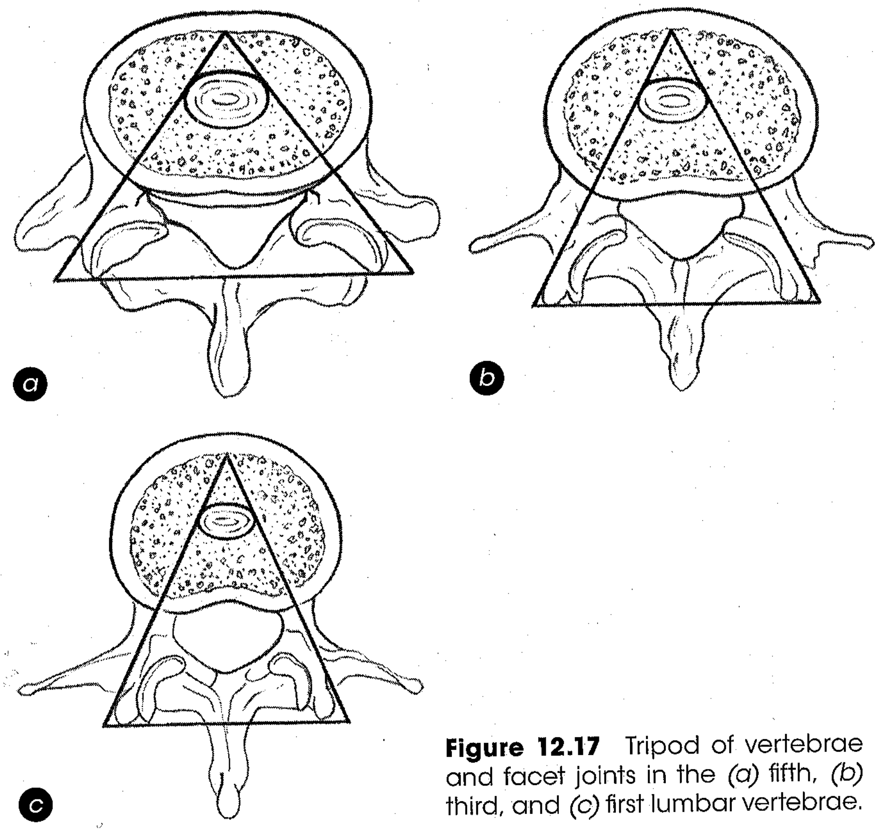

Figure 12.17 Tripod of vertebrae and facet joints in the *(a)* fifth, *(b)* third, and *(c)* first lumbar vertebrae.

FACET JOINTS

In addition to the main weight-bearing intervertebral joints, the apophyseal, or facet, joints connect two adjoining vertebrae. They are fairly flat and are depicted in figure 12.18 as interlinking hands. The hands are also ensuring that the neural foramen stays open for the nerves exiting the spinal cord.

They permit movement in a variety of directions, depending on their angle, while preventing excessive sliding of one vertebra in relation to another. The inferior articular facet of each vertebra stabilizes it by preventing the vertebra from sliding

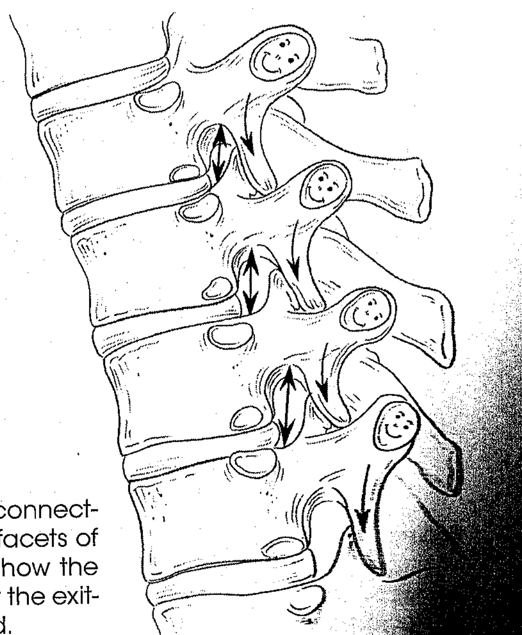

Figure 12.18 The facet joints as interconnecting links of hands; the faces are the facets of the transverse process. The arrows show the importance of maintaining space for the exiting of the nerves from the spinal cord.

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