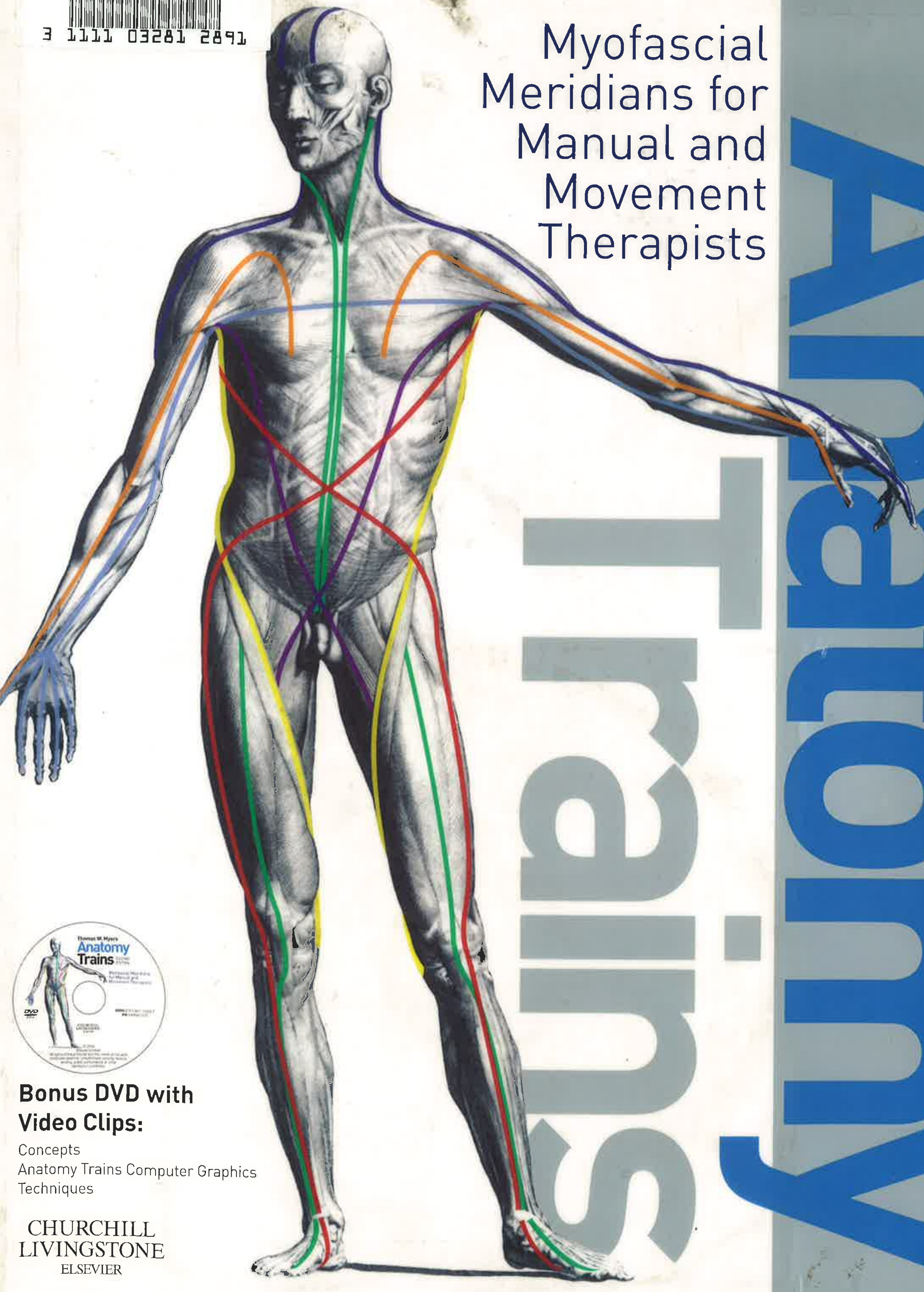
Anatomy Trains

Myofascial Meridians for Manual and Movement Therapists

SECOND EDITION

Thomas W. Myers



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Anatomy Trains Computer Graphics
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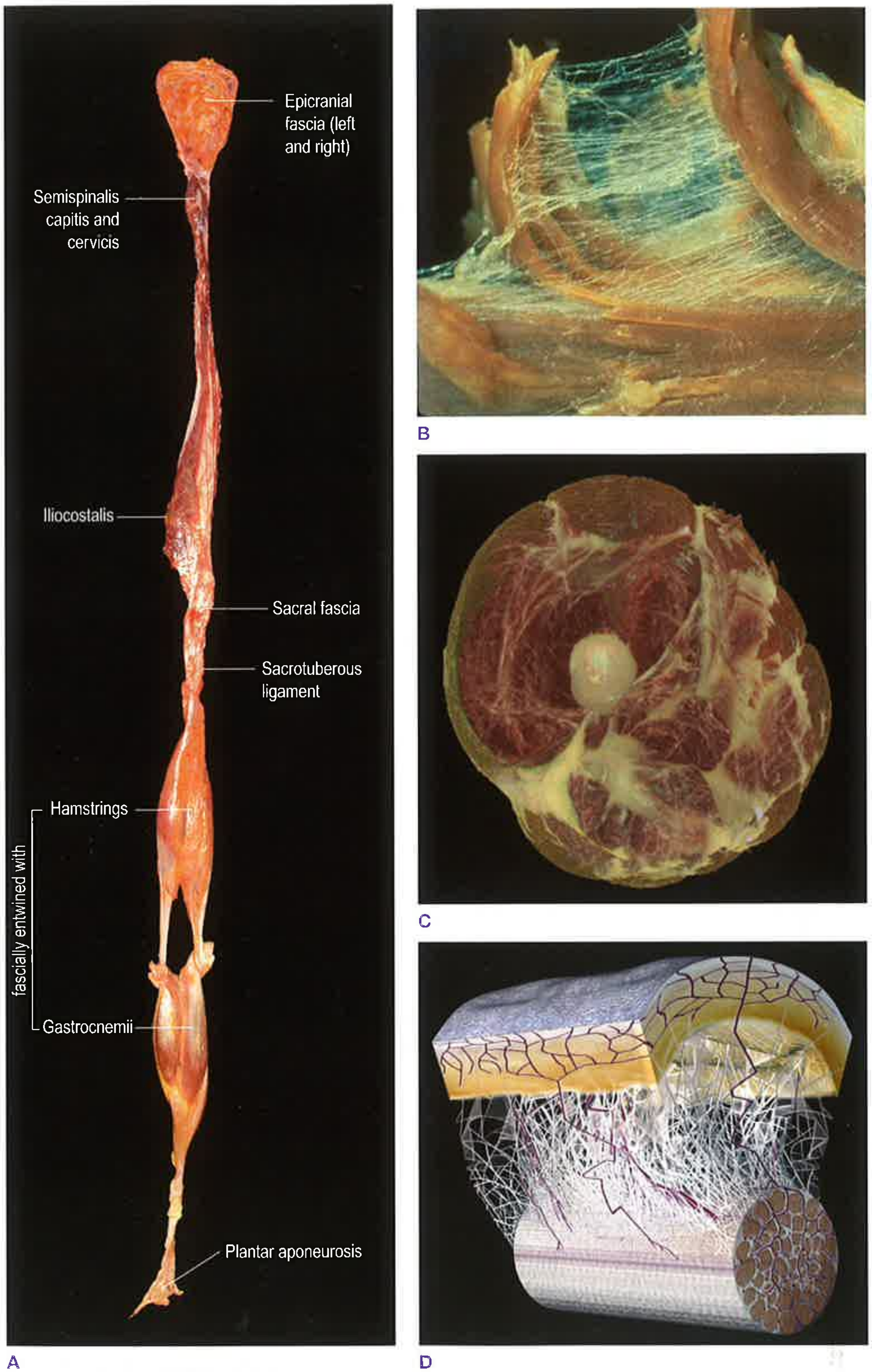


Fig. 1.1 **(A)** A fresh-tissue specimen of the myofascial meridian known as the Superficial Back Line, dissected intact by Todd Garcia from the Laboratories of Anatomical Enlightenment. (Photo courtesy of the author.) (**DVD ref:** This specimen is explained on video on the accompanying DVD) **(B)** A dissection of teased muscle fibers, showing surrounding and investing endomysial fascia. (Reproduced with kind permission from Ronald Thompson.) (**DVD ref:** This and other graphics are available and explained in **Fascial Tensegrity,** available from *www.anatomytrains.com*) **(C)** A section of the thigh, derived from the National Library of Medicine's Visible Human Project, using National Institute of Health software, by structural practitioner Jeffrey Linn. This gives us the first glimpse into what the fascial system would look like if that system alone were abstracted from the body as a whole. Once this process is complete for an entire body, a laborious process now underway, we will have a powerful new anatomical rendering of the responsive system that handles, resists and distributes mechanical forces in the body. (Reproduced from US National Library of Medicine's Visible Human Data® Project, with kind permission.) (**DVD ref:** This and other graphics are available and explained in **Fascial Tensegrity,** available from *www.anatomytrains.com*) **(D)** A diagram of the fascial microvacuole sliding system between the skin and the underlying tendons as described by Dr J. C. Guimberteau. (Diagram courtesy of Dr J. C. Guimberteau.) (**DVD ref: Strolling Under the Skin**, available from *www.anatomytrains.com*)

If we were to render all tissues invisible in the human body except the fibrillar elements of the connective tissue – principally collagen, but with some added elastin and reticulin – we would see the entire body, inside and out, in a fashion similar to the neural and vascular nets, though the areas of density would once again differ. The bones, cartilage, tendons, and ligaments would be thick with leathery fiber, so that the area around each joint would be especially well represented. Each muscle would be sheathed with it, and infused with a cotton-candy net surrounding each muscle cell and bundle of cells **(see Fig. 1.1B)**. The face would be less dense, as would the more spongy organs like the spleen or pancreas, though even these would be surrounded by one or two denser, tough bags. Although it arranges itself in multiple folded planes, we emphasize once again that no part of this net would be distinct or separated from the net as a whole; each of these bags, strings, sheets, and leathery networks is linked to each other, top to toe. The center of this network would be our mechanical center of gravity, located in the middle of the lower belly in the standing body, known in martial arts as the 'hara'.

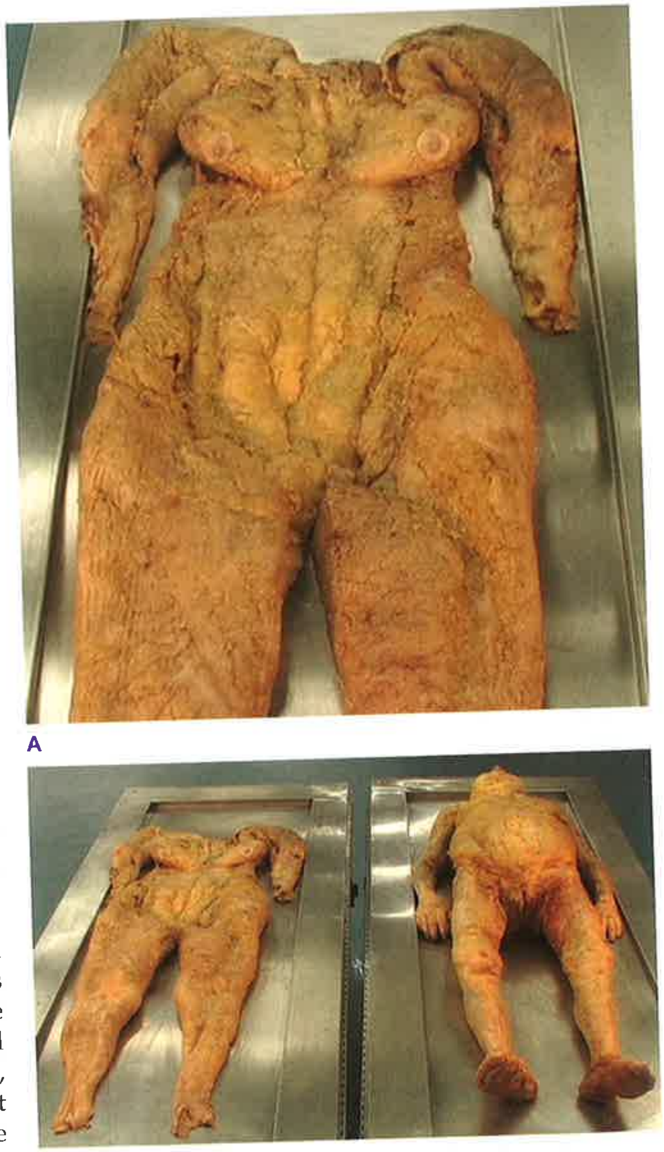
The bald statement is that, like the neural and vascular webs, the fascial web so permeates the body as to be part of the immediate environment of every cell. Without its support, the brain would be runny custard, the liver would spread through the abdominal cavity, and we would end up as a puddle at our own feet. Only in the open lumens of the respiratory and digestive tracts is the binding, strengthening, connecting, and separating web of fascia absent. Even in the circulatory tubes, filled with flowing blood, itself a connective tissue, the potential exists for fiber to form at any moment we need a clot (and in some places where we do not need one, as when plaque builds in an artery).

We could not extract a cubic centimeter, let alone Shylock's pound of flesh, without taking with us some of this meshwork of collagen. With any touch more than feathery light, we contact the tone of this web, registering it whether we are conscious of it or not, and affecting it, whatever our intention.

This ubiquitous network has enough of a regular molecular lattice **(see Fig. 1.14)** to qualify as a liquid crystal, which begs us to question to what frequencies this biological 'antenna' is tuned, and how it can be tuned to a wider spectrum of frequencies or harmonized within itself. Although this idea may seem farfetched, the electrical properties of fascia have been noted but little studied to date, and we are now glimpsing some of the mechanisms of such 'tuning' (pre-stress – see the section on tensegrity below).[39–42]

In contrast to the neural and vascular net, the fascial net has yet to be depicted on its own by any artist we have seen to date. Vesalius' closest rendering is the familiar écorché view of the body, which certainly gives us some idea of the grain of the fabric of the fibrous body, but really renders the myofascia – muscle and fascia together, with a heavy emphasis on the muscle. This is a prejudgment that has been continued in many anatomies, including those in wide use today: the fascia is largely removed and discarded to give visual access to the muscles and other underlying tissues.[43–45]

These common pictures have also removed and discarded two important superficial fascial layers: the epidermis that provides a carpet backing for the skin, and the fatty areolar layer with its well-funded store of white blood cells **(Fig. 1.24)**. If we left these hefty layers in the full picture, we would see the animal equivalent of a citrus 'rind' beneath the very thin skin. This has helped to contribute to a general attitude of viewing the fascial net as a 'dead' scaffolding around the cells, to be parted


A

B

Fig. 1.24 **(A)** An extraordinary one-piece dissection of the areolar/adipose layer of superficial fascia fills in the picture not covered by **Figure 1.23** (or **Fig. 1.6**). This picture does not include the dermis layer of the skin, but does include the fat, the collagen matrix around the fat, and of course the many leucocytes at the histological level. **(B)** Here we see the specimen in full along with the donor who provided it. The concept of this fascial layer as a nearly autonomous organ, somewhat akin to the rind of the grapefruit pictured in **Figure 1.25**, is given a concrete reality through this feat of dissection. (© Gil Hedley 2005. *www.gilhedley.com*. Used with kind permission.)

Ch. 11), we found that the rib cage had shifted to the left, dropping the support out from under the right shoulder (a similar pattern can be seen in **Fig. In. 8**, p. 5). The rib cage had moved to the left to take weight off the right foot. The right foot had not taken its share of the weight since a mild skiing injury to the medial side of the knee three years earlier. The whole pattern was now set into the neuromyofascial webbing.

By working manually with the (by now long-healed but not yet resolved) tissues of the knee and lower leg, then with the quadratus lumborum, iliocostalis, and other determinants of rib cage position, we were able to support the right shoulder from below, so that it no longer 'hung' from the neck. The woman was able to point and click to her heart's content without any recurrence of her 'work-related' problem.

In summary, we may view the connective tissue as a living, responsive, semiconducting crystal lattice matrix, storing and distributing mechanical information. As one of the three anatomic networks that govern and coordinate the entire body, the ECM can be seen as a kind of *metamembrane*, according to Deane Juhan.[74] Just as the membrane is now seen to envelop the inside as well as the surface of a cell, our fibrous metamembrane surrounds and invests all our cells, our tissues, our organs, and ourselves. We develop this idea further in the section on embryology below.

All systems intertwine

Of course, examining these holistic networks apart from each other has been just another reductionist analytical trick – they always are interacting, and always have within the individual and the species, time out of mind **(Fig. 1.29)**. We could as easily speak of a single 'neuromyofascial' web that would encompass all three of these networks acting singly to respond to the changes in the environment.[75] We cannot entirely divorce the mechanical communication of the fibrous net from the neurological communication that would occur nearly simultaneously. Likewise, neither of these networks can be considered separately from the fluid chemistry that brings the nourishment that allows each of them to work in the first place. In fact, each and every biological system is fundamentally a fluid chemical system dependent on flow.

Persisting, then, in this metaphor for one more image, each system has a set of 'ambassadors' that run in both directions, with the ability to alter the state of the other systems and keep them inter-informed **(Fig. 1.30)**. The hormones and neurotransmitters inform the circulatory net what the neural net is 'thinking'; neuropeptides and other hormone-like chemicals keep the nervous system up to date in what the circulatory system is 'feeling'. The circulatory net feeds proteins to the fibrous net and maintains turgor within the pressure-system bags within the body; the fibrous net guides the flow of fluids, allowing and restricting for better or worse as we have described above. It also affects the tonus of the myofibroblasts through fluid chemistry, as we shall describe below in the tensegrity section.

The nervous system feeds into the fibrous system by means of the motor nerves that change the tonus of muscles. Perhaps the most interesting leg of this three-legged stool for the clinician is the set of mechanoreceptors that feed information from the fascial net back to the nervous system. This fascial network is the largest 'sense organ' in the body, dwarfing even the eyes or ears

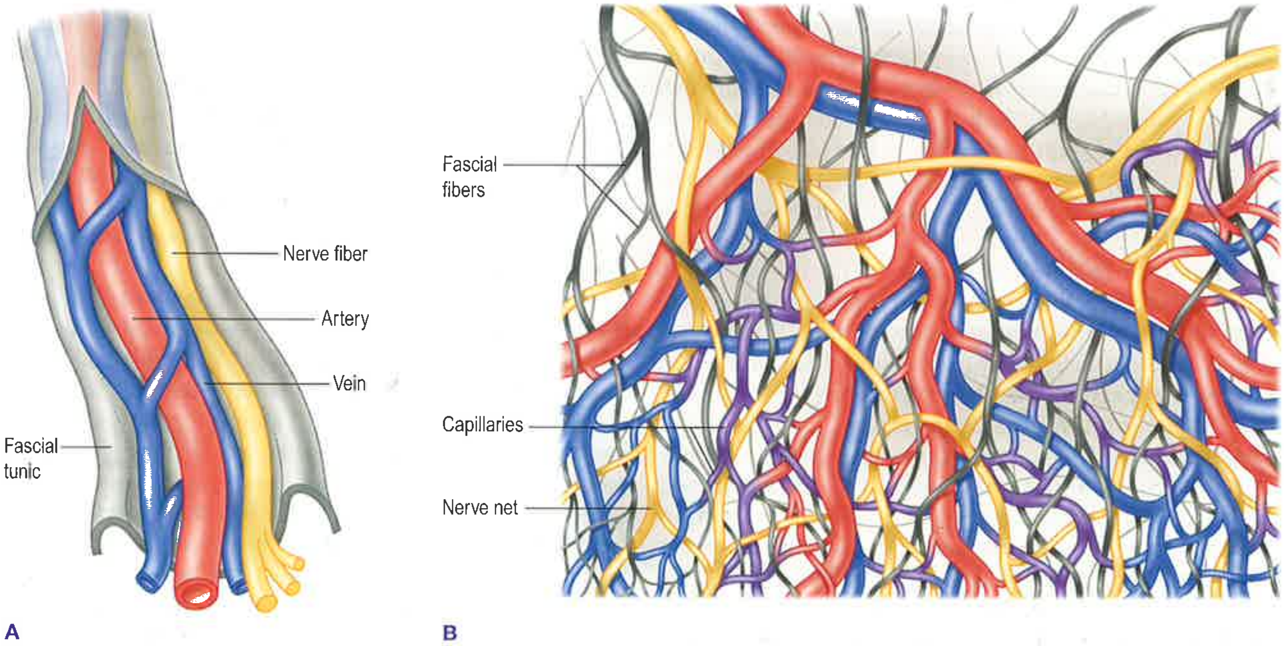


Fig. 1.29 The neural, vascular, and fascial systems run parallel in the neurovascular bundles **(A)** that extend the viscera out into the limbs and farther recesses of the body, with the connective and neural tissues forging the way. When they reach their destination, however, they spread into three enmeshed networks all occupying the same space **(B)**.

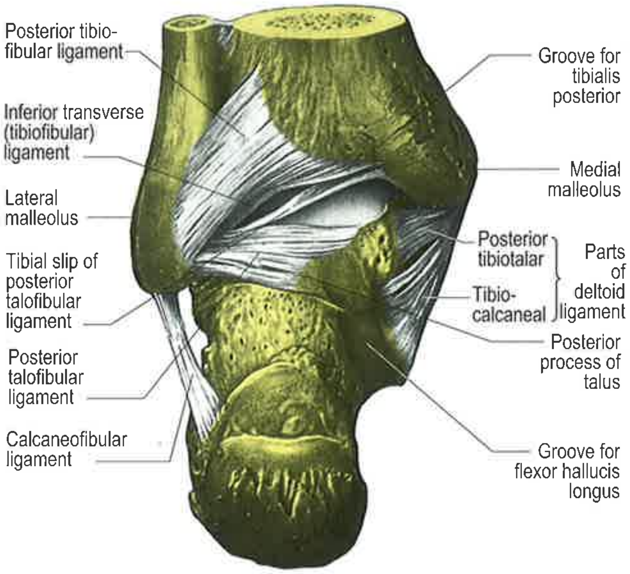


Fig. 1.44 The ligaments we see separated and detailed in the anatomy books are really just thickenings in the continuous encircling 'bone bag' part of the musculoskeletal double-bagging system. (Reproduced with kind permission from Williams 1995.)

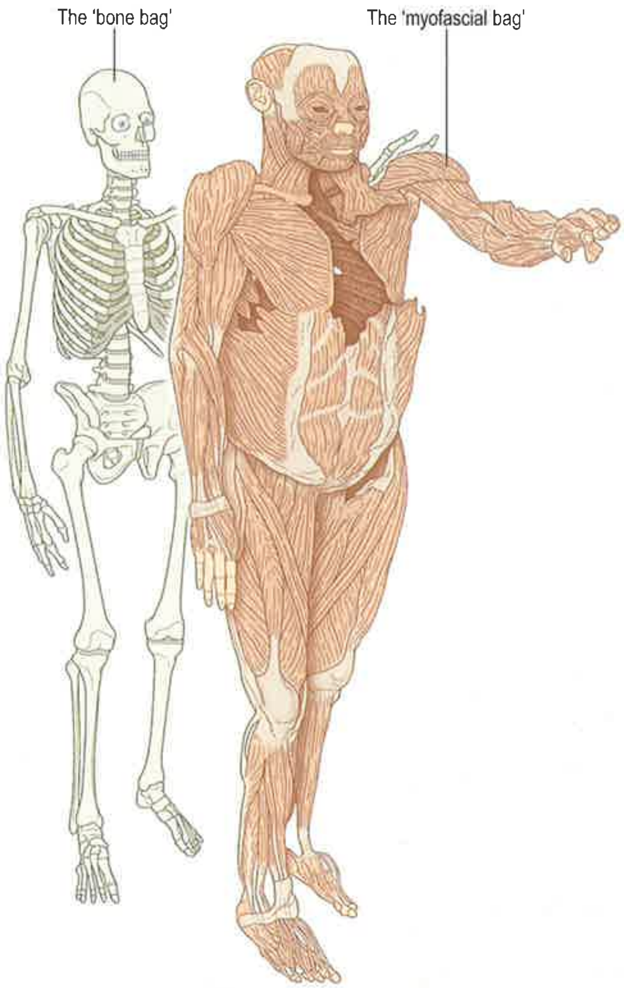


Fig. 1.45 This image, redrawn after a photo of the plastinated bodies in the Korperwelten project of Dr Gunter van Hagens, shows more clearly than any other the connected nature of the myofascia and the fallacy (or limitation, at least) of the 'individual muscle connecting two bones' image we have all learned. To connect this image to this chapter, the 'inner bag' would be the ligamentous bed surrounding the skeleton on the left, and the 'outer bag' would be surrounding (and investing) the figure on the right. To prepare this specimen, Dr van Hagens removed the entire myofascial bag in large pieces and reassembled them into one whole. The actual effect is quite poignant; the skeleton is reaching out to touch the 'muscle man' on the shoulder, as if to say, 'Don't leave me, I can't move without you'. (The original plastinated anatomical preparation is part of the artistic/scientific exhibition and collection entitled Korperwelten (BodyWorlds). The author recommends this exhibition without reservation for its sheer wonder as well as the potency of its many ideas. Some taste of it can be obtained through visiting the website (*www.bodyworlds.com*) and purchasing the catalog or the video.) The Anatomy Trains tracks are some of the common continuous lines of pull within this 'muscle bag', and the 'stations' are where the outer bag tacks down onto the inner bag of joint and periosteal tissue around the bones.

call muscle, which is capable of changing its state (and its length) very quickly in response to stimulation from the nervous system. The containing bag itself we call the deep investing fascia, intermuscular septa (the double-walled part between our hands at the end), and myofascia. Within this conception, the individual muscles are simply pockets within the outer bag, which is 'tacked down' to the inner bag in places we call 'muscle attachments' or 'insertions' **(Fig. 1.45)**. The lines of pull created by growth and movement within these bags create a 'grain' – a warp and weft – to both muscle and fascia.

We need to remind ourselves once again at this point that muscle never attaches to bone. Muscle cells are caught within the fascial net like fish within a net. Their movement pulls on the fascia, the fascia is attached to the periosteum, the periosteum pulls on the bone.

There really is only one muscle; it just hangs around in 600 or more fascial pockets. We have to know the pockets and understand the grain and thickenings in the fascia around the muscle – in other words, we still need to know the muscles and their attachments. All too easily, however, we are seduced into the convenient mechanical picture that a muscle 'begins' here and 'ends' there, and therefore its function is to approximate these two points, as if the muscle really operated in such a vacuum. Useful, yes. Definitive, no.

Muscles are almost universally studied as isolated motor units, as in **Figure 1.46**. Such study ignores the longitudinal effects through this outer bag that are the focus of this book, as well as latitudinal (regional) effects now being exposed by research.[87] It is now clear that fascia distributes strain laterally to neighboring myofascial structures; so that the pull on the tendon at one end is not necessarily entirely taken by the insertion at the other end of the muscle **(see Fig. 1.7)**. The focus on isolating muscles has blinded us to this phenomenon, which in retrospect we can see would be an inefficient way to design a system subject to varying stresses. Likewise, we have focused on individual muscles to the detriment of seeing the synergetic effects along these fascial meridians and slings.

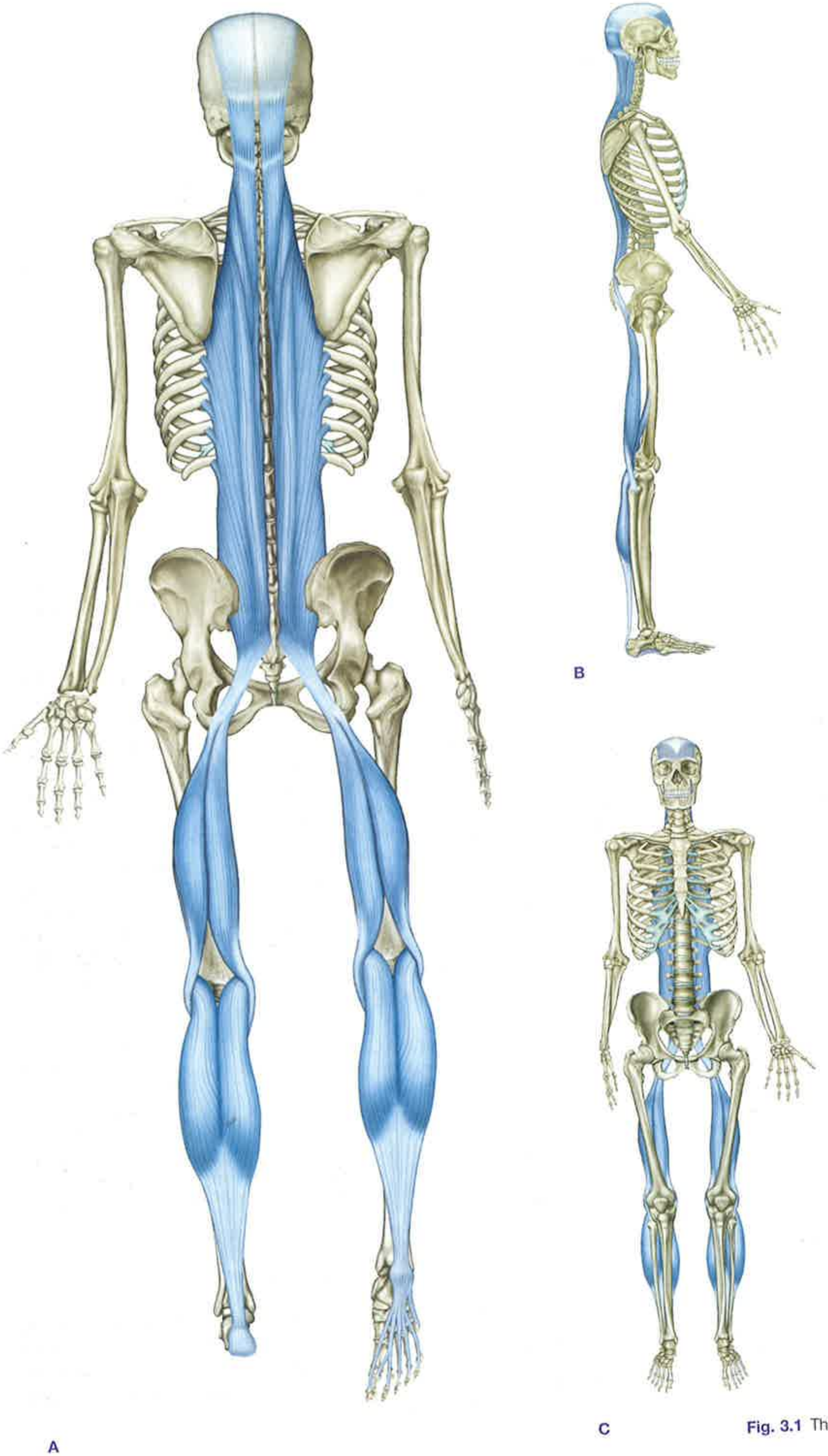


Fig. 3.1 The Superficial Back Line.

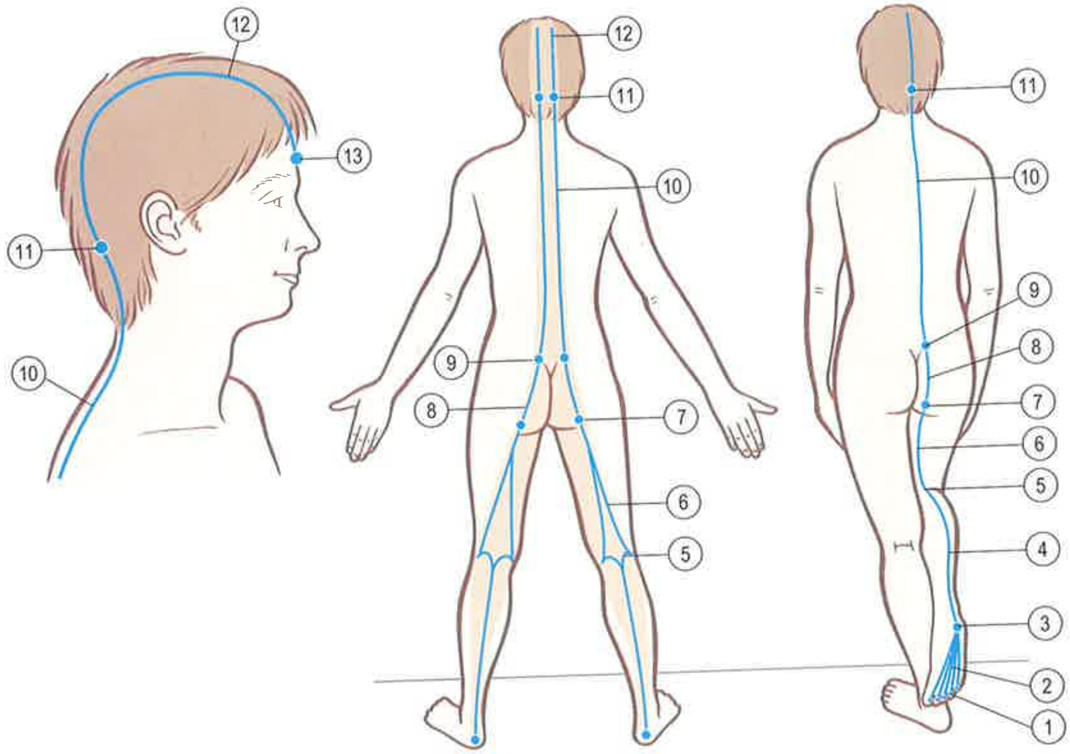


Fig. 3.2 Superficial Back Line tracks and stations. The shaded area shows where it affects and is affected by the more superficial fasciae (dermis, adipose, and the deeper fascia profundis).

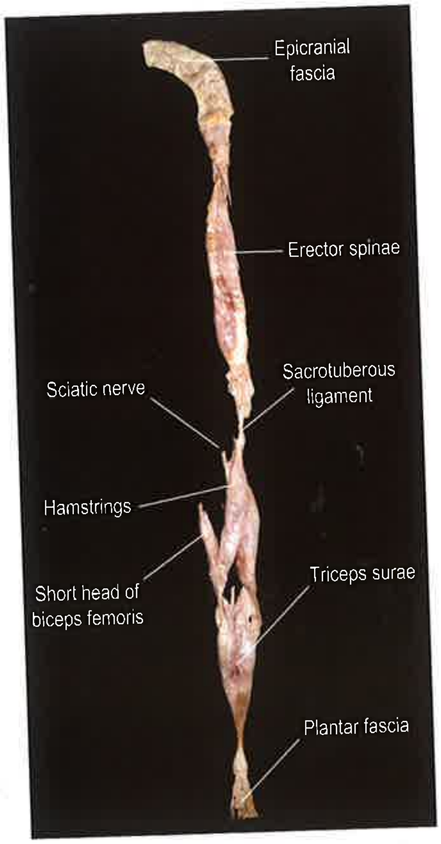


Fig. 3.3 The Superficial Back Line dissected away from the body and laid out as a whole. The different sections are labeled, but the dissection indicates the limitation of thinking solely in anatomical 'parts' in favor of seeing these meridians as functional 'wholes'.

Fig. 3.4 The same specimen laid out on a classroom skeleton to show how the whole is arrayed. The cadaver was a good deal taller than the skeleton.

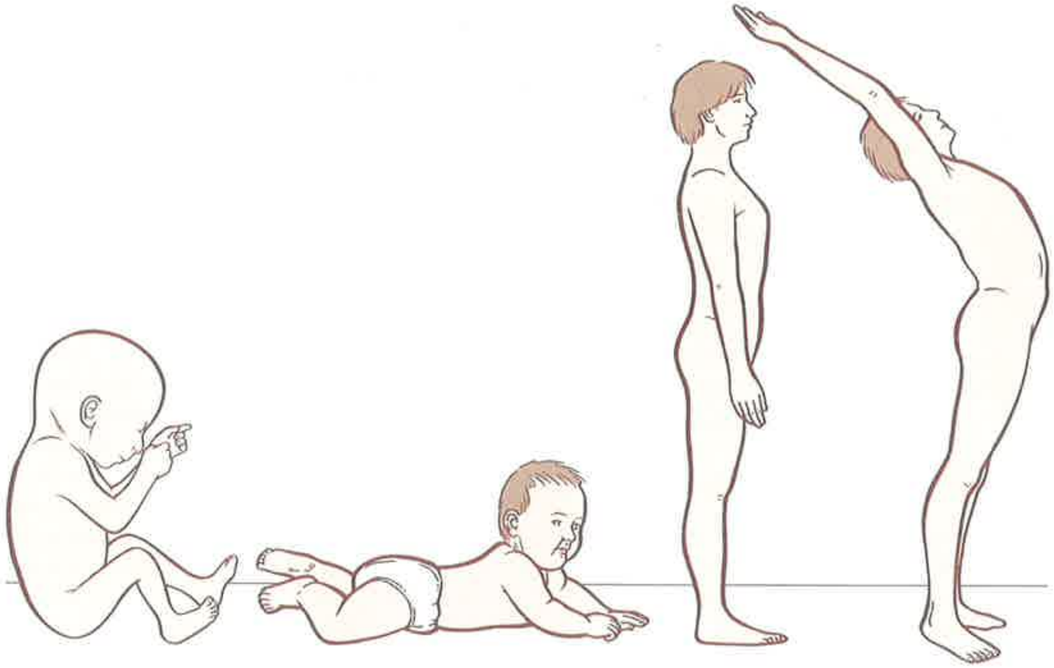


Fig. 3.5 In development, the SBL shortens to move us from a fetal curve of primary flexion toward the counterbalancing curves of upright posture. Further shortening of the muscles of the SBL produces hyperextension.

Table 3.1 Superficial Back Line: myofascial 'tracks' and bony 'stations' **(Fig. 3.2)**

Bony stations		Myofascial tracks
Frontal bone, supraorbital ridge	13	
	12	Galea aponeurotica/epicranial fascia
Occipital ridge	11	
	10	Sacrolumbar fascia/erector spinae
Sacrum	9	
	8	Sacrotuberous ligament
Ischial tuberosity	7	
	6	Hamstrings
Condyles of femur	5	
	4	Gastrocnemius/Achilles tendon
Calcaneus	3	
	2	Plantar fascia and short toe flexors
Plantar surface of toe phalanges	1	

The SBL is a cardinal line that primarily mediates posture and movement in the sagittal plane, either limiting forward movement (flexion) or, when it malfunctions, exaggerating or maintaining excessive backward movement (extension).

Although we speak of the SBL in the singular, there are, of course, two SBLs, one on the right and one on the left, and imbalances between the two SBLs should be observed and corrected along with addressing bilateral patterns of restriction in this line.

Common postural compensation patterns associated with the SBL include: ankle dorsiflexion limitation, knee hyperextension, hamstring shortness (substitution for deep lateral rotators), anterior pelvic shift, sacral nutation, extensor widening in thoracic flexion, suboccipital limitation leading to upper cervical hyperextension, anterior shift or rotation of the occiput on the atlas, and eye–spine movement disconnection.

From toes to heel

Our originating 'station' on this long line of myofascia is the underside of the distal phalanges of the toes. The first 'track' runs along the under surface of the foot. It includes the plantar fascia and the tendons and muscles of the short toe flexors originating in the foot.

These five bands blend into one aponeurosis that runs into the front of the heel bone (the antero-inferior aspect of the calcaneus). The plantar fascia picks up an additional and important 6th strand from the 5th metatarsal base, the lateral band, which blends into the SBL on the outside edge of the heel bone **(Figs 3.6 and 3.7)**.

These fasciae, and their associated muscles that pull across the bottom of the foot, form an adjustable 'bowstring' to the longitudinal foot arches; this bowstring helps to approximate the two ends, thus maintaining the heel and the 1st and 5th metatarsal heads in a proper relationship **(Fig. 3.8)**. The plantar aponeurosis constitutes only one of these bowstrings – the long plantar ligament and spring ligament also provide shorter and stronger bowstrings deeper (more cephalad) into the tarsum of the foot (visible below the subtalar joint in **Fig. 3.8**).

The plantar fascia

The plantar surface of the foot is often a source of trouble that communicates up through the rest of the line. Limitation here often correlates with tight hamstrings,

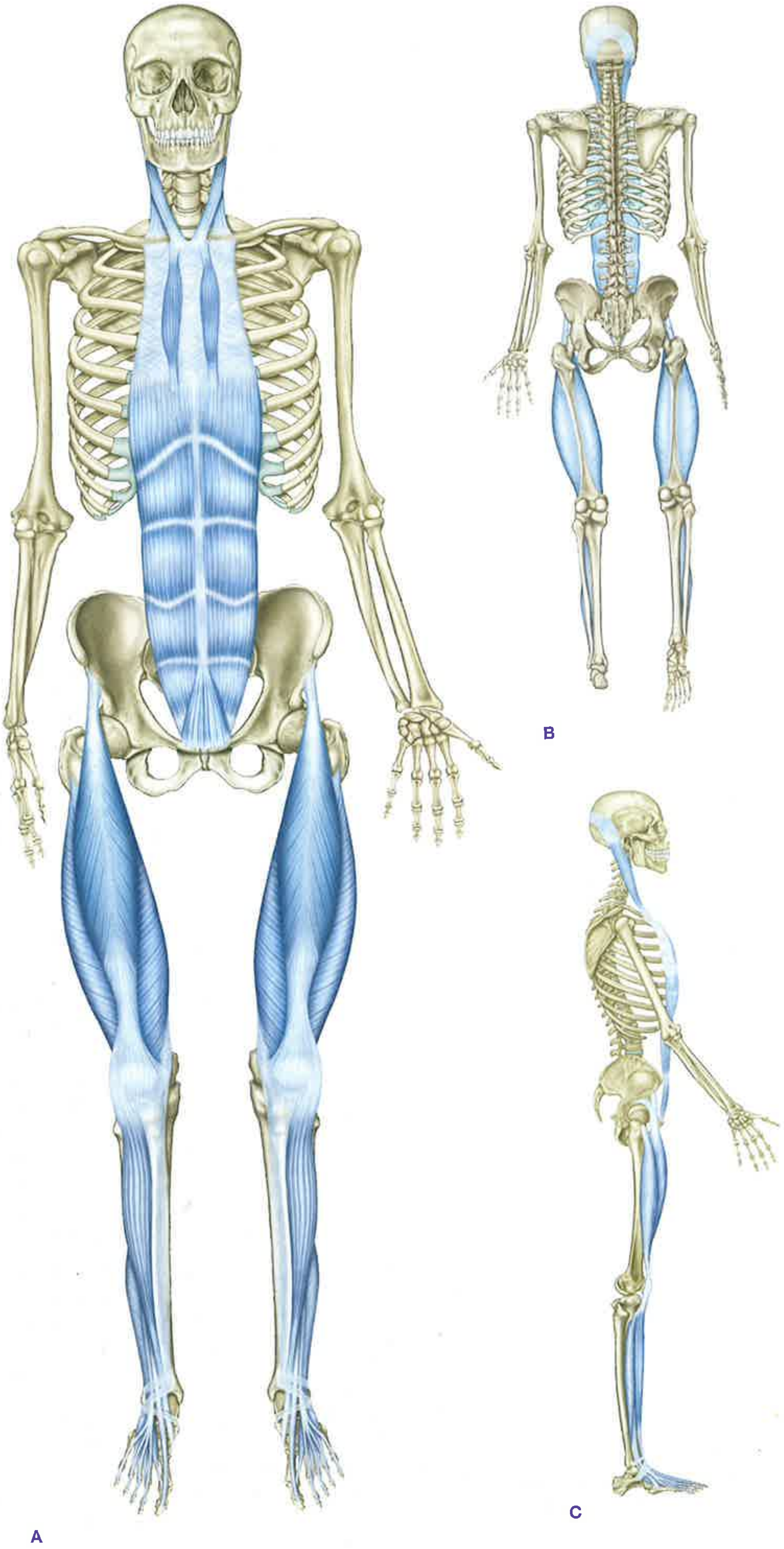


Fig. 4.1 The Superficial Front Line.

Fig. 5.1 The Lateral Line.

Discussion 2

The Lateral Line and fish: vibration, swimming, and the development of walking

Sensing vibration

The top of the LL embraces the ear, located in the temporal bone on the side of the head; indeed, the ideal of Lateral Line posture is always described as passing through the ear. The entire ear, of course, contains structures sensitive to vibratory frequencies from about 20 to 20000 Hz, to gravitational pull, and to acceleration of motion. The ear is a sophisticated rendering of vibratory sensors that are set along the entire lateral line of many ancient and some modern fish, such as sharks, who 'hear' the thrashing of their prey from these lines (**Fig. 5.18**). Later vertebrates seem to have concentrated most of their vibratory sensitivity at the leading end of the organism. Some connection seems to remain, however, in the way that left/right differences can reflect balance problems more than front/back differences.

Swimming

Almost all fish swim with a side-to-side motion. This obviously involves the contraction of the two lateral muscle bands in succession. Perhaps the original creator for this movement (and thus the deepest expression of the lateral line) is found in the tiny intertransversarii muscles that run from transverse process to transverse process in the spine. When one side contracts, it stretches the corresponding muscle on the other side (**Fig. 5.19**). The spinal stretch reflex, an ancient spinal cord movement mediator, causes the stretched muscle to contract, thus stretching the first muscle on the opposite side, which contracts in its turn, and so on. In this way, a coordinated swimming movement (in other words, coordinated waves running down the lateral musculature) can occur with minimal involvement by the brain. A lamprey eel, a modern equivalent to ancient fish, can be decerebrated, and when it is placed in flowing water, it will still swim upstream in a blind, slow, but coordinated fashion, working only through spinal mechanisms – the stimulation from the vibratory sensors on the lateral skin linking to the stretch reflex.

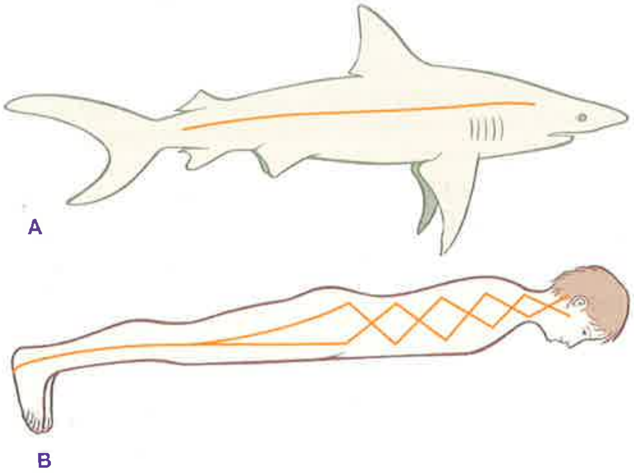


Fig. 5.18 Some fish such as sharks have a line of vibratory sensors running down their lateral line. Humans seem to have concentrated most of that vibratory sensitivity in the ear at the top of the line.

Of course, corresponding movements remain in humans. There are many movements such as walking that work through reciprocal stretch reflexes. The side-to-side motion itself is not so visible in regular adult walking, but its underlying primacy is indicated in the infant at about three to six months, when the side-to-side movement of creeping begins. This movement will later be replaced by more sophisticated crawling movement, which combines flexion/extension and rotation along with the lateral flexion.

Walking

When we assess adult walking, excessive side-to-side motion is seen as an aberration. We expect to see the head and even the thorax moving along fairly straight ahead, with most of the side-to-side accommodation handled at the waist and below. From the point of view of myofascial meridians, the entire LL is involved in such adjustments, and should be considered in correcting deviations of too much or too little lateral flexion in the underlying pattern of walking.

For our primary forward motivating force we humans use flexion/extension, sagittal motion (as the dolphins and whales do as well), not side-to-side motion as the fish do. Our walking involves a little side-to-side accommodation, as we have noted, but the contralateral motion of human walking involves a lot of rotation, especially through the waist and lower rib cage, which mediate between opposed oscillations of the pelvic girdle and the shoulder girdle.

The series of 'X's or the 'basket weave' that characterizes the LL in the trunk and neck are perfectly situated to modulate and 'brake' these rotatory movements. Therefore, the woven structure of the LL in the trunk can be seen as partial arcs of spirals that are used like springs and shock absorbers to

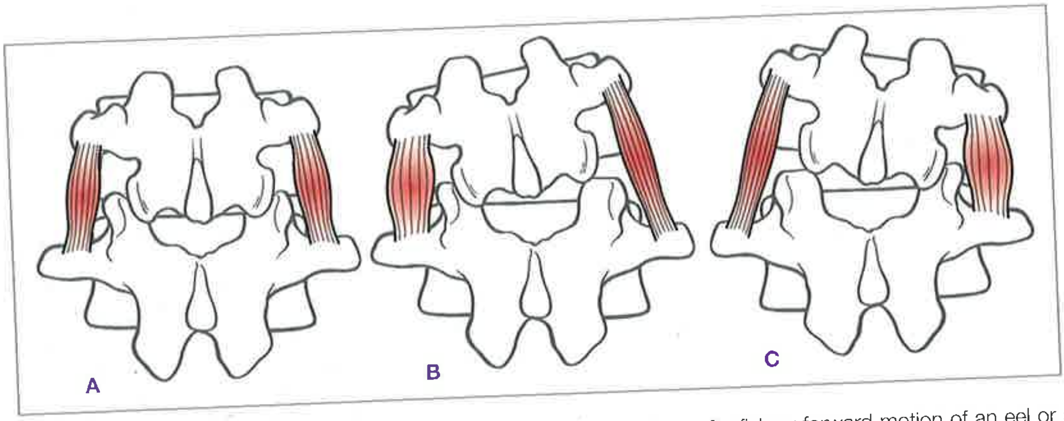


Fig. 5.19 Lateral movement, the kind involved in the swimming motions of a fish or forward motion of an eel or snake, consists of reciprocal reflexes flowing down the musculature in waves. When one side is contracted, the other side is stretched, inducing a contraction in it, which stretches the first side, so it contracts, and so on and on upstream.

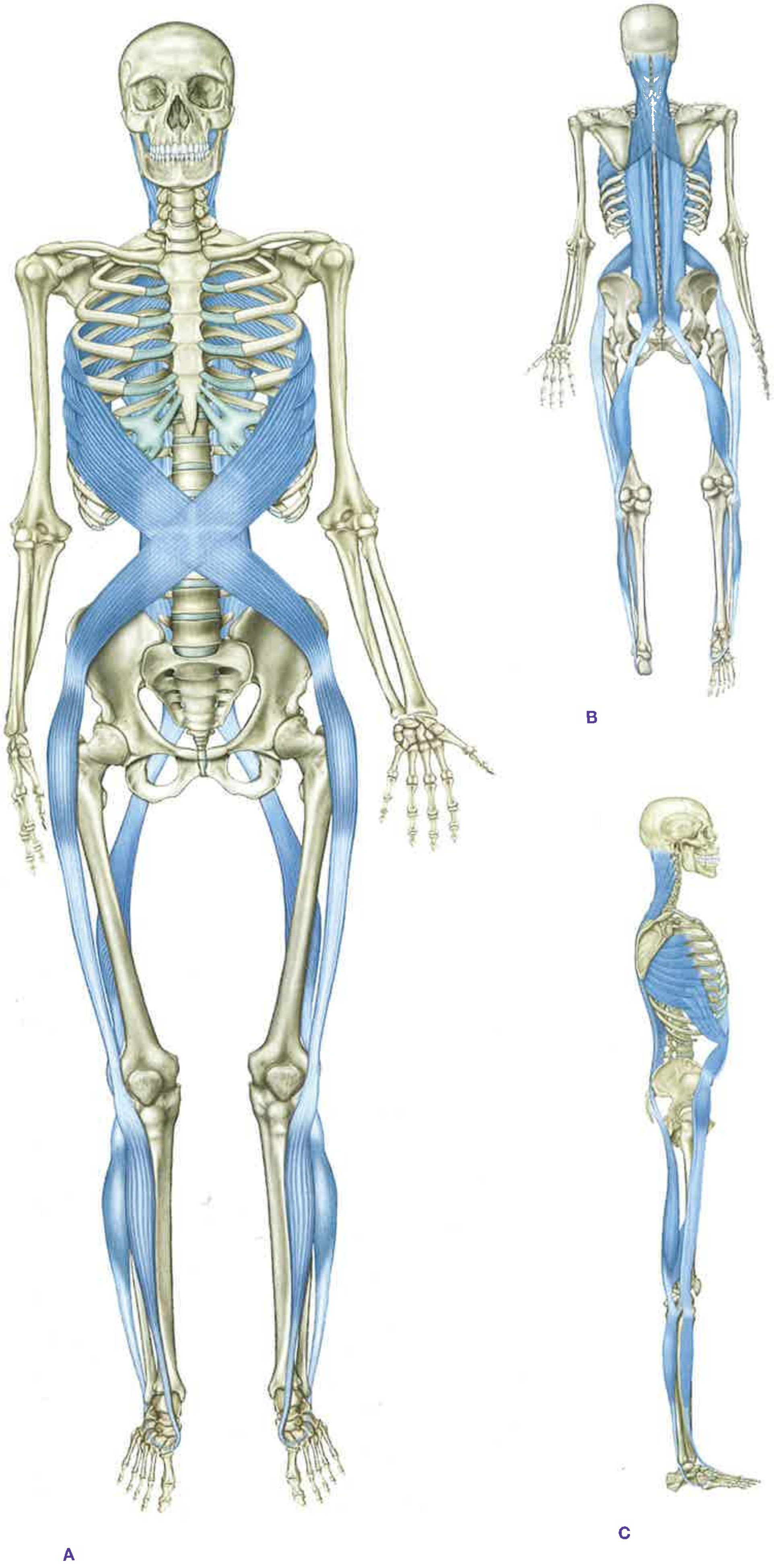


Fig. 6.1 The Spiral Line.

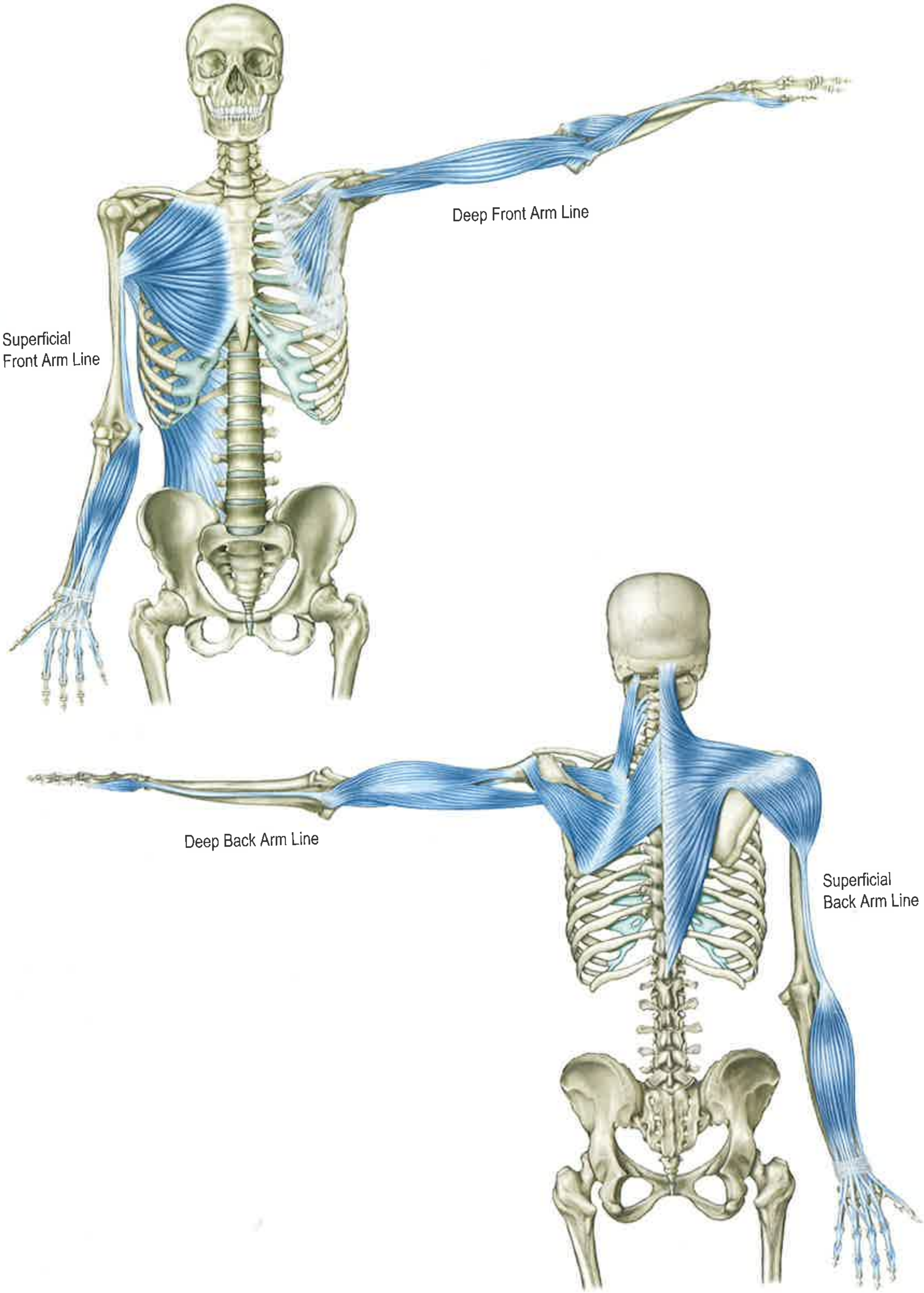


Fig. 7.1 The Arm Lines.

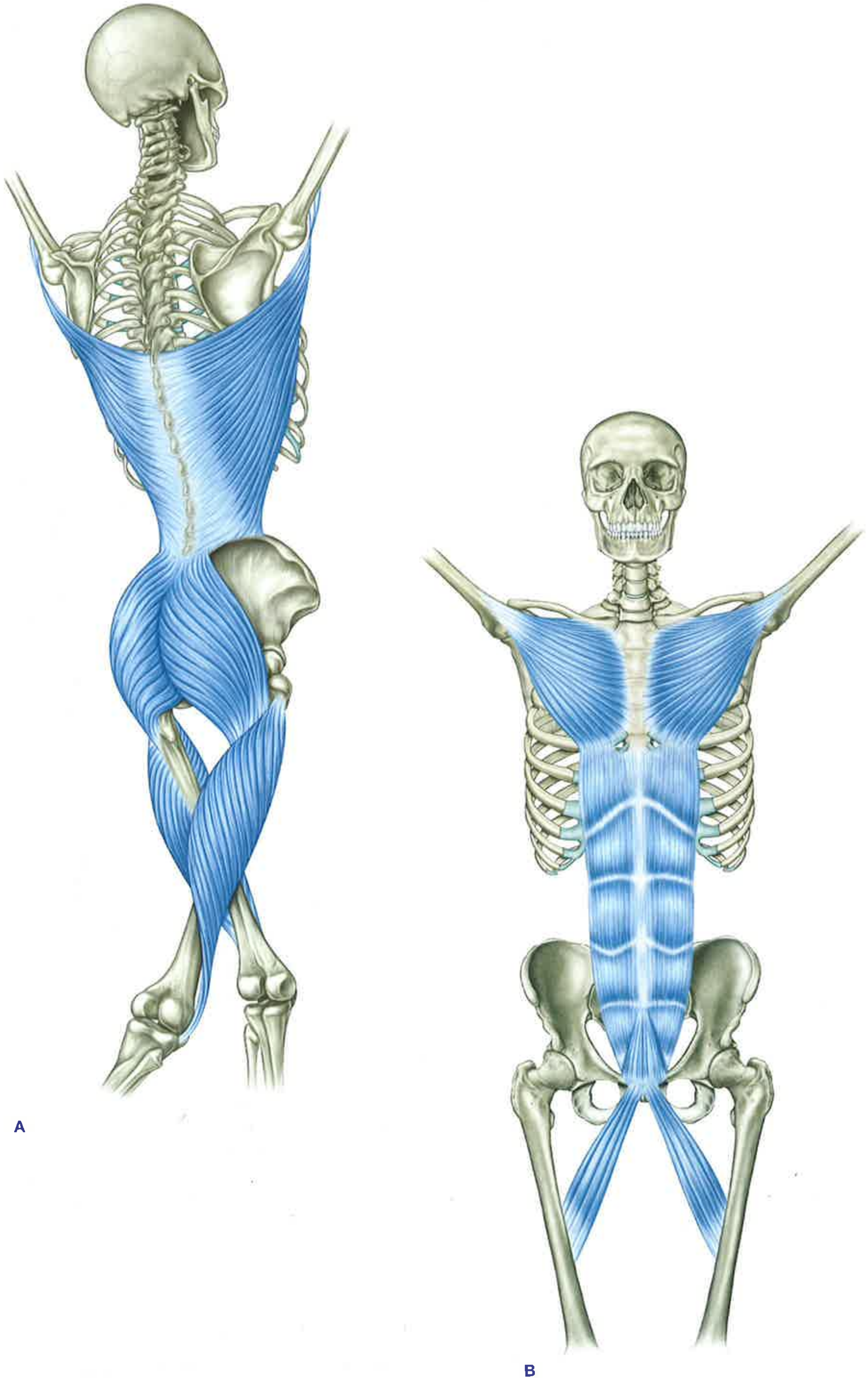


Fig. 8.1 The Back and Front Functional Lines.

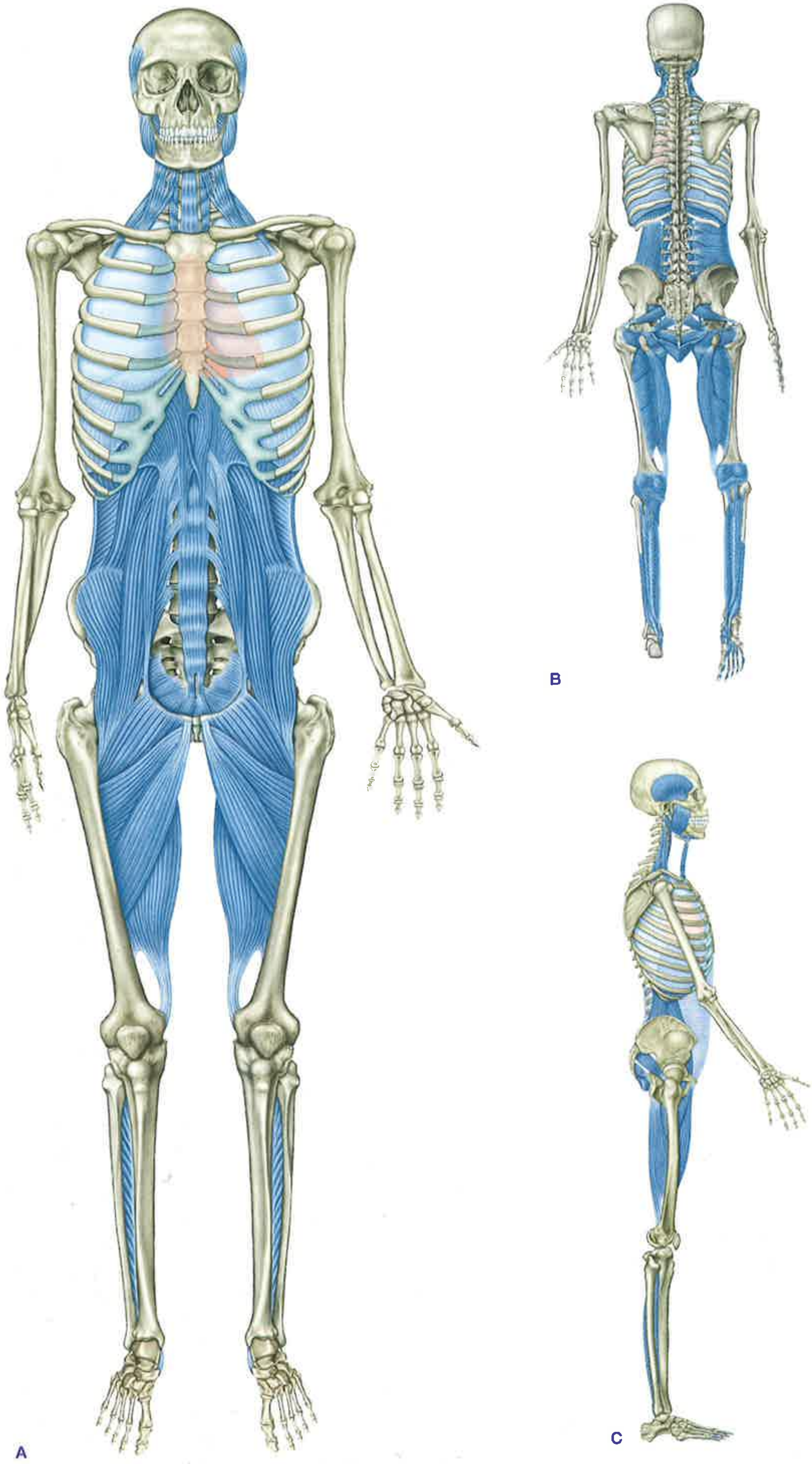


Fig. 9.1 The Deep Front Line.

Fig. 10.17 Full-flexion phase.

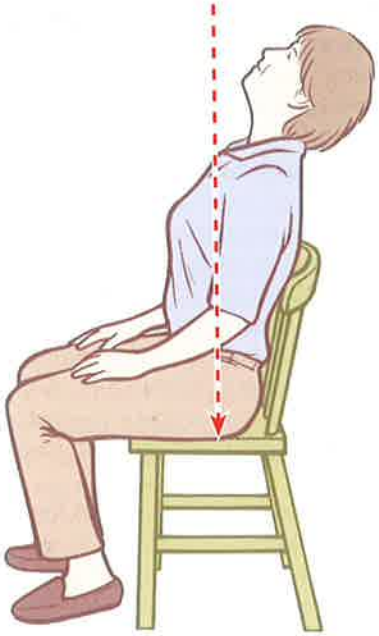


Fig. 10.19 Improper hyperextension phase with head hyperextended beyond the rest of the spine.

Fig. 10.18 Improper full flexion pose with chest falling behind pelvis.

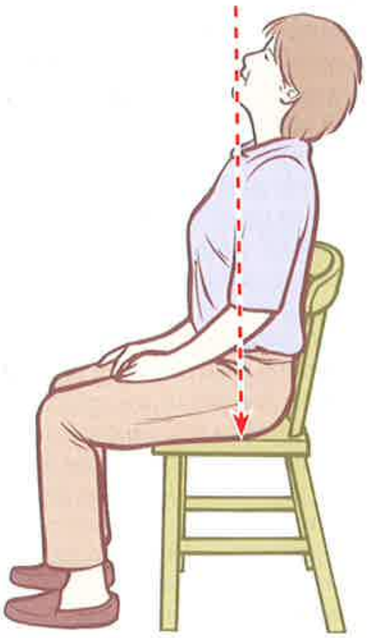


Fig. 10.20 Proper hyperextension phase.

integrity of the spine, which should act at all times like a unified spring, not like a Christmas 'slinky' in February.

Since sitting in this way projects a natural authority as well as ease, you may find that people in a group are naturally turning to you to see if you will speak. If this is uncomfortable, or not what you want to do, it is possible to let your back find the chair back while still maintaining the support from the pelvis, rather than letting the chest fall off the pelvis, sitting on the tailbone, and assuming a subservient sitting posture.

If you guide clients into these movements, be sure they are initiating from the pelvis. A hand on their lower back will usually tell you where the movement is coming from. Sometimes another hand on the head is necessary to keep the head engaged with the rest of the spine. Be sure to let the client perform the full motion entirely solo several times before the session ends, and reinforce the