that structure governed function and that function influenced structure.

5. The use of manipulative therapy. This became an integral part of Still's philosophy because he believed that restoration of the body's maximal functional capacity would enhance the level of wellness and assist in recovery from injury and disease.

It is unclear when and how Dr. Still added manipulation to his philosophy of osteopathy. It was not until 1879, some 5 years after his announcement of the development of osteopathy, that he became known as the "lightning bonesetter." There is no recorded history that he met or knew the members of the Sweet family as they migrated west. Still never wrote a book on manipulative technique. His writings were extensive, but they focused on the philosophy, principles, and practice of osteopathy.

Still's attempt to interest his medical colleagues in these concepts was rebuffed, particularly when he took them to Baker University in Kansas. As he became more clinically successful, and nationally and internationally well known, many individuals came to study with him and learn the new science of osteopathy. This led to the establishment in 1892 of the first college of osteopathic medicine at Kirksville, Missouri. In 2014, there are 35 osteopathic training sites (including five branch campuses) in the United States graduating more than 4,500 students per year.[10] Osteopathy in other parts of the world, particularly in the United Kingdom and in the commonwealth countries of Australia and New Zealand, is a school of practice limited to structural diagnosis and manipulative therapy, although strongly espousing some of the fundamental concepts and principles of Still. Osteopathic medicine in the United States has been from its inception, and continues to be, a total school of medicine and surgery while retaining the basis of osteopathic principles and concepts and continuing the use of structural diagnosis and manipulative therapy in total patient care.

Chiropractic

Palmer (1845 to 1913) was, like Still, a product of the midwestern portion of the United States in the mid-19century. Although not schooled in medicine, he was known to practice as a magnetic healer and became a self-educated manipulative therapist. Controversy continues as to whether Palmer was ever a patient or student of Still's at Kirksville, Missouri, but it is known that Palmer and Still met in Clinton, Iowa, early in the 20th century. Palmer moved about the country a great deal and founded his first college in 1896. The early colleges were at Davenport, Iowa, and at Oklahoma City, Oklahoma.

Although Palmer is given credit for the origin of chiropractic, it was his son Bartlett Joshua Palmer (1881 to 1961) who gave the chiropractic profession its momentum. Palmer's original concepts were that the cause of disease was a variation in the expression of normal neural function. He believed in the "innate intelligence" of the brain and central nervous system and believed that alterations in the spinal column (subluxations) altered neural function, causing disease. Removal of the subluxation by chiropractic adjustment was viewed to be the treatment. Chiropractic has never professed to be a total school of medicine and does not teach surgery or the use of medication beyond vitamins and simple analgesics. There remains a split within the chiropractic profession between the "straights," who continue to espouse and adhere to the original concepts of Palmer, and the "mixers," who believe in a broadened scope of chiropractic that includes other therapeutic interventions such as exercise, physiotherapy, electrotherapy, diet, and vitamins.

In the mid-1970s, the Council on Chiropractic Education (CCE) petitioned the U.S. Department of Education for recognition as the accrediting agency for chiropractic education. The CCE was strongly influenced by the colleges with a "mixer" orientation, which led to increased educational requirements both before and during chiropractic education. Chiropractic is practiced throughout the world, but the vast majority of chiropractic training continues to be in the United States. The late 1970s found increased recognition of chiropractic in both Australia and New Zealand, and their registries are participants in the health programs in these countries.[11]

MediCal Manipulators

The 20th century has found renewed interest in manual medicine in the traditional medical profession. In the first part of the 20th century, James Mennell and Edgar Cyriax brought joint manipulation recognition within the London medical community. John Mennell continued the work of his father and contributed extensively to the manual medicine literature and its teaching worldwide. As one of the founding members of the North American Academy of Manipulative Medicine (NAAMM), he was instrumental in opening the membership in NAAMM to osteopathic physicians in 1977. He strongly advocated the expanded role of appropriately trained physical therapists to work with the medical profession in providing joint manipulation in patient care.

James Cyriax is well known for his textbooks in the field and also fostered the expanded education and scope of physical therapists. He incorporated manual medicine procedures in the practice of "orthopedic medicine" and founded the Society for Orthopedic Medicine. In his later years, Cyriax came to believe that manipulation restored function to derangements of the intervertebral discs and spoke less and less about specific arthrodial joint effects. John Bourdillon, a British-trained orthopedic surgeon, was first attracted to manual medicine as a student at Oxford University. During his training, he learned to perform manipulation while the patient was under general anesthesia and subsequently used the same techniques without anesthesia. He observed the successful results of non–medically qualified manipulators and began a study of their techniques. A lifelong student and teacher in the field, he published five editions of a text, *Spinal Manipulation*. Subsequent to his death in 1992, a sixth edition of *Spinal Manipulation* was published with Edward Isaacs, MD, and Mark Bookhout, MS, PT, as coauthors.

The NAAMM merged with the American Association of Orthopaedic Medicine in 1992 and continues to represent the United States in the International Federation of Manual Medicine (FIMM).

Practice of Manual Medicine

Manual medicine should not be viewed in isolation nor separate from "regular medicine" and clearly is not the panacea for all ills of humans. Manual medicine considers the functional capacity of the human organism, and its practitioners are as interested in the dynamic processes of disease as those who look at the disease process from the static perspective of laboratory data, tissue pathology, and the results of autopsy. Manual medicine focuses on the musculoskeletal system, which constitutes more than 60% of the human organism, and through which evaluation of the other organ systems must be made. Structural diagnosis not only evaluates the musculoskeletal system for its particular diseases and dysfunctions but can also be used to evaluate the somatic manifestations of disease and derangement of the internal viscera. Manipulative procedures are used primarily to increase mobility in restricted areas of musculoskeletal function and to reduce pain. Some practitioners focus on the concept of pain relief, whereas others are more interested in the influence of increased mobility in optimizing joint stability and function of the musculoskeletal system. When appropriately used, manipulative procedures can be clinically effective in reducing pain within the musculoskeletal system, in increasing the level of wellness of the patient, and in helping patients with a myriad of disease processes.

Goal of Manipulation

In 1983, in Fischingen, Sweden, a 6-day workshop was held that included approximately 35 experts in manual medicine from throughout the world. They represented many different countries and schools of manual medicine with considerable diversity in clinical experience. The proceedings of this workshop represented the state of the art of manual medicine of the day.[12] That workshop reached a consensus on the goal of manipulation: The goal of manipulation is to restore maximal, pain-free movement of the musculoskeletal system in postural balance.

This definition is comprehensive but specific and is well worth consideration by all students in the field.

Role of the Musculoskeletal System in Health and Disease

It is indeed unfortunate that much of the medical thinking and teaching look at the musculoskeletal system only as the coat rack on which the other organ systems are held and not as an organ system that is susceptible to its own unique injuries and disease processes. The field of manual medicine looks at the musculoskeletal system in a much broader context, particularly as an integral and interrelated part of the total human organism. Although most physicians would accept the concept of integration of the total body including the musculoskeletal system, specific and usable concepts of how that integration occurs and its relationship in structural diagnosis and manipulative therapy seem to be limited.

There are five basic concepts that this author has found useful. Since the hand is an integral part of the practice of manual medicine and includes five digits, it is easy to recall one concept for each digit in the palpating hand. These concepts are as follows:

1. Holism
2. Neurologic control
3. Circulatory function
4. Energy expenditure
5. Self-regulation

Concept of Holism

The concept of holism has different meanings and usage by different practitioners. In manual medicine, the concept emphasizes that the musculoskeletal system deserves thoughtful and complete evaluation, wherever and whenever the patient is seen, regardless of the nature of the presenting complaint. It is just as inappropriate to avoid evaluating the cardiovascular system in a patient presenting with a primary musculoskeletal complaint as it is to avoid evaluation of the musculoskeletal system in a patient presenting with acute chest pain thought to be cardiac in origin. The concept is one of a sick patient who needs to be evaluated. The musculoskeletal system constitutes most of the human body, and alterations within it influence the rest of the human organism; diseases within the internal organs manifest themselves in alterations in the musculoskeletal system, frequently in the form of pain. It is indeed fortunate that holistic concepts have gained increasing popularity in the medical community recently, but the concept expressed here is one that speaks of the integration of the total human organism rather than a summation of parts. We must all remember that our role as health professionals is to treat patients and not to treat disease.

Concept of Neural Control

The concept of neurologic control is based on the fact that humans have the most highly developed and sophisticated nervous system in the animal kingdom. All functions of the body are under some form of control by the nervous system. A patient is constantly responding to stimuli from the internal and external body environments through complex mechanisms within the central and peripheral nervous systems. As freshmen in medical school, we all studied the anatomy and physiology of the nervous system. Let us briefly review a segment of the spinal cord **(Fig. 1.1)**. In this figure are depicted the classic somatosomatic reflex pathways with afferent impulses coming from the skin, muscle, joint, and tendon. Afferent stimuli from the nociceptors, mechanoreceptors, and proprioceptors all feed in through the dorsal root and ultimately synapse, either directly or through a series of interneurons, with an anterior horn cell from which an efferent fiber extends to the skeletal muscle. It is through multiple permutations of this central reflex arc that we respond to external stimuli, including injury, orient our bodies in space, and accomplish many of the physical activities of daily living. This figure also represents the classical viscerovisceral reflex arc wherein the afferents from the visceral sensory system synapse, in the intermediolateral cell column, with the sympathetic lateral chain ganglion or collateral ganglia, which then terminate onto a postganglionic motor fiber to the target

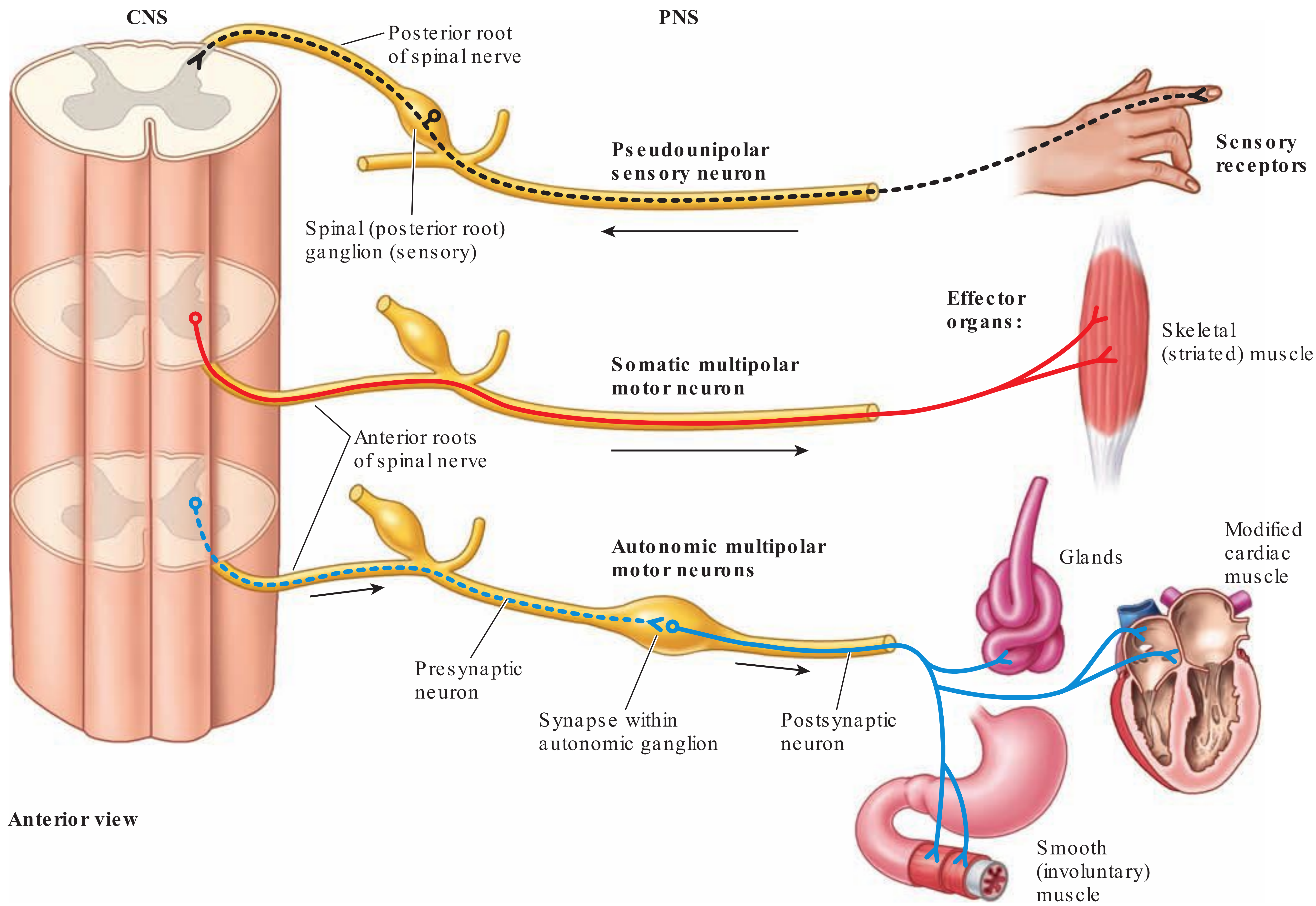

figure 1.1 Cross section of spinal cord segment.

end organ viscera. Note that the skin viscera also receive efferent stimulation from the lateral chain ganglion.

These sympathetic ref ex pathways innervate the pilomotor activity of the skin, the vasomotor tone of the vascular tree, and the secretomotor activity of the sweat glands. Alteration in the sympathetic nervous system activity to the skin viscera results in palpatory changes that are identifiable by the structural diagnostic means.[13] Although this figure separates these two pathways, they are in fact interrelated, so somatic afferents inf uence visceral efferents and visceral afferents can manifest themselves in somatic efferents. This figure represents the spinal cord in horizontal section, and it must be recalled that ascending and descending pathways—from spinal cord segment to spinal cord segment as well as from the higher centers of the brain—are occurring as well.

Another neurologic concept worth recalling is that of the autonomic nervous system (ANS). The ANS is made up of two divisions, the parasympathetic and sympathetic. The parasympathetic division includes cranial nerves III, VII, VIII, IX, and X and the S2, S3, and S4 levels of the spinal cord. The largest and most extensive nerve of the parasympathetic division is the vagus. The vagus innervates all of the viscera from the root of the neck to the midportion of the descending colon and all glands and smooth muscle of these organs. The vagus nerve **(Fig. 1.2)** is the primary driving force of the cardiovascular, pulmonary, neuroimmune, endocrine, and gastrointestinal systems[14,15] and has an extensive distribution. Many pharmaceutical agents alter parasympathetic nervous activity, particularly that of the vagus.

The sympathetic division of the ANS **(Fig. 1.2)** is represented by preganglionic neurons originating in the spinal cord from T1 to L3 and the lateral chain ganglion including the superior, middle, and inferior cervical ganglia; the thoracolumbar ganglia from T1 to L3; and the collateral ganglia. Sympathetic fibers innervate all of the internal viscera as does the parasympathetic division but are organized differently. The sympathetic division is organized segmentally. It is interesting to note that all of the viscera above the diaphragm receive their sympathetic innervation from preganglionic fibers above T4 and T5, and all of the viscera below the diaphragm receive their sympathetic innervation preganglionic fibers from below T5. It is through this segmental organization that the relationships of certain parts of the musculoskeletal system and certain internal viscera are correlated. Remember that the musculoskeletal system receives only sympathetic division innervation and receives no parasympathetic innervation. Control of all glandular and vascular activity in the musculoskeletal system is mediated through the sympathetic division of the ANS.

Remember that all these ref ex mechanisms are constantly under the local and central modifying control of excitation

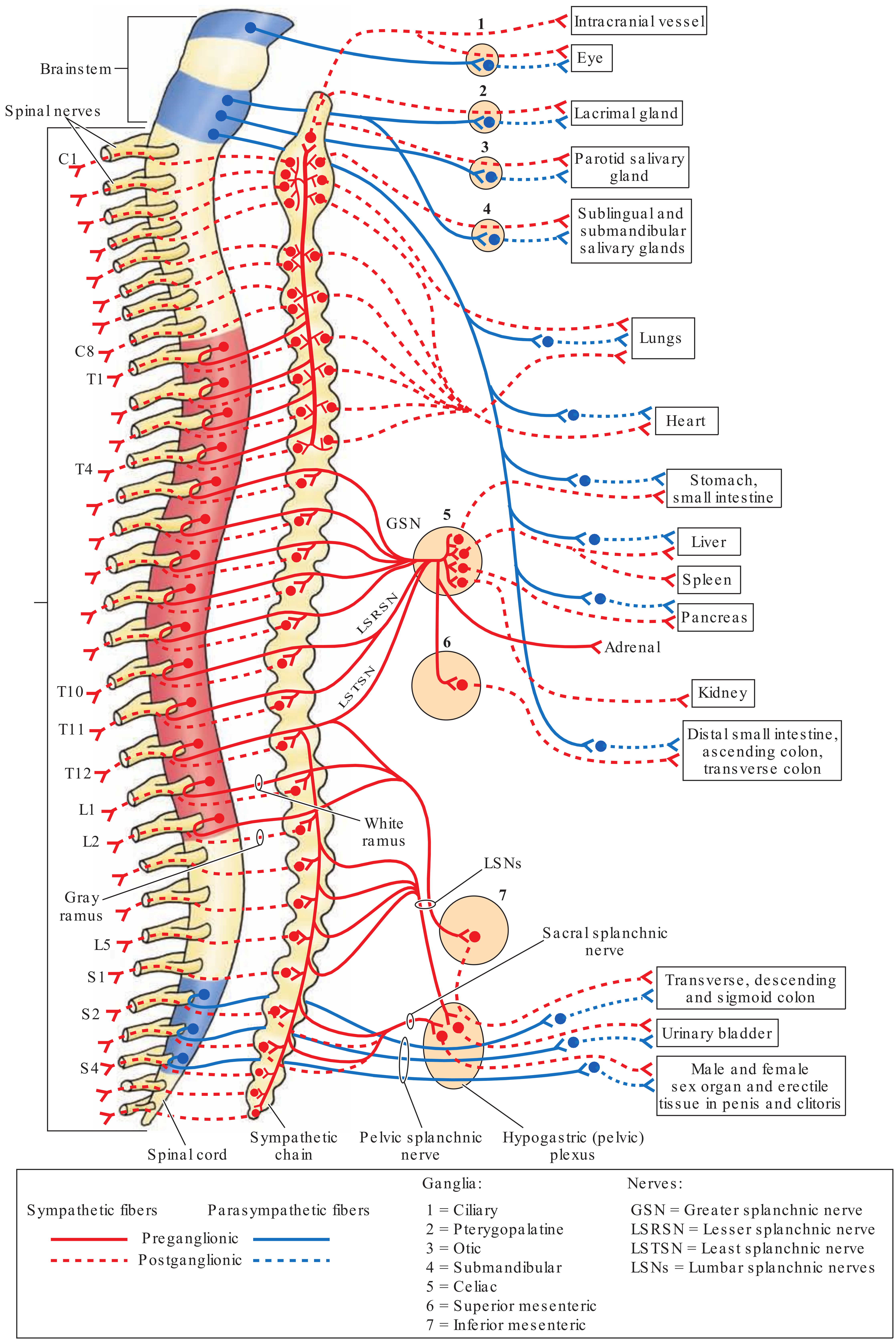

figure 1.2 Autonomic nerve distribution.

■ STEP 10. MOBILITY OF THE HEAD AND NECK

1. Patient sits on the table with the operator standing behind.
2. Operator grasps head between the two hands (**Fig. 2.51**).
3. Operator introduces backward bending (**Fig. 2.52**). Normal extension is 90 degrees.
4. Operator introduces forward bending (**Fig. 2.53**). Normal range is 45 degrees of f exion.
5. Operator introduces right-side bending (**Fig. 2.54**) and left-side bending (**Fig. 2.55**). Normal range is 45 degrees to each side.
6. Operator introduces rotation to the left (**Fig. 2.56**) and to the right (**Fig. 2.57**). Normal range is 80 to 90 degrees on each side.
7. Operator evaluates range, quality of movement during the range, and end feel, looking for symmetry or asymmetry. If asymmetric, additional diagnostic evaluations of the cervical spine, upper thoracic spine, and rib cage are necessary.

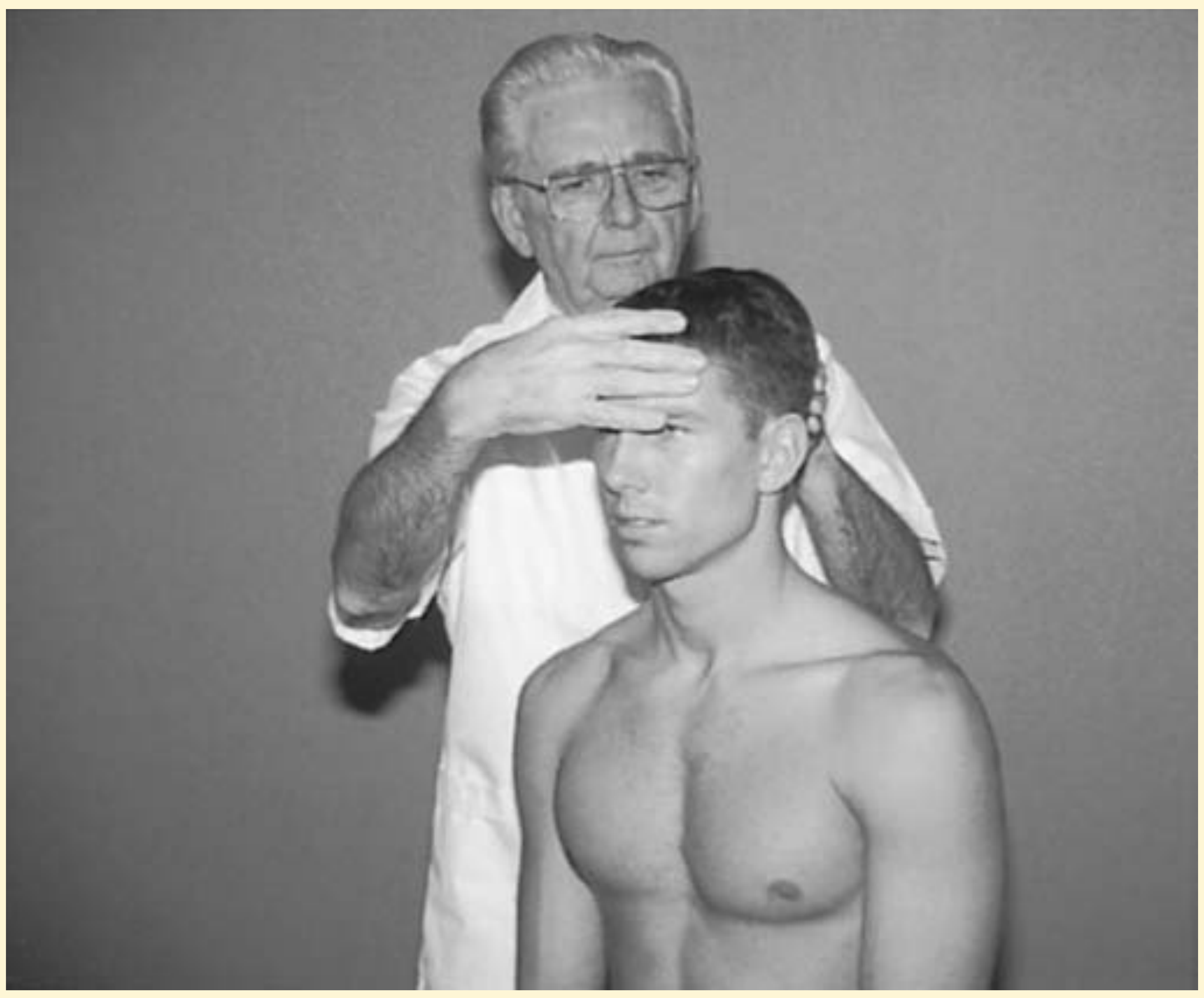

Figure 2.51 Preparation for passive neck motion; hands contact the front and back of the head.

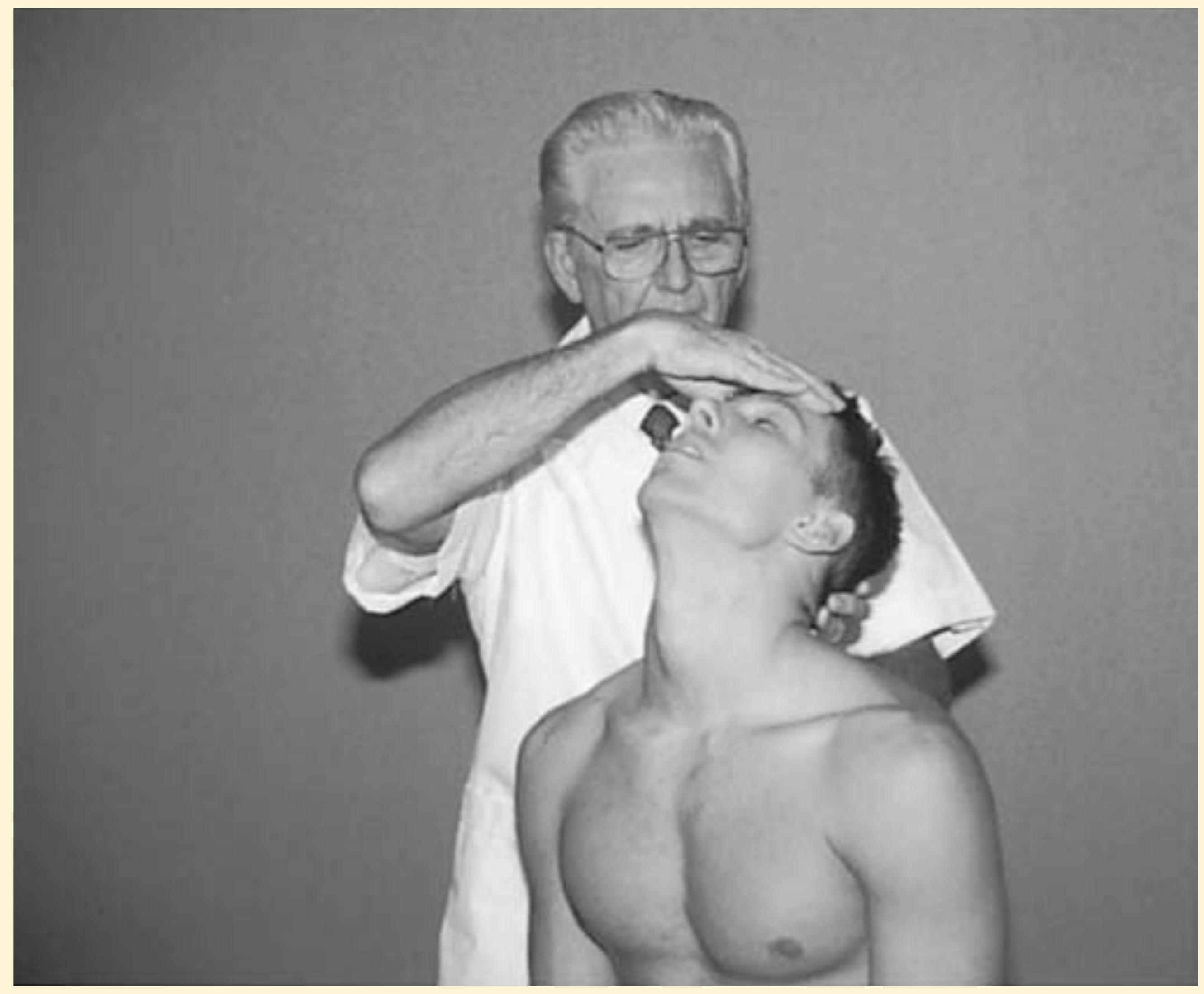

Figure 2.52 Backward bending.

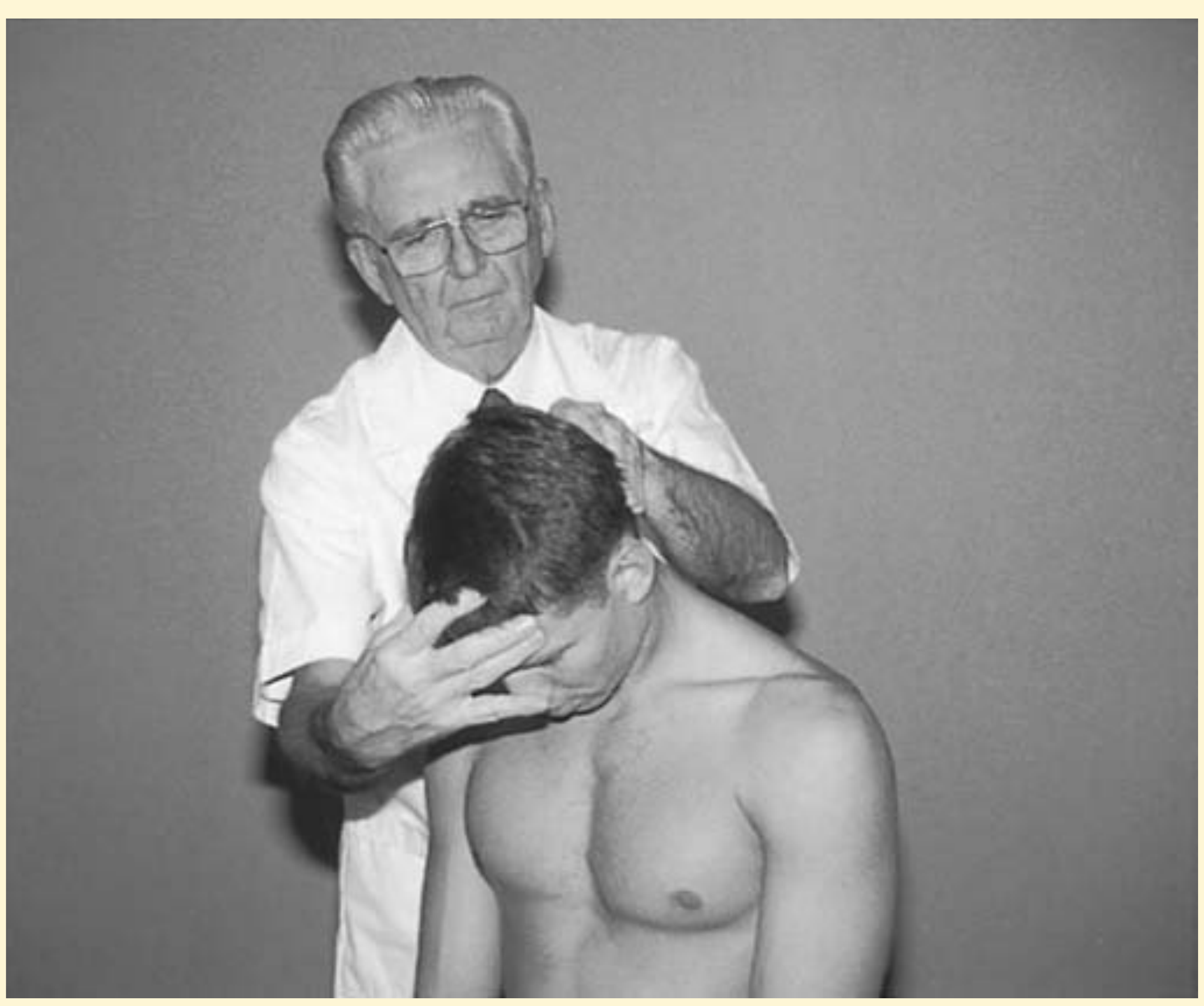

Figure 2.53 Forward bending.

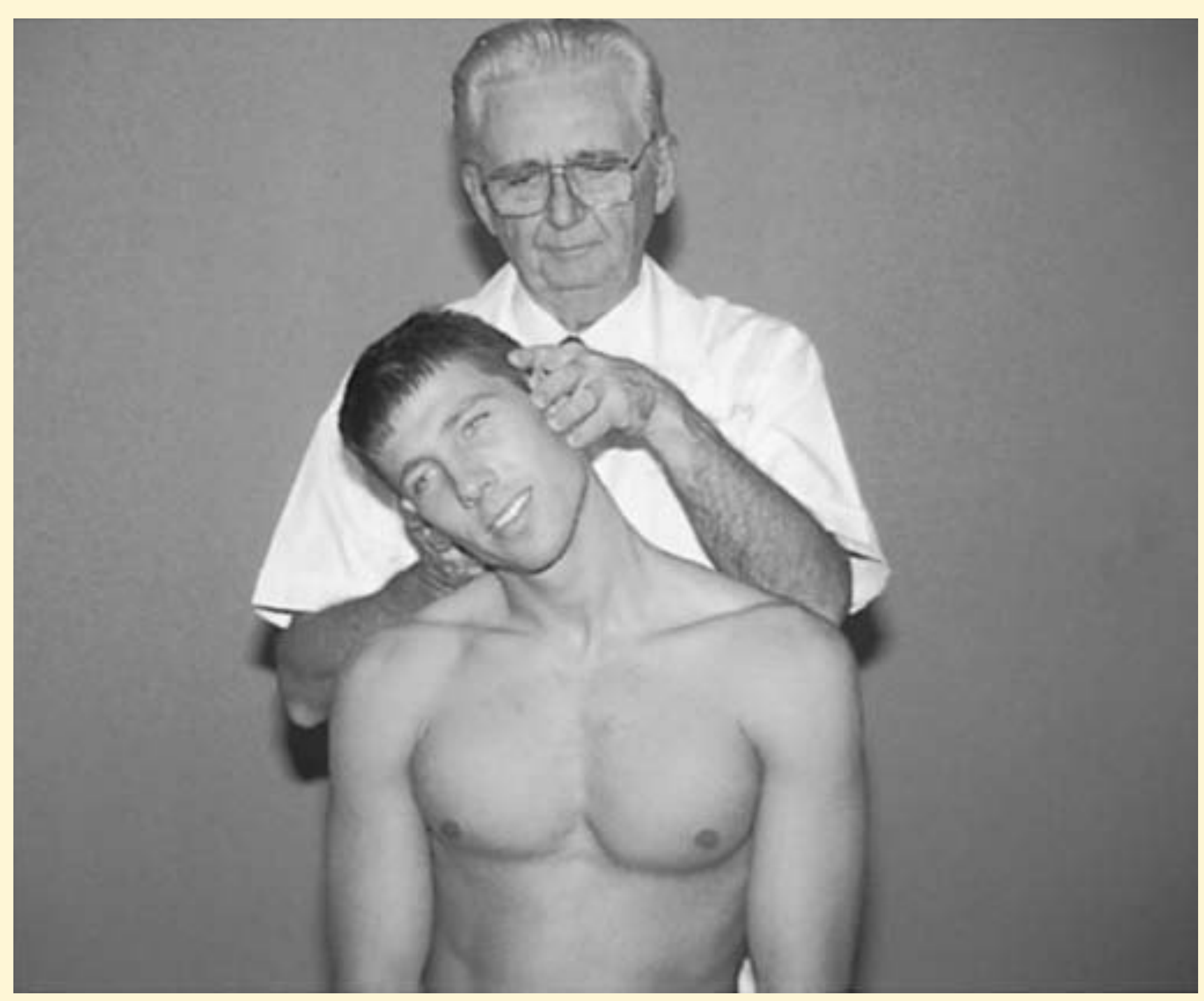

Figure 2.54 Right-side bending.

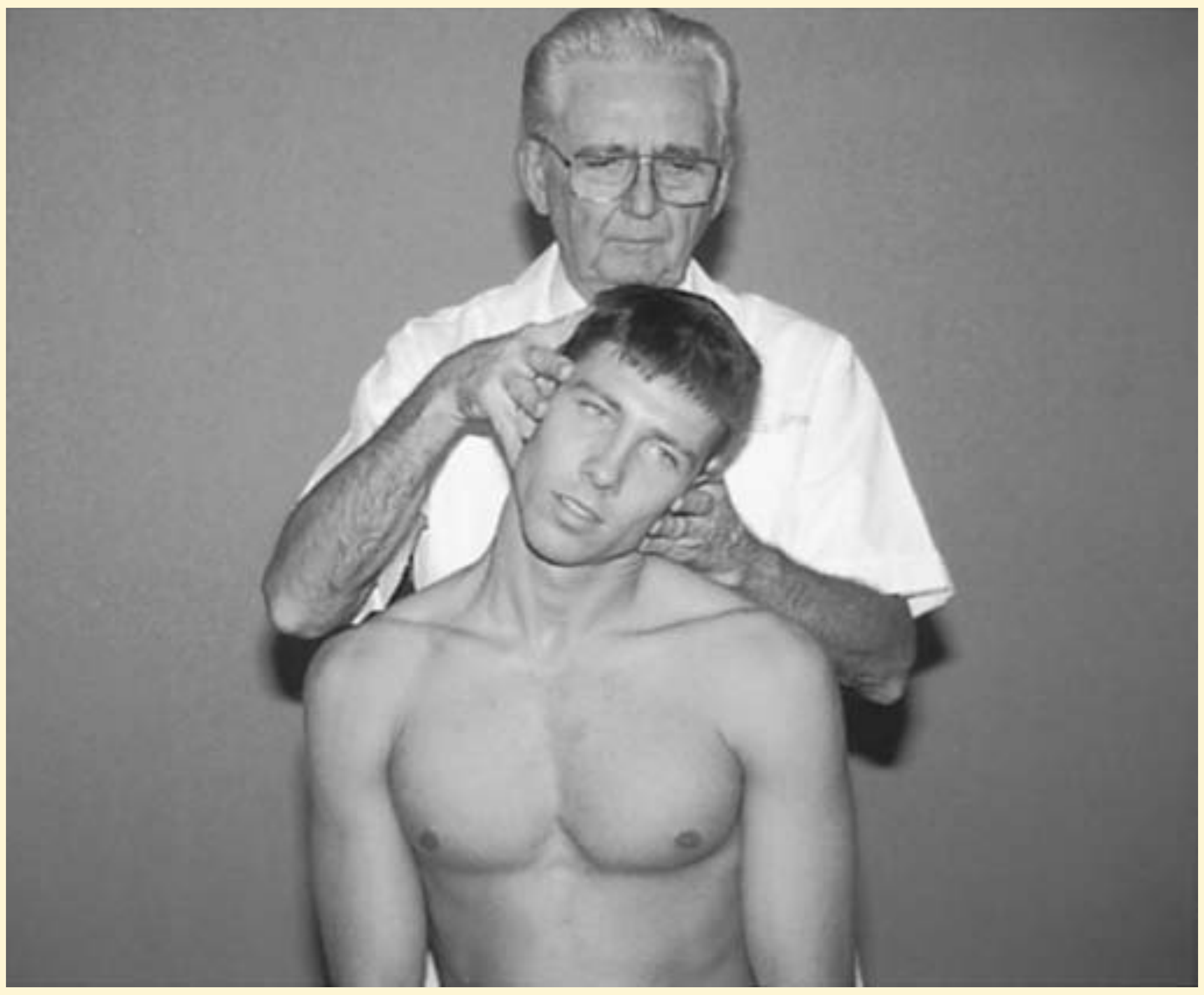

Figure 2.55 Left-side bending.

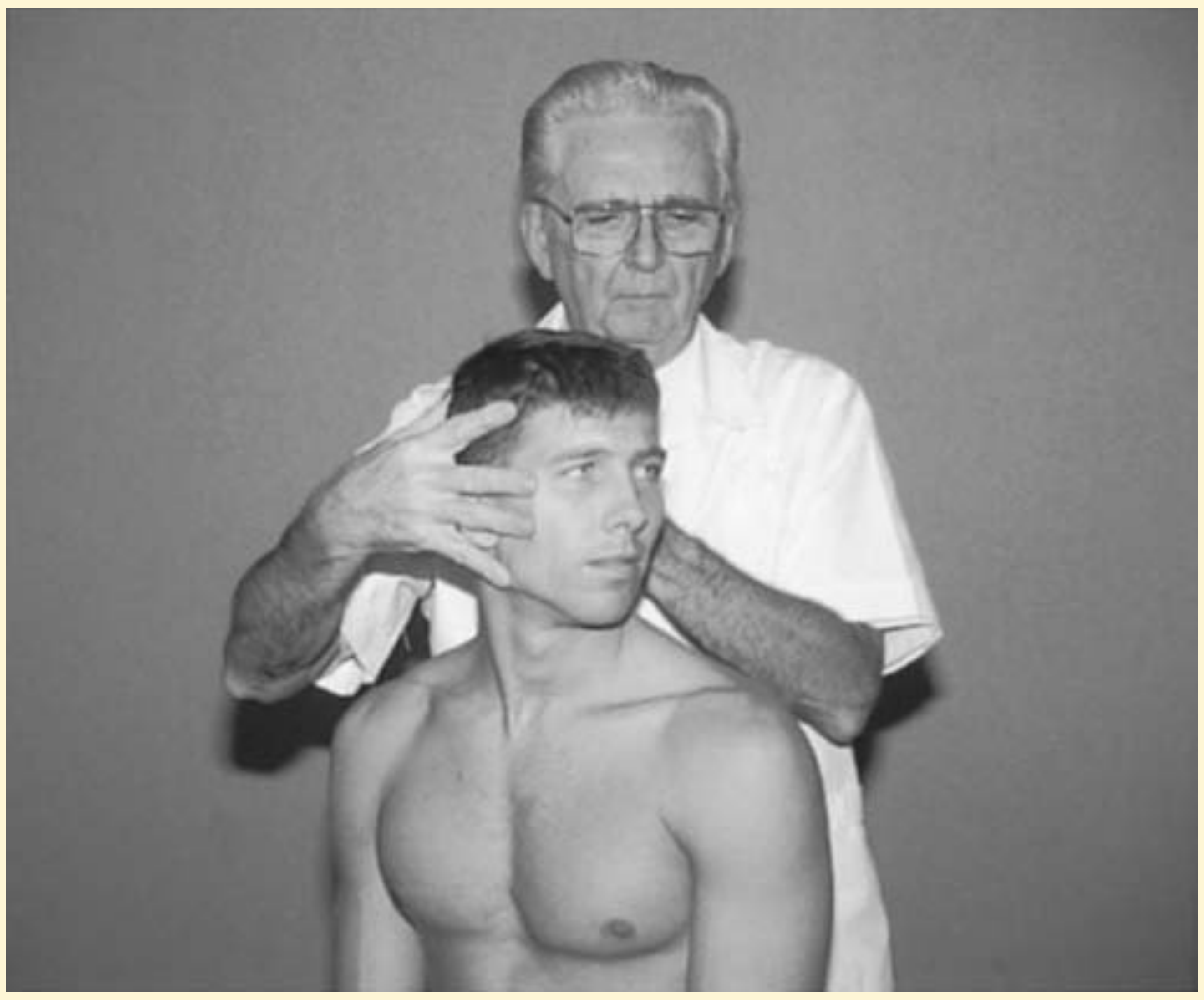

Figure 2.56 Left rotation.

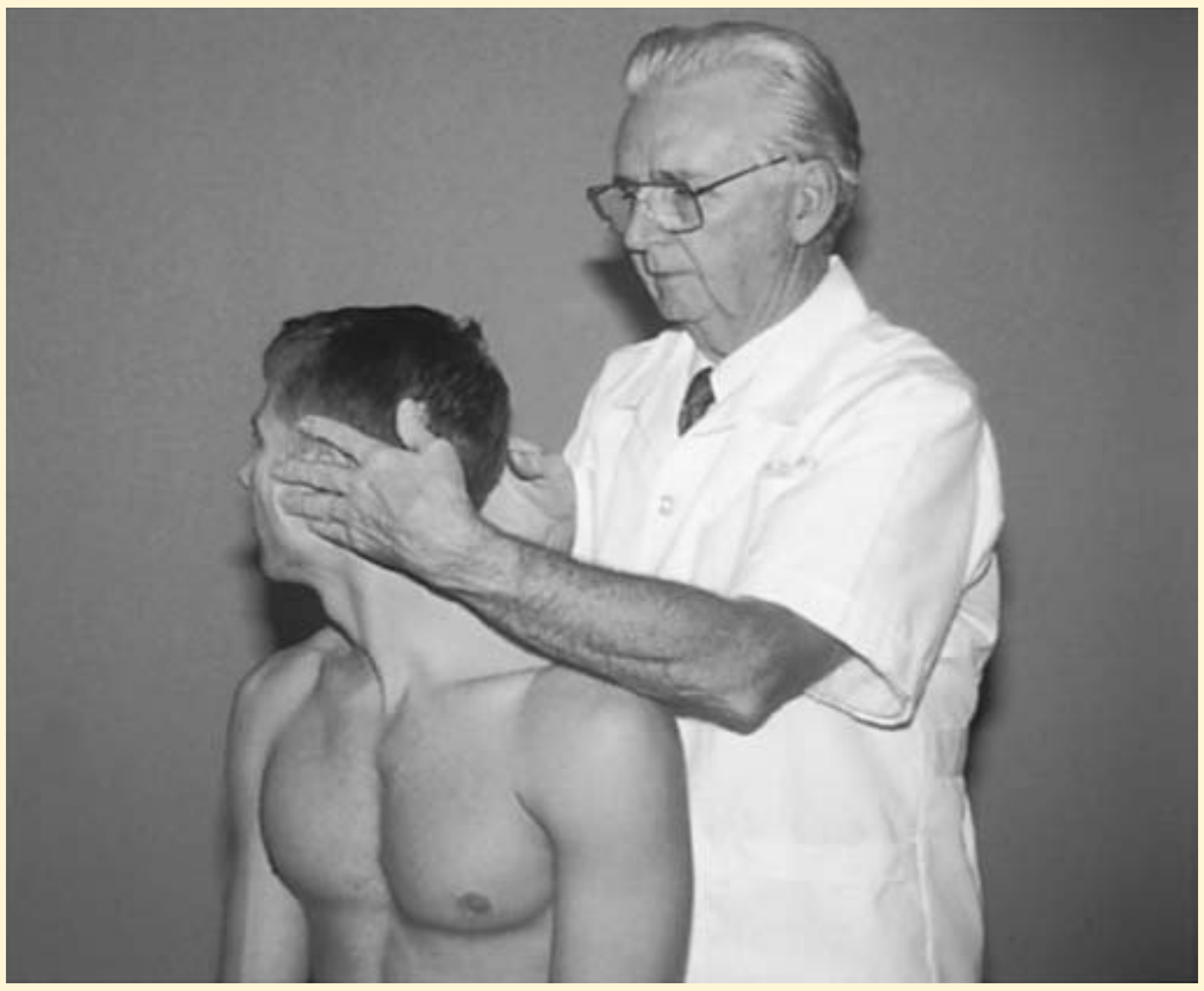

Figure 2.57 Right rotation.

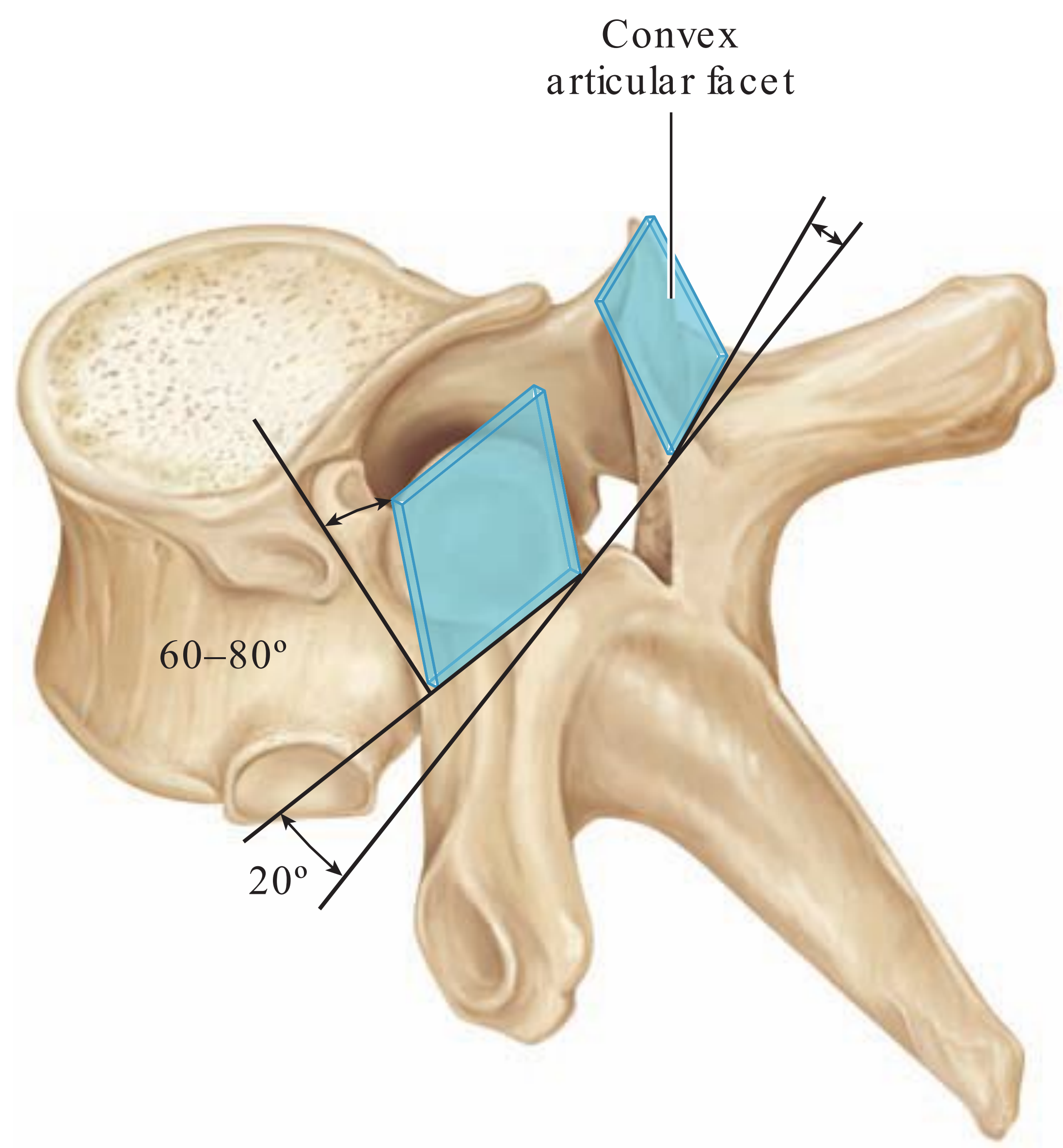

Figure 5.14 Facet orientation in the transverse plane along the vertebral column.

which are also shingled from above downward. The spinous processes are quite long and overlap each other, particularly in the mid to lower region. Conventionally, the relation of the palpable tips of the spinous processes to the thoracic vertebral bodies is referred to as "the rule of 3s" (**Fig. 5.15**). The purpose of "the rule of 3s" is for one to easily locate the transverse processes. The spinous processes of T1 to T3 are palpable at the same vertebral level as their respective transverse processes. The spinous processes of T4 to T6 project one-half vertebral body below their respective transverse process. The spinous processes of T7 to T9 are located a full vertebral body lower than their respective transverse process. The spinous processes of T10 through T12 return to being palpable at the same vertebral level as their respective transverse processes.[15]

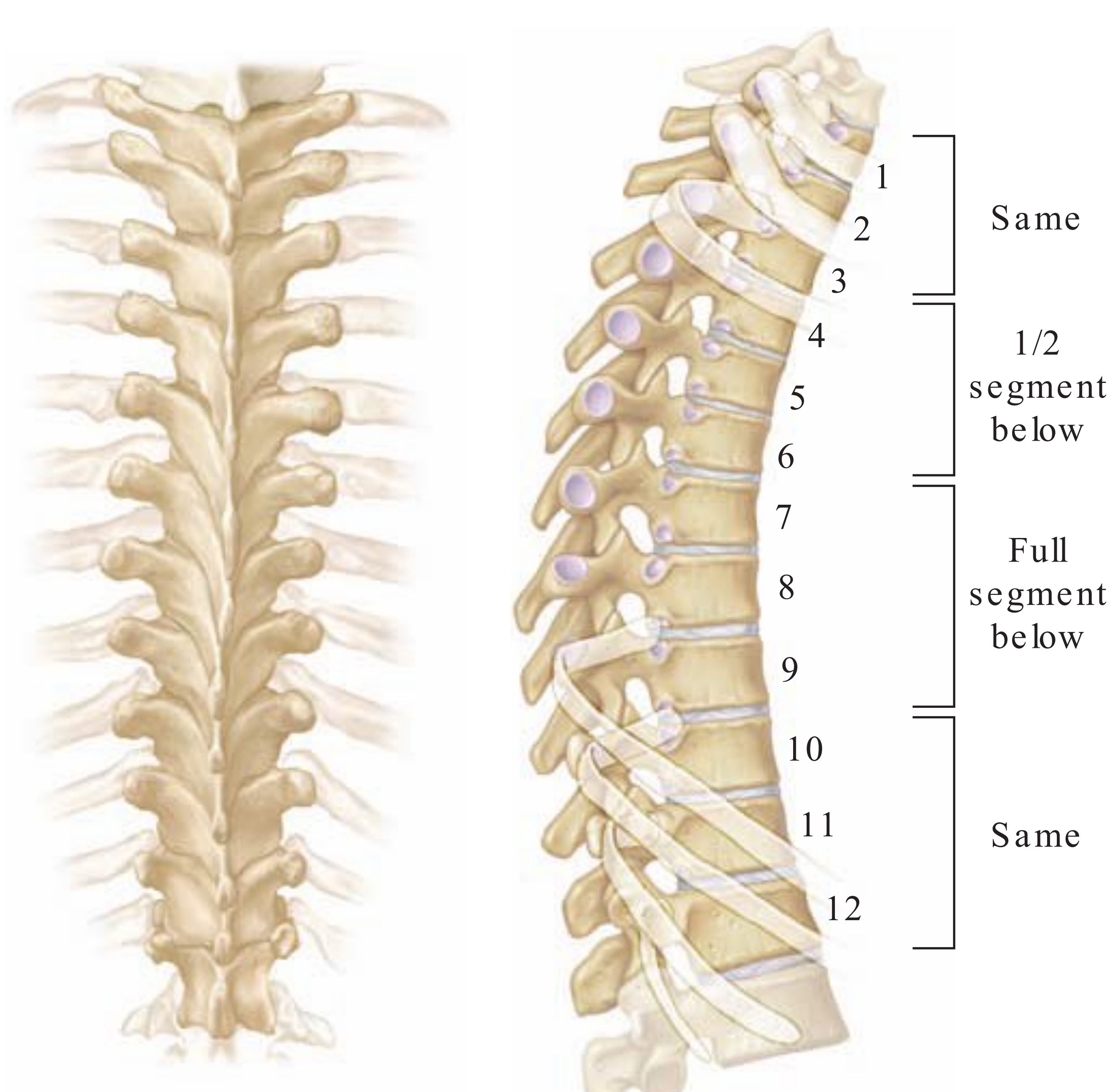

Figure 5.15 Thoracic spine rule of 3s. The spinous process segmental relativity to its transverse process.

Theoretically, there should be a great deal of freedom of movement in multiple directions in the thoracic spine, but the attachment of the ribs to the thoracic vertebra and sternum markedly restricts the available motion. The coupling behavior of thoracic rotation and side bending has been very controversial. A recent systematic review of studies examining *in vivo* and *in vitro* thoracic spine coupled motion showed no consistent coupling patterns when the rotation or side bending was introduced to a neutral (not flexed or extended) spine.[16] Despite this controversy, there appears to be some consensus that arises with contributed anatomical, clinical, and experimental data.[4,17,18]

Coupling mechanics of the thoracic spine motion cannot be complete without elucidation of its effect on the rib cage. During flexion of a vertebral segment, the rib attached to the inferior demifacet of the superior segment will follow the superior segment forward. This turns its superior border anteriorly, inducing anterior rotation or internal rotation of the affected rib (i.e., T5 and the sixth rib) (**Fig. 5.16**). During extension of a vertebral segment, the rib attached to the inferior demifacet of the superior segment will follow the superior segment backward. This turns its superior border posteriorly, inducing posterior rotation or external rotation of the affected rib (**Fig. 5.17**).

Because of the limitations of motion due to the rib cage, flexion and extension of the thoracic spine quickly deliver control of motion to the facets, such that any side bending from a forward or backward bent position will couple ipsilaterally. In the absence of dysfunction and alteration in the anterior–posterior curvature, side bending of the thoracic spine will behave similar to a flexible rod and couple with rotation in the opposite direction. This motion is permitted because the facets in the upright posture are not controlling motion and because the ribs on the convex side internally rotate and those on the concave side externally rotate in response to compressive/distractive forces on the respective ribs laterally. This torsioning of the ribs delivers

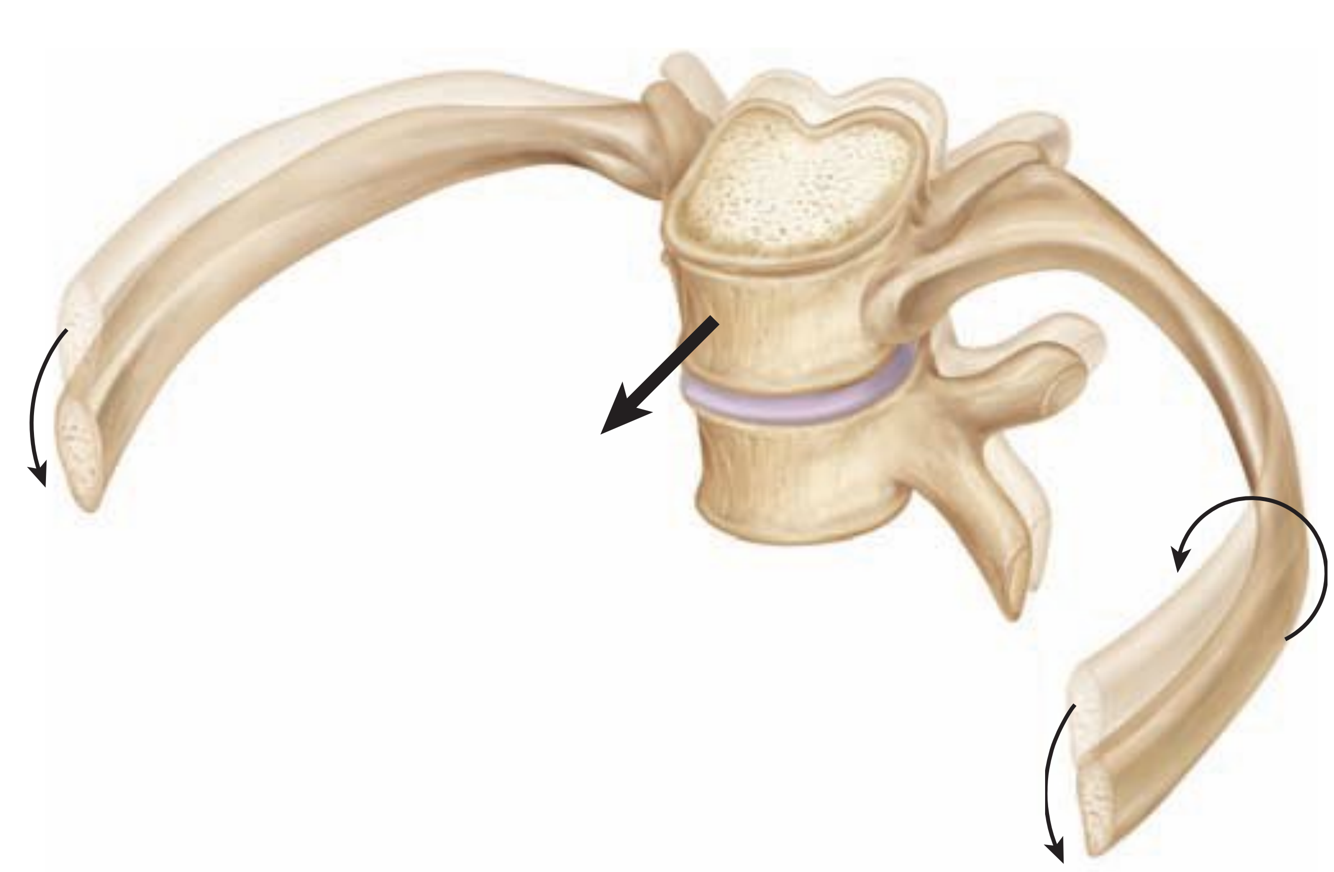

Figure 5.16 The osteokinematic and arthrokinematic motion proposed to occur in the thorax during flexion.

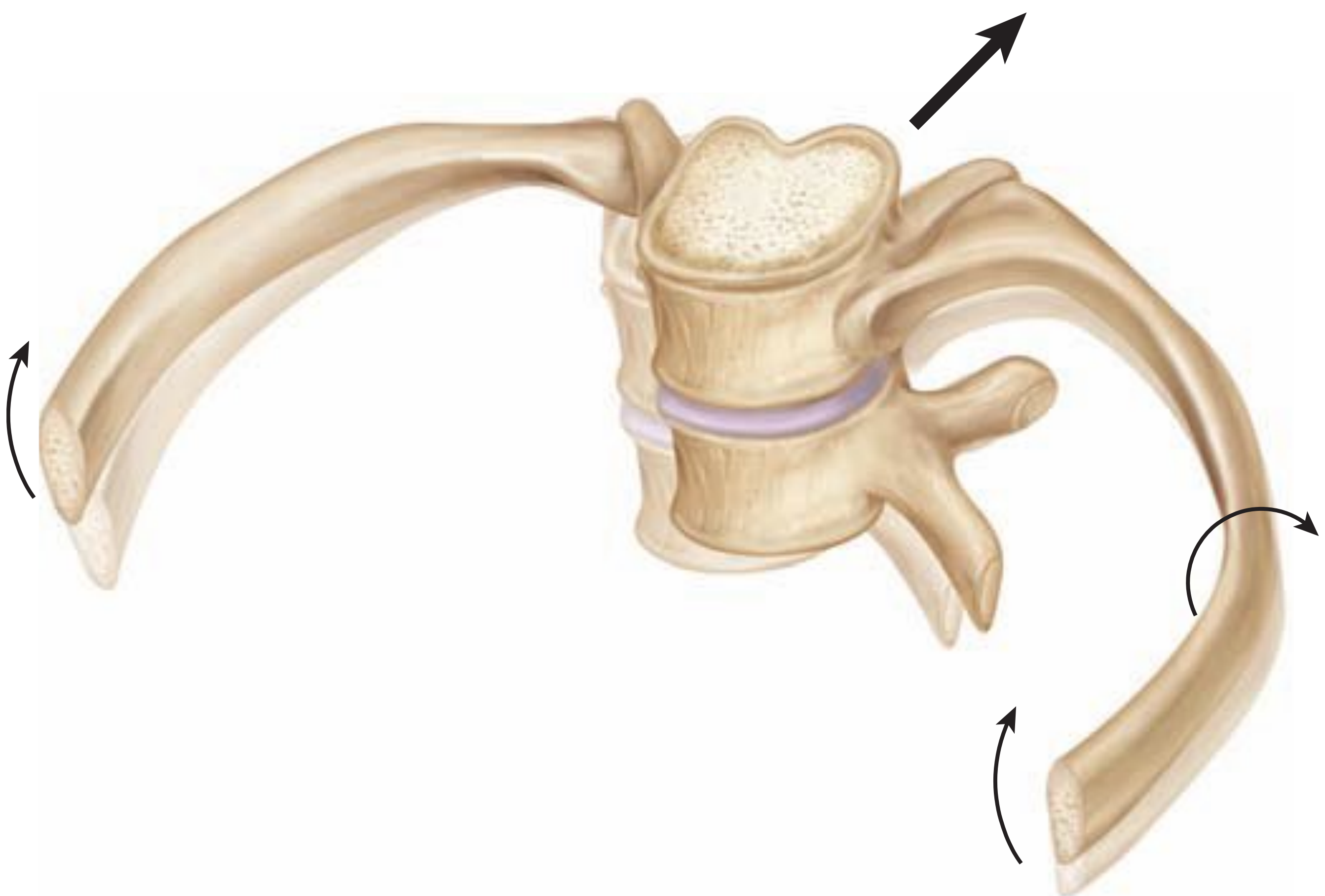

Figure 5.17 The osteokinematic and arthrokinematic motion proposed to occur in the thorax during extension.

contralateral rotational forces back into the costovertebral joints and vertebral body[18] **(Fig. 5.18)**.

In the absence of dysfunction or alteration in the anterior–posterior curvature, rotation of the thoracic spine quickly delivers control to the facets. In addition, right rotation of T4 on T5 torsions the right fifth rib posteriorly, as it travels posteriorly with the right inferior demifacet of T4, and the left fifth rib anteriorly, as it travels anterior with the left inferior demifacet of T4. The rib inf uence on rotation becomes significant as it exerts a pulling force onto the right transverse process, via its superior costotransverse ligament, toward the side of rotation, adding to right-side bending[17,18] **(Fig. 5.19)**.

Lumbar Vertebrae

In the lumbar region, the vertebral bodies **(Fig. 5.20)** become even more massive and support a great deal of weight. The spinous processes project posteriorly in relation to the vertebral body to which they are attached and are broad, rounded, and easily palpable. The transverse processes project laterally, with

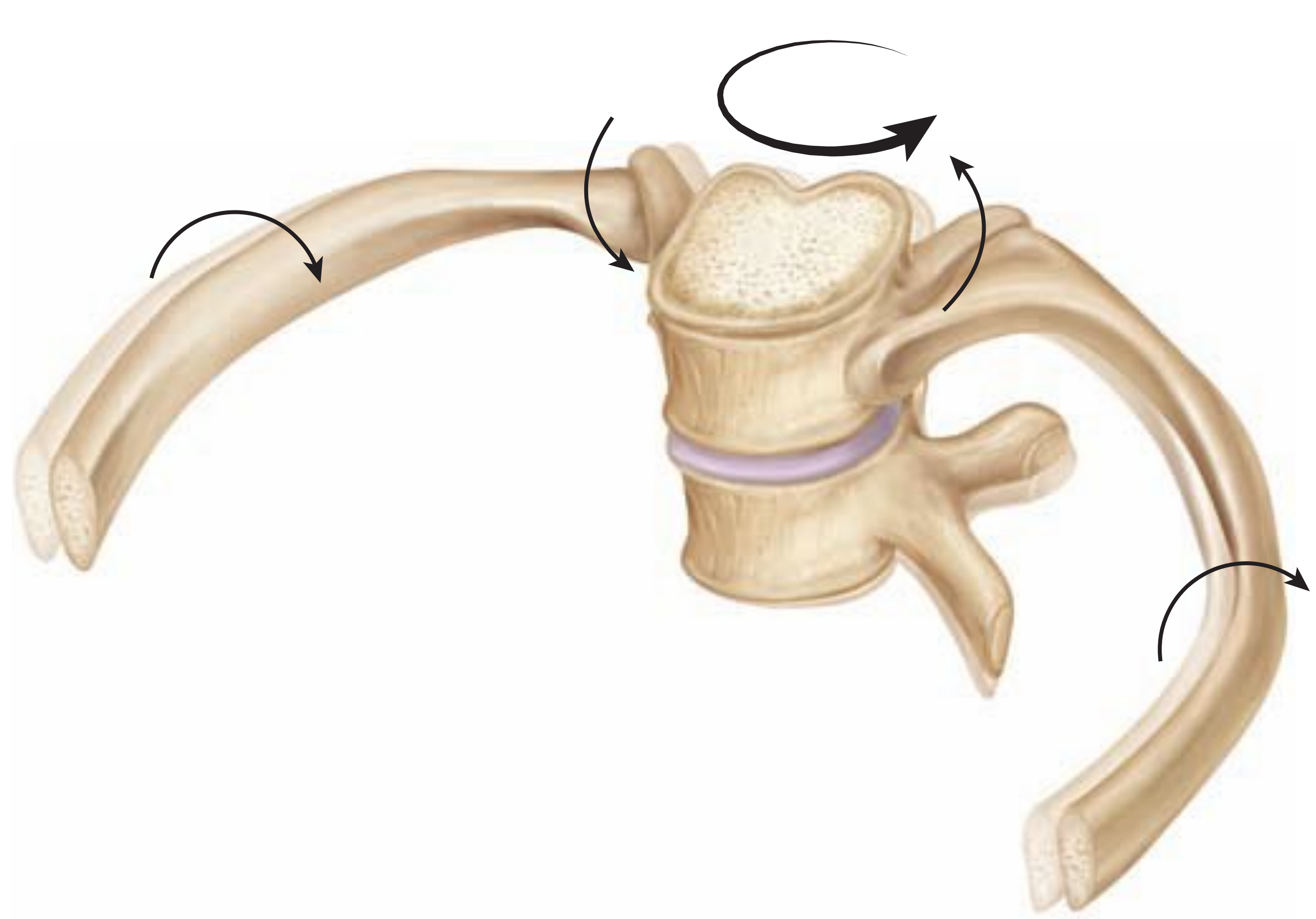

Figure 5.18 During right-side bending, the bilateral costal rotation in opposing directions tends to drive the superior vertebra into left rotation.

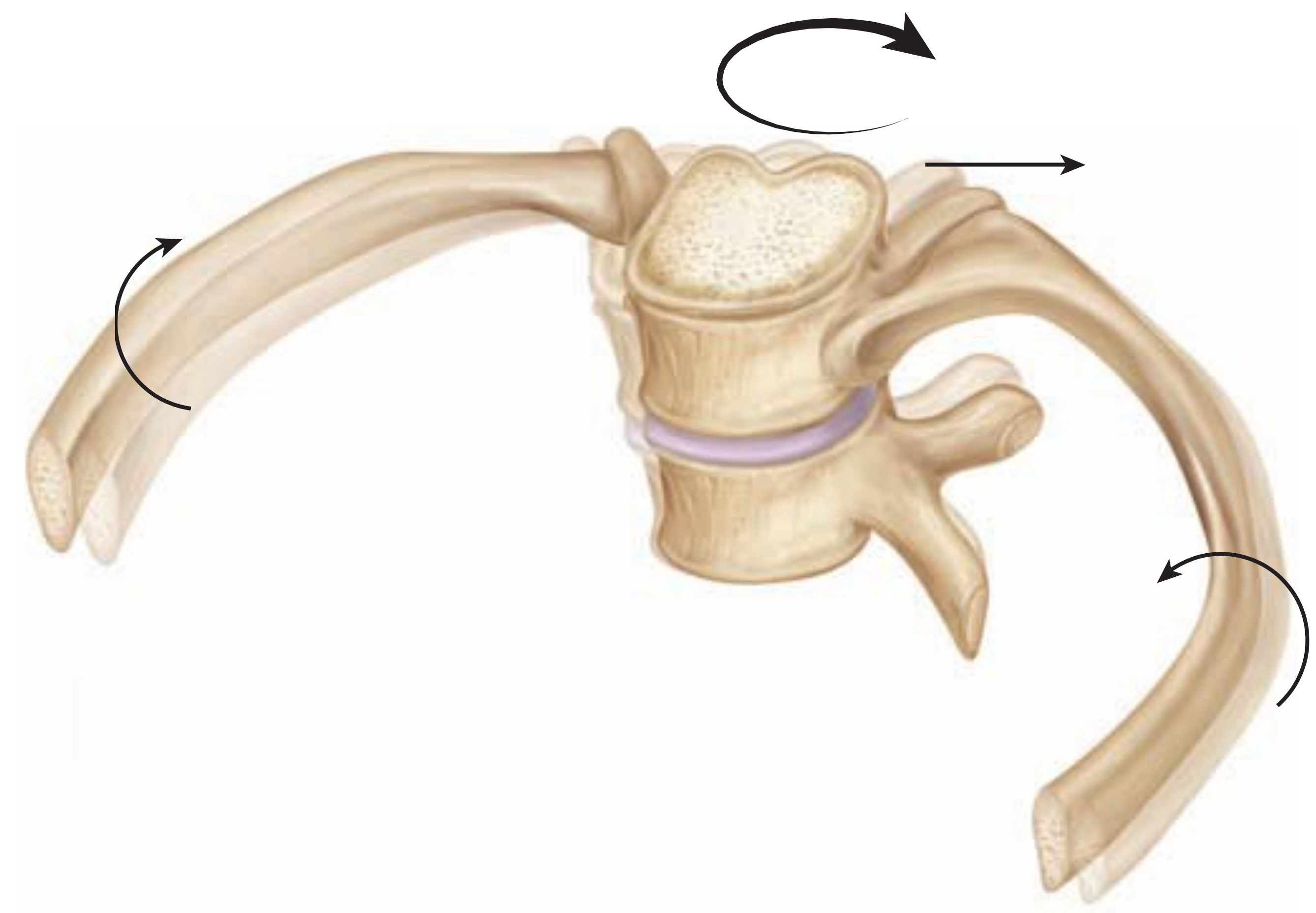

Figure 5.19 As the superior thoracic vertebra rotates to the right, it translates to the left. The right rib posteriorly rotates and the left rib anteriorly rotates as a consequence of the vertebral rotation.

those attached to L3 being the broadest in range. The lumbar zygapophysial joint superior articular surface is convex and inferior articular surface is concave; the orientation of the superior articular surface is backward and medially limiting the amount of side bending and rotation available. Given the orientation of the facets, f exion delivers control to the facets, whereas physiological extension allows the bodies of the vertebra to maintain control.

In the lumbar region, asymmetric facing of the zygapophysial joints or "tropism" is not uncommon. In the absence of tropism, vertebral dysfunction, or alterations in the anteroposterior curvature of the spine, side bending will couple with rotation to the opposite side.[12] The lumbar vertebral segments have large intervertebral disks and vertically oriented articular facets. The side-bending forces are directed into the disk on the side of convexity and onto the lateral vertebral body ligamentous structures of the concavity. Rotation into the concavity reduces the pressure within the disk and minimizes the stretch of the lateral vertebral ligaments.

In the absence of tropism, vertebral dysfunction, or alterations in the anteroposterior curvature of the spine, axial rotation from above to the right will couple with side bending to the left at L1–L3 and side bending to the right at L3–L5.[19] The transition at L3–L4 likely resolves the reciprocal left rotation from below, generated from fixation of the lumbar spine at the sacrum.

With the spine in the f exed position, side bending quickly directs control of motion to the facets and couples rotation to the same side.[20] With the spine in the extended position, side-bending forces are maintained by the bodies of the vertebra and couple rotation to the opposite side. In the lumbar region, non-natural coupling results in significant reduction in freedom of motion. With the trunk forward bent, side bent, and rotated to the same side, any additional movement places the lumbar spine at risk for muscle strain, zygapophysial joint dysfunction, annular tear of the intervertebral disk, or posterolateral protrusion of nuclear material in a previously compromised disk annulus.

Mobilization with Impulse Technique

1. The patient sits on the table with the operator standing in front.
2. The operator's hands grasp the patient's hand and wrist with the operator's thumbs contacting the dorsal aspect of the scaphoid and lunate **(Fig. 18.83)** and index fingers grasping the volar aspect of the scaphoid and lunate **(Fig. 18.84)**.
3. The operator engages dorsiflexion barrier and applies mobilization with impulse thrust by taking the patient's wrist toward the floor **(Fig. 18.85)**.
4. The operator engages palmar flexion barrier and provides a mobilization with impulse thrust by carrying the wrist toward the ceiling **(Fig. 18.86)**.

Figure 18.83 Thumbs contact the dorsal scaphoid and lunate.

Figure 18.84 Index fingers grasp the volar scaphoid and lunate.

Figure 18.85 Engage dorsiflexion barrier.

Figure 18.86 Engage palmar flexion barrier.

Joint Play

Distal Radioulnar and Ulnar–Meniscal–Triquetral Articulations

1. The patient stands or sits on the table with the operator in front.
2. The operator stabilizes the patient's hand and radiocarpal region by placing the index finger in the web of the patient's thumb (**Fig. 18.90**) and the thenar eminences and middle, ring, and little fingers grasping the distal radius and proximal carpals (**Fig. 18.91**).
3. The operator grasps the distal ulna between the thumb and pads of the fingers (**Fig. 18.92**).
4. The operator provides anteroposterior glide and medial and lateral rotary joint play movements of the distal ulna (**Fig. 18.93**).

Figure 18.90 Index finger in the web of the thumb.

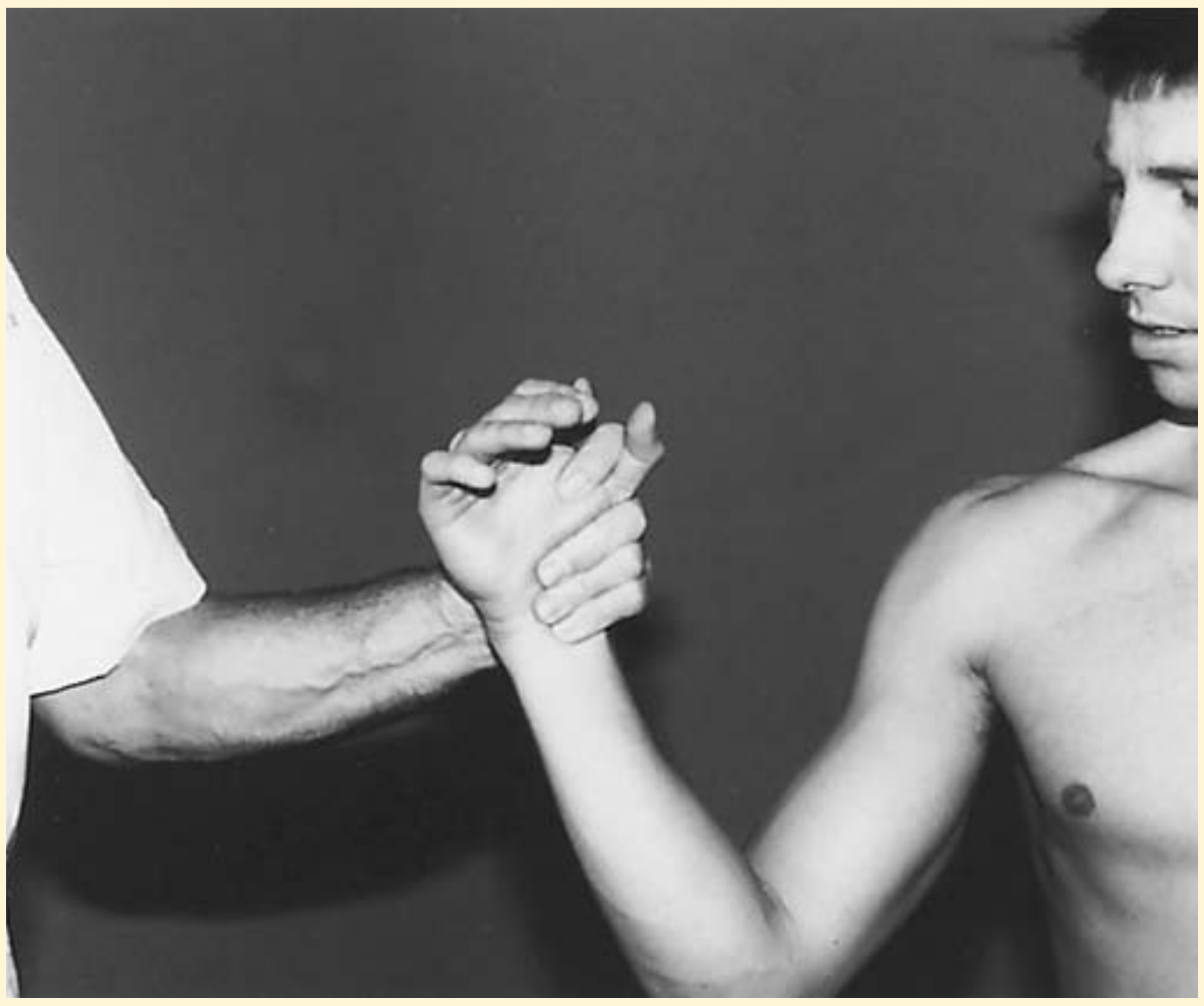

Figure 18.91 Grasp the distal radius.

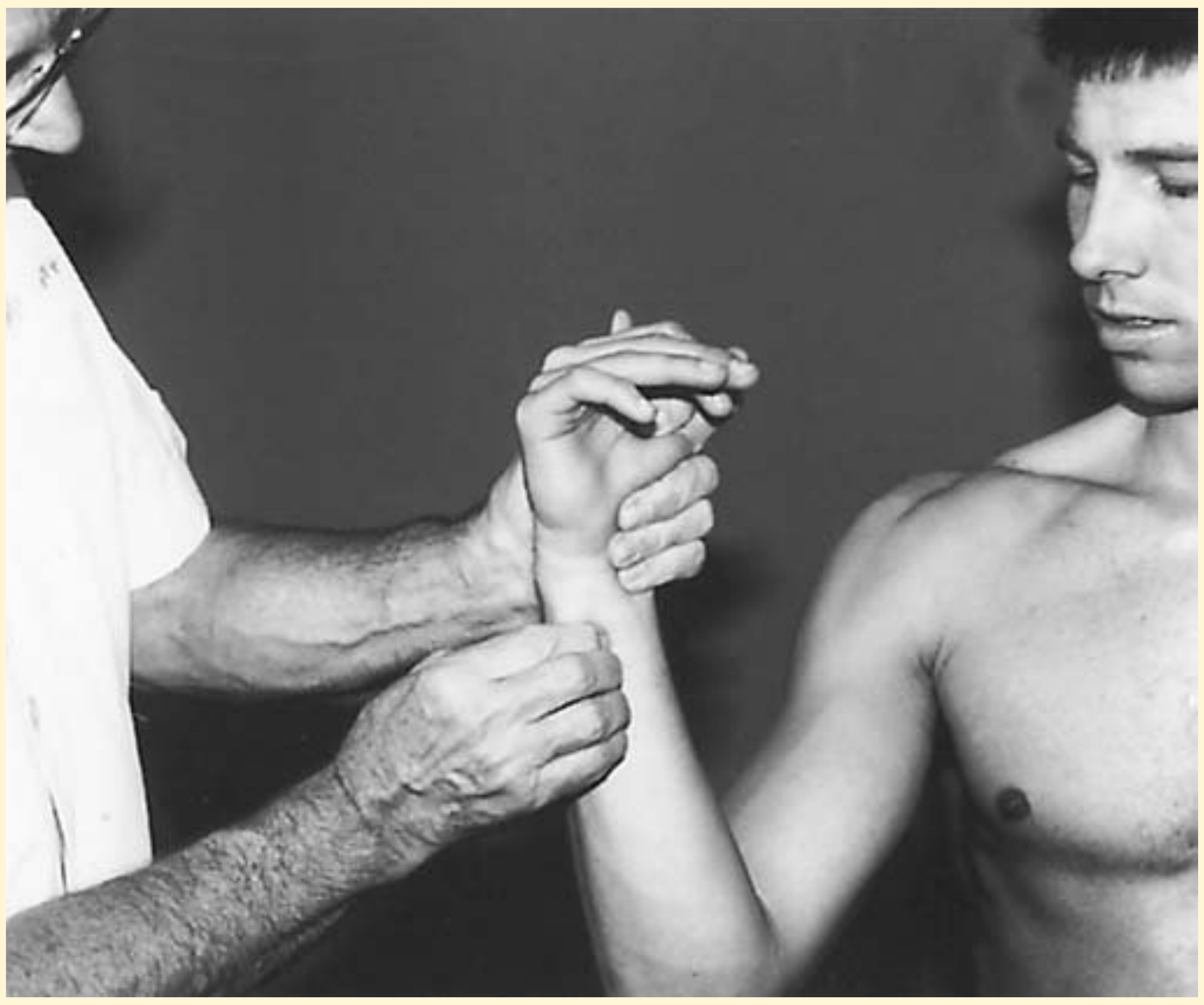

Figure 18.92 Grasp the distal ulna.

Figure 18.93 Anteroposterior glide and medial and lateral rotary joint play.