The intricate complexity of the thoracic spine is best illustrated by considering its intimate connection with the rib cage, its proximity and neurologic connections with the viscera of the thorax and abdomen, and its influence on the cervical and lumbar spine. This interconnection makes possible a wide range of diverse interactions. Although widespread disability exists for cervical and lumbar spine disorders, the thoracic spine is conspicuously absent from the picture. If pain is not a major disability factor for the patient, wherein lies the putative morbidity? This question can best be answered by analyzing the mechanical traumas that do affect the region. From this perspective, one can appreciate how and where disease occurs.

Degenerative joint disease is relatively common in the thoracic spine. Circumferential tears of the annulus are an early occurrence in the degeneration process. At a later date, fissures develop, radiating from the nucleus outward, primarily at the posterolateral angles. Radial fissures occur most frequently in the thoracic spine (1).

Degenerative joint disease at the central joint leads to anterior disc thinning. This is possibly due to increased compressive loads that are encountered here. Subchondral bone and end-plate sclerosis signify that normal disc nutrition has been interrupted. Stabilization processes, such as anterior osteophyte formation, occur later in the course of the disease. These anterior osteophytes can compress the sympathetic trunks, which are in close proximity (2).

For optimal health of the region, it is necessary to prevent or minimize degeneration. Normal joint movement is likely to limit the degenerative processes of the joint (3). Magnetic resonance imaging (MRI) is useful in identifying early changes in the disc (4). Whether or not chiropractic care can facilitate normal joint function early in the course of the disease largely determines the extent to which future morbidity can be influenced (See Chapter 13).

CLINICAL ANATOMY AND BIOMECHANICS
Osseous Structures

The thoracic spine is usually formed by 12 vertebrae (See Anomalies). The middle thoracics are considered the typical thoracic vertebrae. They have deeply imbricated spinous processes (Fig. 8.1A-B), coronally oriented facets (Fig. 8.2), hemifacets for the costovertebral articulations on the superior and inferior aspects of the lateral vertebral bodies, and vertebral bodies equal in anteroposterior and transverse diameters (5). There are also articular surfaces on the transverse processes that form the vertebral surface of the costotransverse joints.

The upper thoracic vertebrae, especially T1, are cervical-like, while the lower thoracic tend to resemble the lumbar spine. The thoraco-lumbar junction (i.e., T10-L1) has mortice-like zygapophyseal joints (6). This arrangement markedly restricts axial rotation and extension. When adjusting this area, it is important to not hyperextend the segment. Instead, the vertebra should be moved forward through the center of mass of the segment. Forces that cause extension or flexion of the motion segment will...
create the most movement at adjacent levels (7). Figure 8.3 demonstrates the primary pattern of thrust for thoracic motion segments.

**Ligamentous Structures**

The thoracic spine has ligaments that are typical of the spine in general. The anterior longitudinal ligament tends to be narrower than in the cervical spine. The interspinous and capsular ligaments are also thinner and looser than in the cervical spine. The posterior longitudinal ligament is broad and uniform in the upper thoracic spine. In the lower thoracic spine it is denticulated, narrow over the vertebral bodies, and broad over the intervertebral disc (8).

The intervertebral disc has a much less developed nucleus in comparison with the cervical and lumbar spine (8). The disc's ability to swell is somewhat reduced in the thoracic spine (9). The disc is avascular, and its nutritional requirements rely on imbibition through the semi-permeable end-plates from avascular buds between the spongiosa and the end-plates. Movement is required for this flow of nutrients, and the disc deteriorates with its loss (3). The thoracic disc height is smaller in relation to the vertebral body thickness, when compared to other regions of the spine. Support is also provided by the costovertebral and costotransverse ligaments. The end-plates of the normal disc are relatively parallel. A kyphosis is achieved through the wedge-like shape of the vertebral bodies (8).

**Costovertebral Joint**

The typical costovertebral joint is a pair of demifacets on adjacent vertebral bodies at the lateral margins, which articulate with the convex rib head in a synovial joint. There is capsular attachment to the annulus of the disc and the posterior longitudinal ligament. The intermediate interarticular ligament subdivides the joint and attaches the rib head to the facets. There are also ligaments attaching the rib head to the adjacent vertebral bodies (8,10) (Fig. 8.4).

**Costotransverse Joint**

The posterior tubercle of the rib neck articulates with a facet on the transverse process in a synovial joint. These joints are absent in the lower two or three ribs. The costovertebral and costotransverse joints allow rotation around an axis formed by the two articulations (10,11).

Clinical observations suggest that subluxation of the ribs is relatively rare, compared to the incidence of vertebral dysfunction (i.e., three-joint complex). Axial rotation of the motion segment can often create pain along the posterior rib margin. Intercostal neuritis is more likely due to irritation near the nerve root than entrapment elsewhere.

Subluxation of the rib at the anterior can occur when there is moderate rotation of the thoracic spine (e.g., scoliosis). These subluxations can be reduced from the anterior (See Chapter 16), but if the spine is not derotated, reoccurrence is likely. Traumatic blows to the thorax can also subluxate the anterior ribs. These injuries reduce quickly with an adjustment, provided that there is not severe ligamentous laxity and that the adjustment quickly follows the trauma. The rib usually fractures before severe trauma occurs at the costotransverse or costovertebral joints.
Nervous System

SPINAL CORD

The cervical cord enlargement continues down to the T2 segmental level, and the lumbar cord enlargement is between the T9 and T12 segments (12). The epidural space between the spinal cord and the margins of the thoracic neural canal is relatively narrow (13). Dislocation, subluxation, and fracture into the spinal canal can cause cord injury. In the pediatric, gross cord and nerve root injury can occur with only relatively slight radiographic alterations (14–16).

Blood Supply. The cord is supplied by the anterior and posterior spinal arteries. The “Arteria Radicularis Magna” or “Artery of Adamovicz” is located in the lower thoracic spine and supplies the lower two-thirds of the spinal cord. The intercostal arteries send branches to the vertebral body and spinal muscles. Branches also enter through the intervertebral foramen and supply the posterior vertebral body, nerve root, dura mater, vertebral arch, and extradural contents of the canal (10). The narrowest part of the thoracic canal from T4 to T9 is also the area of poorest blood supply (3). Brieg (17) has shown how tension in the spinal cord will lead to decreased blood flow to the cord tissue. Hyperflexion of the spinal canal, or adhesions in the area may lead to tension in the meninges and spinal cord (17).

NERVE ROOTS

There are 12 pairs of thoracic nerve roots which course through the intervertebral foraminae formed by the same numerical vertebra and its subjacent neighbor. The nerve root divides into the anterior and posterior primary divisions, the sinuvertebral or recurrent meningeal nerve, and the white and gray communicating nerves that join the sympathetic trunk. The posterior primary division of the nerve root has medial and lateral branches. The medial branch innervates short medial back muscles and the skin of the back as far as the midscapular line. Lateral branches innervate the sacrospinalis muscles. The lateral branches of the lower six thoracic nerve roots send sensory branches to the skin of the lower lateral back, and the T12 lateral branches send fibers along the iliac crest descending to the skin of the front part of the gluteal region. Some filaments reach as low as the greater trochanter of the femur (8,12).

The anterior primary division of the nerve root becomes the intercostal nerve with the exception of T12 which becomes the subcostal nerve (8,12). Anterior branches of the anterior primary division supply the intercostal muscles, parietal pleura, and the skin over the anterior thorax and abdomen (12).

The major portion of the T1 nerve root and portions of T2 and T3 enter the brachial plexus (12). They have sensory branches that innervate the axillae and the medial side of the arm and forearm. Lesions in this area can cause symptoms characteristic of thoracic outlet syndrome.

The T12 nerve root enters the lumbar plexus and becomes the iliohypogastric nerve (12). A lateral branch innervates the upper lateral thigh and an anterior branch descends anteriorly to the symphysis pubis. Pain in either of these areas can result from nerve irritation at the spinal level. The lower three to four thoracic nerve roots send branches to the periphery of the diaphragm and the serratus posterior inferior muscle (12).

The recurrent meningeal or sinuvertebral nerve is formed by the ventral ramus and a root from the gray ramus communicans and reenters the intervertebral foramen to innervate the dura, epidural and posterior vertebral body vascular structures, posterior superficial layers of the annulus fibrosis, epidural fat and the posterior longitudinal ligament (18–20).

The gray communicans connects the sympathetic trunk to the ventral rami. Branches from it also innervate the lateral portion of the intervertebral disc (19,20).

SYMPATHETIC NERVOUS SYSTEM

Traditionally, preganglionic cell bodies from the lateral columns were thought to be confined to the thoracic and upper lumbar levels (8,12). Mitchell (21) however, has identified preganglionic sympathetic cell bodies at all levels of the spinal cord. Randall (22) has confirmed these observations at the lower lumbar levels. Richter and Woodruff (23) mapped the lumbar sympathetic dermatomes through operations (at all levels) on the various lumbar ganglia.
The preganglionic efferent fibers travel with the ventral root, and via the white communicating rami, enter the sympathetic chain ganglia that lie along the lateral vertebral bodies. On entering the chain ganglia, the fibers may synapse in the ganglia with ganglionic cells, pass superiorly or inferiorly along the sympathetic chain and synapse at other levels, or continue through the ganglia out to the intermediary sympathetic ganglia. The collateral or intermediary sympathetic ganglia include the celiac, superior mesenteric, and inferior mesenteric ganglia.

The greater and lesser splanchnic nerves arising from the lower seven thoracic sympathetic ganglia travel to the celiac and superior mesenteric ganglia, where they synapse. The postganglionic fibers go through the celiac plexus to the abdominal viscera. Lower thoracic sympathetic fibers may travel to the inferior mesenteric ganglion from which postganglion fibers pass through the hypogastric plexus to the lower abdominal and pelvic viscera (12) (See Chapter 13).

VERTEBRAL ANOMALIES

Vertebral anomalies are frequently found in the thoracic spine. There may be differences in number of vertebral segments (Fig. 8.5) and developmental anomalies of bone tissue. Malformed spinous processes are common. Using static palpation of these structures solely to identify vertebral rotation is questionable. Hemivertebrae are due to failure of one of the vertebral body ossification centers to grow. They can be seen with other anomalies, such as Klippel-Feil syndrome and meningocele. A solitary hemivertebra will cause a structural scoliosis (See Chapter 9). An anterior-posterior hemivertebra is rare and can cause a gibbus formation. It is associated with cretinism and achondroplasia. A "scrambled spine" is multiple hemivertebrae (24).

Nuclear impression or persistent notochord is an irregularity of the end-plates and causes a characteristic "Cupid’s Bow" or double hump contour of the endplates. Block vertebrae may occur in the thoracic spine. Klippel-Feil syndrome is defined as multiple block vertebrae. Sixty percent of these patients show the triad of a short webbed neck, low hairline, and diminished range of motion. Sprengel’s deformity is a failure of the scapula to descend during gestation; 25 to 35% of Klippel-Feil patients will have Sprengel’s deformity (25). Females are twice as likely to display it as males (24).

Schmorl’s nodes are commonly seen in the thoracic spine. These are nuclear herniations through the endplates. This condition may be due to an inherent weakening of the end-plate, trauma, or a pathologic process. The radiographic appearance is of a small protrusion into the vertebral body through the end-plate that has a surrounding rim of sclerosis. Sclerosis of the end-plate most likely interferes with the nutritional requirements of the disc (See Chapter 2).

Venous clefs or Clefts of Hahn appear radiographically as a lucent horizontal line through the vertebral body. These clefs are commonly seen in childhood and often persist into adulthood. This phenomenon represents the communication of the basivertebral vein and the anterior external plexus. They are common in the lower thoracic spine but are of unknown clinical significance (24).

Rib cage anomalies, such as bifurcated ribs, rib foramen, synostosis and accessory ribs, or the absence of ribs, can occur. Srb’s Anomaly (24) is an involution of one or both first ribs caused by shortening and incomplete fusion of the first and second ribs. A bony plate is formed with absence of the intercostal space. A pseudoarthrosis may be present (24).

Most radiologists consider costochondral calcification to be a normal variant. Gonstead (26) hypothesized that costochondral calcification was a strong indicator of chemistry imbalance in the body especially when accompanied by calcification of the thyroid gland and a kyphotic cervical spine.
Rib Cage and Respiration

The biomechanics of the thoracic spine cannot be studied without including the rib cage. Inspiration is largely an active process, whereas exhalation is mostly passive. There is a slight amount of axial rotation around the axis formed by the costovertebral and costotransverse joints that allows elevation and depression of the ribs. In the lower thoracic spine, the elevation is accompanied by lateral or transverse expansion of the rib cage, whereas in the upper thoracic spine the elevation is accompanied by AP expansion. Because of the elevation and expansion of the rib cage, the costal cartilage is the element that absorbs the torque that occurs at the costoternal junction. This torque action is then released during exhalation thus reducing muscular effort (11).

The rib cage increases the moment of inertia of the thoracic spine, acts as a barrier to impacts, and increases the overall stiffness of the region due to the multiple ligamentous attachments (See Chapter 2).

Posture

The dorsally convex thoracic curve and the sacrum form the primary curves of the spinal column. The thoracic curve is present at birth and is formed predominately by the wedge-like configuration of the vertebral bodies. The disc spaces are relatively parallel. White and Panjabi (27) report that the common range for the thoracic curve is between 20 and 40°. The apex of the curve occurs at about the T6-T7 segmental levels (28). In the young, the thoracic curve tends to be less in females when compared with their male counterparts. The female curve does progress with age, however, so that during middle age the magnitudes are comparable for both sexes. Fon et al. (29) studied the range of the thoracic curve compared with chronologic age in 316 patients who were undergoing elective surgery or had a preemployment radiographic examination (Table 8.1 and Table 8.2). For the examination, the patient’s arms were above the shoulders for the lateral view. This may have diminished the curve in some individuals. Since all of the sagittal curves are interdependent (30), it is important to not analyze the thoracic region in isolation (Fig. 8.6A-B).

<table>
<thead>
<tr>
<th>Table 8.1.</th>
<th>Degree of Kyphosis in Males by Age*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years)</td>
<td>n</td>
</tr>
<tr>
<td>2–9</td>
<td>26</td>
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<tr>
<td>10–19</td>
<td>28</td>
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<td>20–29</td>
<td>37</td>
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<tr>
<td>30–39</td>
<td>26</td>
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<tr>
<td>40–49</td>
<td>20</td>
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<tr>
<td>50–59</td>
<td>10</td>
</tr>
<tr>
<td>60–69</td>
<td>9</td>
</tr>
<tr>
<td>70–79</td>
<td>3</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Table 8.2.</th>
<th>Degree of Kyphosis in Females by Age*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years)</td>
<td>n</td>
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<tr>
<td>2–9</td>
<td>23</td>
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<tr>
<td>10–19</td>
<td>22</td>
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<td>20–29</td>
<td>24</td>
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<td>30–39</td>
<td>26</td>
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<td>32</td>
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<tr>
<td>50–59</td>
<td>17</td>
</tr>
<tr>
<td>60–69</td>
<td>7</td>
</tr>
<tr>
<td>70–79</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 8.3. The Range of Motion (i.e., Elastic + Neutral Zones) of the Thoracic Spine During Lateral Bending and Y Axis Rotation

<table>
<thead>
<tr>
<th>Motion Segment</th>
<th>One Side Lateral Bending</th>
<th>One Side Axial Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Limits of Ranges (Degrees)</td>
<td>Representative Angle (Degrees)</td>
</tr>
<tr>
<td>T1-T2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>T2-T3</td>
<td>5-7</td>
<td>6</td>
</tr>
<tr>
<td>T3-T4</td>
<td>3-7</td>
<td>5</td>
</tr>
<tr>
<td>T4-T5</td>
<td>5-6</td>
<td>6</td>
</tr>
<tr>
<td>T5-T6</td>
<td>5-6</td>
<td>6</td>
</tr>
<tr>
<td>T6-T7</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>T7-T8</td>
<td>3-8</td>
<td>6</td>
</tr>
<tr>
<td>T8-T9</td>
<td>4-7</td>
<td>6</td>
</tr>
<tr>
<td>T9-T10</td>
<td>4-7</td>
<td>6</td>
</tr>
<tr>
<td>T10-T11</td>
<td>3-10</td>
<td>7</td>
</tr>
<tr>
<td>T11-T12</td>
<td>4-13</td>
<td>9</td>
</tr>
<tr>
<td>T12-L1</td>
<td>5-10</td>
<td>8</td>
</tr>
</tbody>
</table>


Kinematics

With the exception of axial rotation, the ranges of motion of the thoracic spine are much less than other regions of the spinal column. There are also marked regional differences within the thoracic spine. The upper dorsal region behaves much like the lower cervical spine, and the T10-12 area has similarities to lumbar spine motion.

LATERAL FLEXION (± θZ)

The neutral zone (See Chapter 2) in lateral flexion is 2.2° (27). The neutral zone can increase with degeneration, after unfavorable surgery, with repetitious loading, and after trauma (27). The range of motion (neutral zone + elastic zone) is approximately 6° in the upper and middle thoracic spine, and 8° or so in the lower (27). Lateral flexion is limited by the ipsilateral facet joint and contralateral flaval and intertransverse ligaments (11). The rib cage limits movement as well (Table 8.3).

ROTATION (± θY)

The neutral zone in axial rotation is 1.2° (27) (Table 8.3). Rotation is limited primarily by the costoternal structures (11). The range of motion is approximately 2° in the lower thoracic area and 10° or so in the upper regions (27). The greatest amount of axial rotation and therefore, the greatest amount of stress, occurs in the middle thoracic area (31). During walking, the counterrotation of the shoulders to that of the pelvis may cause strain at the transition zone (i.e., T6-T8) and increase symptomatology in a patient with subluxation in the area.

FLEXION/EXTENSION (± θX)

The thoracic spine is more stiff when extended than when it is flexed (32,33). In general, there is less range of motion for extension. The neutral zone from the neutral position for flexion and extension is 1.5°. The upper thoracic total range of motion is approximately 4° at each motion segment. There are 6° at the middle thoracics and 12° at the lower segments (27).

Flexion is limited by the posterior ligaments, such as the interspinous, flava, capsular, and posterior longitudinal. Extension is limited by the spinous processes and the facet joints and, to an extent, by the anterior longitudinal ligament and anterior portion of the annulus (11).

THORACIC SUBLUXATION COMPLEX

Subluxations in other regions of the spine may and often do cause compensatory changes in the thoracic spine. Correction of these subluxations can reduce or eliminate the compensation reactions. It is important to only adjust those segments exhibiting fixation dysfunction. Stress radiographic methods are useful to detect this dysfunction as well as to reveal compensatory hypermobilities and normal segments.

Compensation Reaction

The direction a vertebra subluxates depends on the anatomy of the articulations (posterior and central joint orientations), the global postural mechanics (kyphosis), and the mechanism of injury. Some thoracic injuries occur with the spine in a flexed position. It follows, therefore, that if ligaments are damaged when the motion segment is flexing, then the vertebra will be in an extreme flexion position after the trauma (34,35). Treatment should be directed at this level and not at the compensation above.

For every subluxation, the motion segments above will usually compensate. It is less common for the compensation to occur below. One example may be the individual with a kyphotic cervical spine (primary) which
leads to a flattened thoracic curve (secondary). In the cervical spine, extension malposition will be compensated for by flexion of the segments above. The range of motion for sagittal plane motion in the cervical region (± 10°) is large (approx. 15°) for each individual motion segment; therefore, subluxations in the sagittal plane are easily compensated for. This is in sharp contrast to the thoracic spine, where range of motion in the sagittal plane is quite limited, especially extension from T1 to T6. This is also the most common site for thoracic “dishing” to occur (36). The hypothetical sequence of events for a typical thoracic (i.e., T7-T8) flexion injury occurs as follows:

1. Subluxation is produced due to hyperflexion injury with ligamentous (including disc) damage. There may be only slight radiographic (neutral lateral) alterations, unless there is swelling or degenerative joint disease, or marked flexion positional dyskinesia of the motion segment.
2. The T7-T8 functional spinal unit is sprained with T7 hyperflexed on the subjacent motion segment (Fig. 8.7).
3. The T6-T7 motion segment does not compensate by moving into extension because of its limited ability to do so.
4. Compensation occurs over multiple levels (e.g., 3–4) because of the limited range of motion in extension at individual motion segments from T1 to T6.
5. Because the flexion lesion at T7 directs the segments above towards the thoracic cavity, these segments will palpate or visualize as being relatively anterior or “dished.”

The area of the dishing will usually be painful and edematous and be resilient to compressive palpation (+2). The correction is made by adjusting a segment caudal to the compensation. The spinous contact is usually preferred in this regard.

**Strain and Sprain**

Myotendinous strains or ligamentous sprains follow trauma to the thoracic spine. Sprains or strains occurring in the rib cage, cervical spine, or upper extremities may affect the biomechanics of the thoracic spine. Strains are exacerbated by resisted contraction. Sprains are exacerbated with passive motion of the injured joint. Subluxations are considered to have damaged (sprained) ligamentous elements. It is important to not direct the force of an adjustment into the direction of ligamentous injury.

**Disc Disease**

Intervertebral disc disorders such as herniation are not common in the thoracic spine. This region accounts for only 2% of the intervertebral disc herniations (13). The most probable explanation for this is the limited motion of the thoracic spine due to the rib cage. Herniations are more common in the lower thoracic spine (Fig. 8.8). Disc damage without herniation is relatively common. Radial fissures of the disc are often found in the thoracic spine (1). The true prevalence of thoracic disc herniation and related pathologies is likely to be determined with increased use of advanced imaging devices such as MRI (37).

![Figure 8.7](image1.png)  
**Figure 8.7.** A hyperflexed T7 creates an anterior position of the thoracic curve above.

![Figure 8.8](image2.png)  
**Figure 8.8.** Herniation of the T9 intervertebral disc. A slight retrolisthesis is also detected at the affected level. There are annular protrusions at L1 and L2 with retrolisthesis of both segments.
Nerve root compromise from direct disc protrusion is uncommon in the thoracic spine because the intervertebral foramina are primarily level with the body rather than the disc. The limited movement of the thoracic spine also protects the neural elements by keeping their positions relatively constant (13). Because of the tremendous anterior compressive load at the central joint due to the kyphosis, protrusions of the disc tend to be posteriorly, affecting the cord rather than the nerve roots (13). Thoracic disc disease is usually associated with myelopathy.

A history of recent trauma may not be present because many patients with disc protrusions have a gradual onset of symptoms (38). Thoracic disc protrusion with myelopathy tends to produce lower extremity and lower GI tract disorders (13). Paraplegia is often present with lower thoracic disc herniation. Magnetic resonance imaging or computerized tomography scan should confirm the diagnosis.

Initially, the patient should receive conservative management. The area of involvement should be tested by preloading the joint (bring to tension). If neurologic signs or symptoms increase with the maneuver, the adjustment is less likely to be successful. As with all adjustments, the force should be as specifically directed as possible. If neurologic signs or bowel and bladder dysfunction increase, neurosurgical referral is warranted.

Thoracic Myelopathy

Thoracic myelopathy can be caused by disc disease as previously noted. Thoracic hyperkyphosis can also cause myelopathy by pressing the cord against the anterior canal wall. In extreme kyphosis, the dura mater may be stretched to the point of putting pressure on the posterior cord. Scoliosis rarely causes myelopathy, but traction in an attempt to straighten the spine may compromise the soft tissue within the cord. Halo-pelvic traction for kyphoscoliosis can compromise the brainstem (17). Thoracic myelopathy often manifests itself in lower extremity and lower gastrointestinal disorders (13).

Nerve Root Disorders

Nerve root compression or irritation can cause symptoms along the course of the involved spinal nerve. In the thoracic spine, radiculopathy commonly takes the form of intercostal pain. Brachial referral patterns can occur directly from thoracic subluxation or as a result of compensatory hypermobility in the cervical spine above. The lowest thoracic segments contribute to the cluneal nerve which can give rise to referral patterns along the iliac crests and lower back.

Herpes zoster or shingles is a disorder associated with the dorsal root ganglia. Nerve root irritation may make the peripheral nerve more susceptible to clinical infection with the herpes virus.

Horner’s syndrome is often associated with upper thoracic subluxation (36). This syndrome usually follows acceleration/deceleration injuries of the neck which stretch the sympathetic chain.

Scheuermann’s Disease

Scheuermann’s disease is not an osteochondrosis. The mechanism causing the condition is unknown, although trauma arresting growth plate development is one of many theories (39). The disease affects the growth plate of the vertebral body, especially at the anterior.

The typical profile is a male, age 13 to 17. Presenting clinical features include pain, fatigue, and increased thoracic kyphosis (24).

The characteristic radiographic signs are decreased anterior vertebral body height, increased thoracic kyphosis, and Schmorl’s nodes affecting at least three contiguous segments. There may also be limbus bones, decreased disc height, osteophytes, postural changes to the cervical and lumbar spine, and persistent venous channels (24).

Disc herniation, although rare, can occur with Scheuermann’s disease. The involved segment is usually at the area with the greatest kyphotic angulation. Spastic paraparesis and sphincter dysfunction are common sequelae. These patients should initially be managed by chiropractors, provided the neurologic signs are stable and not deteriorating. When the condition is chronic, an adequate trial of care is necessary. The results of surgery for this disorder are mixed (40–43).

Degenerative Joint Disease

Degenerative joint disease is progressive and noninflammatory. The most likely causes are repetitive microtrauma or a macrotraumatic event. The most common radiographic features include osteophytes, sclerosis, and disc space narrowing (Fig. 8.9A-B). Anterior narrowing of the disc is relatively common and may lead to an increased kyphosis. Anterior osteophyte formation can compress the sympathetic trunk (2). Costovertebral and costotransverse arthrosis, which usually occurs in the lower thoracic area, may cause pain and simulate an upper gastrointestinal disorder (24). Osteophytes are not seen on the left side of the anterior vertebral body. This is thought to be due to pulsations of the descending aorta (24). Treatment is directed to the fixed segment(s). Prevention or diminishment of this sequential process lies in early intervention (See Chapter 14). Unfortunately, children rarely report long-lasting symptomatology which would otherwise alert the doctor or parent that a chiropractic examination is in order.

Interscapular Pain

Interscapular pain of nonvisceral or nonmetastatic cause has often been referred to as benign (44). Bourne (45) sug-
gests that the term “benign” be discarded, because it has no other purpose than to reassure the patient that malignant disease has not been diagnosed. The patient does not consider the pain to be benign and is seeking relief for what can be severe and incapacitating symptoms. The pain is often described as dull, aching and continuous and is aggravated by coughing, sneezing, and deep breathing. A few patients may have hyperesthesia of radicular distribution (44). The pain may appear to be of rib origin to the novice clinician. Clinical observations and recent evidence (4) suggest that there is a primary spinal component. Bruckner et al. (4) found that 90% of patients with this disorder had intervertebral disc dehydration (determined with MRI) compared with only 13% of a control group. The finding of spinal tenderness was usually just above the level of disc pathology (4). The most tender area may be a hypermobile compensation. If multiple segments appear to be involved, at least initially, it may be wise to adjust the lowest tender level. Manipulating multiple segments in a nonspecific fashion will do little to help in determining the offending motion segment. Reliance on objective parameters such as skin temperature differentials and stress radiographic abnormalities is encouraged. Occupational factors, such as prolonged bending, are often related to chronic interscapular pain (46). If there is a “dishing” of the thoracic curve, it is wise to focus treatment just below the sectional deformity (35) (See Compensation Reaction).

**Spinal Stenosis**

Stenosis in the thoracic spine is not common, especially when compared with the cervical or lumbar regions. Narrowing of the thoracic spinal canal can be due to a variety of factors, such as trauma, disc herniation, hypertrophy of the posterior elements lining the canal, and tumor. The imaging system of choice for visualizing canal stenosis is MRI (47).

**Rheumatoid Arthritis**

Rheumatoid arthritis is not common in the thoracic spine. Corticosteroid treatments for patients with rheumatoid arthritis may result in iatrogenic disorders such as osteoporosis and compression fractures (24).

**Viscerosomatic Disorders**

Symptoms localized to the thoracic region can be referred from visceral organs. The pathways appear to be the sympathetic nervous system and appear to be associated with the embryologic neuromeres. Referring organs include the gallbladder, lungs, pancreas, heart, and kidneys.

If during the course of care, the patient responds poorly or if complaints continually return, there may be a viscerogenic referral pattern. In these cases, it is important to analyze for the subluxation based on objective criteria. If the signs of subluxation appear to not correspond with the magnitude or nature of the complaint, then further investigation or specialist consultation is warranted.

**Somatovisceral Disorders**

Musculoskeletal/neuromusculoskeletal disorders (e.g., subluxation) can cause symptoms similar to those caused by referral from malfunctioning visceral organs. Perhaps
the most common of these is the angina-like symptoms due to thoracic spinal problems. This has been called pseudocardiac disease (48) or cervicoprecordial angina (49,50). The condition may cause chest pain and left shoulder and arm pain. Thoracoabdominal radiculopathy can occur and may be confused with primary visceral pathology (51). Marinacci and Courville (52) studied this phenomenon in a group of patients suspected of having gallbladder or intestinal disease. One-half of the patients were operated on before the diagnosis of nerve root irritation was considered. For the management of patients with primary spinal pathology and concomitant visceral symptomatology or pathology, the reader is referred to Chapter 13.

EXAMINATION

The analysis of the thoracic spine begins with a history (53). Other than general health information, queries should include smoking, alcohol use, trauma, osteoporosis or other metabolic disorders, and current or past visceral disorders. These might have an effect on the evaluation of the thoracic spine. The patient may relate a specific traumatic event to the onset of symptomatology. In other cases, a more insidious nature may prevail. This is especially true of interscapular pain. The patient must be gownned or unclothed for the examination. This includes follow-up examinations as well, because subtle signs of injury such as skin texture changes (54), edema and erythema would go undetected.

Inspection

Symmetry and skin quality are first observed. Sagittal and coronal curvatures are noted as are shoulder heights and scapular position. The most common evaluation in the thoracic spine is a scoliosis check. Scoliosis in a child must be studied for progression (See Chapter 9). Scoliosis is often associated with a loss of the normal thoracic curve. A kyphoscoliosis may develop in some individuals. An extremely kyphotic thoracic curve, especially if it has progressed to a marked gibbus deformity, must be evaluated for fracture or underlying pathology such as osteoporosis. "Dishing" of the thoracic spine may indicate loss or reversal of the normal thoracic curve, but often the thoracic curve is normal or near normal and the overlying musculature is atrophied. Imbrication of the spinous processes may give a "dished" appearance to the thoracic spine.

Altered scapular position may indicate muscle weakness. Shoulder symmetry should be observed because asymmetry can indicate injury, scoliosis, congenital malformations, or handedness. Aberrant shape of the chest (e.g., pectus excavatum) may indicate other underlying pathology or anomaly.

Surgical scars should be noted. Coloration and skin quality are observed, since neurotrophic changes or pathology may alter quality and color. Lipomas and moles are often found in the thoracic region. They may direct the doctor to a vertebral subluxation level, if associated with a dermatomal or pattern distribution. Café-au-lait spots must be investigated if large or numerous, as they may indicate neurofibromatosus or fibrous dysplasia.

Range of motion is measured, noting pain and restriction. Interruptions in smooth bending motions (inflexion points) indicate fixation dysfunction or anomaly (See Chapter 4). The radiograph may be used to make the differentiation. Pain on passive motion is suggestive of joint or ligamentous sprain. Pain during resisted isometric motion is indicative of muscle or tendinous strain.

Thorax expansion is studied by comparing girths on full exhalation and full inhalation. Measurements are taken at the nipple-line. In males, there should be a change of at least 1¾ to 2½ inches; in females, 1 to 1½ inches. Lesser values may indicate ankylosing spondylitis and costotransverse or costovertebral articulation ankylosis or pulmonary dysfunction (55,56)

Instrumentation

A paraspinal skin temperature differential instrument (e.g., Nervoscope) can be used to scan the thoracic spine for temperature asymmetries. Plaugh et al. (57) found good reliability for the Nervoscope in the thoracic spine (i.e., T4-T8) both between examiners and during test-retest. This study used 19 relatively pain-free females as subjects. Because static radiologic findings are often equivocal in the thoracic spine, more weight is given to the findings of temperature analysis and palpation in this region. The glide speed for a Nervoscope should be approximately two inches per second (35) (See Chapter 4) and the instrument is moved in a caudal direction during the scan.

Static Palpation

The thoracic spine should be palpated for tenderness and edematous “pitting” in the interspinous area and over the transverse process (See Chapter 4). The lowermost tender thoracic spinous is often the level of involvement (26). Tenderness can be elicited by applying pressure to the spinous tip, followed by continued pressure over the upward length of the process. Pain arising in any particular segment of the thoracic spine is much more precisely localized than is the case with the upper and lower regions of the spinal column. This is due to the lack of large numbers of intersegmental neurologic connections as seen in the cervical and lumbar spine (18).

Compensatory areas often have associated musculature alterations that are tight and rope-like. The area or site of subluxation, in contrast, is usually more edematous and flaccid on palpatory assessment.

Rubbing over the area of the subluxation often pro-
duces a persistent hyperemia (red response). If hyperemia is asymmetrical or persists for an abnormally long period of time, then this may indicate underlying autonomic dysfunction in the area (58). Skin texture should be noted. Texture and color changes may indicate neurotrophic (e.g., trophedema) (See Chapter 3) or other pathologic changes.

Subdermal masses, such as lipomas or cysts, can be readily palpated. Palpation of the paravertebral musculature can detect spasm, tonic changes, etc.

Osseous anomalies, such as deviated spinous processes, may be visualized and palpated, as can vertebral landmarks, such as the typically prominent spinous processes of T1, T4, and T10. These will aid in vertebral count. The T9 spinous process is usually very small. The doctor should correlate the palpation examination with the AP neutral upright radiograph. Projectional distortion of the radiograph must always be accounted for (See Chapter 5). Active “trigger points” in the paravertebral myofascial tissues should be noted.

Motion Palpation

The main purpose of motion palpation is to detect fixation dysfunction. Unless a fracture is present (See Chapter 12), an adjustment is not given unless there is fixation of the motion segment. Hypermobilities, which appear to be due to direct injury, pathology, or as a compensatory reaction, are usually not distinguishable from normal segments, unless extreme. Stress radiography is useful in identifying hypermobile or normal motion segments (Fig. 8.10).

The doctor should motion palpate flexion and extension, lateral flexion, rotation and coupled extension, lateral flexion, and rotational movements. In flexion and extension, interspinous separation and approximation are detected. The upper thoracic spine is usually evaluated by extreme extension of the cervical spine or the patient elevating and crossing the arms and the examiner raising and lowering them while digitally evaluating the interspinous space closure and opening. Lateral flexion is palpated by pushing the spinous process opposite from the side of passive lateral flexion. Rotation and coupled movements are usually determined by applying digital pressure against the spinous or transverse processes (35,59).

Orthopaedic Tests

Adam’s sign is a test to differentiate structural from functional scoliosis (See Chapter 9). If pain and restriction are present, this test should be followed by tests for intervertebral disc syndrome. Adam’s test is performed standing,
sitting, or kneeling. Lateral curvatures and rib cage asymmetries are noted in the upright position. The patient then flexes forward. If the curvature straightens, the scoliosis is considered functional. If it persists, it is structural.

Beevor’s sign is a test for nerve root lesions. The patient lies supine with fingertips interlocked behind the head. The patient attempts to flex the head toward the feet. If the umbilicus moves cephalically, there may be a T10-T12 nerve root lesion. If the umbilicus moves caudally, there may be a T7-T10 nerve root lesion (55). A positive test may occur in patients with poliomyelitis or meningocele.

The Soto-Hall test was originally developed for cervico-thoracic fractures. The patient is supine. The examiner places one hand under the occiput and the other stabilizes the chest. The examiner passively flexes the head toward the sternum. Localized pain may indicate osseous or ligamentous injury (55,56).

If firm spinous percussion or placing a tuning fork on the spinous results in an increase in pain, a fracture is suspected. Tuning fork examination is also used if a rib fracture is a possibility. Compression tests should accentuate the pain from a rib fracture.

Neurologic Tests

Muscle stretch or deep tendon reflexes are not typically evaluated for thoracic root levels, but lumbar reflexes should be tested as pathology in the thoracic spine may affect these (60). Dermatomal evaluation can be done with an open pin, cotton wisp for light touch, hot and cold objects for temperature, or tuning fork for vibratory sense.

Infrared or telethermography is useful in identifying sensory-autonomic alterations (61).

Plain Film Radiography

The 14” x 36” anteroposterior and lateral full spine radiograph usually provides an adequate view of the thoracic spine with the proper filtration and high speed (e.g., 1200) screens. The two exposure lateral film usually has its cutoff point at the T9-T11 levels (35). Great care must be taken during the exposures to ensure that all segments are visualized (See Chapter 5). The single exposure lateral full spine is preferred, although facility limitations pertaining to the necessary film focal distance precludes widespread usage. The upper thoracic region is frequently difficult to penetrate, and a spot view, such as a “swimmer’s” projection or other imaging modalities, such as tomography, may be required if osseous pathology or fracture is suspected.

Positional dyskinesia of the thoracic spine is often difficult to visualize on the lateral film. Not typically detected is the obvious posterior inferior malposition seen in the cervical or lumbar spine. Because of the rib cage, the kyphosis and the orientation of the apophyseal joints, positional dyskinesia tends to be posterior and superiorward (i.e., hyperflexion) (35).

Global thoracic lateral flexion views are helpful in evaluating the subluxation. If lumbar lateral flexion is included, visualization of normal and abnormal motion is more complex. The T6 motion segment is considered the transition area between the coupled motion of spinous rotation to the concave side in the lower thoracic and the coupling of spinous rotation to the convex side in the upper thoracic spine (Fig. 8.11A-C) (See Chapter 2). When the thoracic spine is isolated, the spinous processes of the entire region should rotate to the convex side of bend (31,62).

The listing is derived primarily from the results of stress radiographic analysis and the neutral AP radiograph (Fig. 8.12A-B). Radiopaque markers can be used to help locate the dysfunctional motion segment (Fig. 8.13). The authors have provided several studies of the thoracic spine in lateral bending. This should provide the reader with an appreciation of the complex biomechanics of the region (Figs. 8.14–8.16). The examiner should note the presence of lateral flexion (or lack of) toward the side of bend. The spinous process should rotate toward the convexity of bend. The adjustment is designed to restore the main motion of lateral bending as well as coupled motions.

Visualization of rib fractures is often difficult, especially if there is recent injury. Expert consultation may be warranted in these cases.

Special Procedures

Certain suspected pathologies, or nonresponse, or deterioration after treatment may require additional investigation, such as visceral palpation, MRI, CT scan, thermography, laboratory tests, sonograms, somatic evoked potential tests, electromyelography, and nerve conduction velocity tests. Magnetic resonance imaging is best used for soft tissue evaluation, whereas computerized tomography is superior for osseous tissue analysis, such as canal size or bone pathology. These ancillary procedures are especially important if extraspinal or visceral disorders are suspected. In certain cases, the mental status may need to be evaluated for functional overlays. Referral to a clinical psychologist is warranted for these patients.

THORACIC ADJUSTMENT

The segmental contact points for adjusting the thoracic spine are the spinous process and the transverse process. Spinous contact on the imbricated segments (e.g., T5-T9) is the uppermost portion of the spinous, immediately subjacent to the next cephalic vertebra (See Figure 8.3). This contact is used to direct the thrust as close to the vertebral body as possible.
Figure 8.11. A, Neutral AP radiograph. B, Left lateral bending. Relatively normal motion is present. The spinous coupling motion is to the convexity of bend. C, Right convexity present on the neutral radiograph demonstrating marked fixation dysfunction in right bending. This restriction causes the patient to recruit the upper lumbar spine for right bending. When the lumbar spine is lateral flexed with the thoracic spine, the spinous processes will rotate to the concavity of bend at the lower levels.

Figure 8.12. A, Left lateral bending. Below T6 there is marked fixation dysfunction. B, Right lateral bending. T6 and T7 demonstrate fixation dysfunction. Relatively normal motion is present above and below these levels. C, Neutral AP of the patient in A and B. T9 is listed as PLS. The positional dyskinesia of the segment should be verified with radiographs in lateral bending.
The primary adjustment is the single hand contact prone or knee chest adjustment. The contact hand is the superior or cephalic hand and the driving hand is the inferior or caudal hand for the lower and middle thoracic spine. For the upper three or four thoracics, contact is made with the inferior hand. The thrust is from posterior to anterior (+Z), in an arcing motion through the plane line of the facets and disc (See Figure 8.3).

The thumb-pisiform contact may be used rather than the pisiform, especially if more specificity is needed. The double-thumb contact is usually made on the spinous process but can be used for transverse process contacts as well (See Chapter 14).

The double thenar contact is used for both transverse processes. The thrust is made through only one thenar however.

For the single hand contact, the driving hand is placed over the contact hand. If the pisiform is used, the pisiform on the driving hand is typically placed over the fossa. An alternative is to use a loose fist with the second phalanges flat over the dorsum of the hand and the second interphalangeal joint of the first finger overlying the pisiform of the contact hand.

When subluxations are adjusted using the transverse processes as levers, a spinous contact may need to be used a few times to complete correction. The adjustment using a single transverse process contact, in some cases, may not be sufficient to reduce the posteriority of the segment.

The upper two or three thoracic vertebrae may be adjusted in the cervical chair (See Chapter 10). The most common tables used for adjusting the thoracic spine are the hi-lo, pelvic bench, slot (See Chapter 7), and the knee chest. The more kyphotic the patient, the easier it is to perform adjustments on the slot table, pelvic bench, or hi-lo. A person with a more lordotic or flat kyphosis will be more easily adjusted in the knee-chest position (26).

**Hi-lo Table**

When using the hi-lo table, the contact point is as noted above. Typically, the chest piece is unlocked and at its most stiff position. Anterior excursion of the thoracic spine can be attained by having the doctor place a knee on

![Figure 8.13](image)

Figure 8.13. T7 is listed as PI-Ht. The right pedicle is larger than the left. This is compared with the pedicle shapes and position of the segment below. It is important to analyze the positional dyskinesia in a relative fashion (i.e., compared to the subjacent vertebra). Notice the radiopaque marker where a skin temperature differential was detected.

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**Figure 8.14.** A. Left lateral bending. The reader is encouraged to review each segmental level. An appreciation for the complexity of movements that are possible should follow. It is seems unlikely that these subtle aberrations can be accurately palpated. B. Right lateral bending. T5-T8 show marked restriction in right bending. Notice the compensatory hyper lateral flexion at T3, and to a lesser extent, T4.
the abdominal piece to lower it. The patient should be questioned regarding chest and throat region comfort.

**Pelvic Bench and Slot Table**

Adjustments and positioning are similar to the hi-lo table. Because the thoracic cage is compressed against the table, the added resistance may require a proportional increase in force. This is done primarily by increasing the acceleration of the thrust. The upper and middle thoracic spine especially can be adjusted on this table (Fig. 8.17A-B). A variety of hand and segmental contacts may be used. For straight posterior listings, double transverse process contacts can be used. This variation may be helpful if there is marked tenderness over the spinous process. Double-thanar, double-pisiform and pisiform-thanar hand placements are often used. If a single transverse contact is called for, a pisiform or rarely, thenar, may be used. The patient should be questioned regarding chest and throat region comfort before the adjustment is made.

**Knee Chest Table**

Contraindications for the knee-chest table include inability of the patient to relax in this position and failure to use a set-hold characteristic for the adjutive thrust (63). In

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**Figure 8.15.** A, Left lateral bending. The reader is encouraged to review each level for lateral flexion (or lack of) and the normal coupling pattern of spinous rotation to the convexity of bend. B, Right lateral bending. The reader is encouraged to review each level for lateral flexion (or lack of) and the normal coupling pattern of spinous rotation to the convexity of bend.

**Figure 8.16.** A, Left lateral bending. The reader is encouraged to review each level for lateral flexion (or lack of) and the normal coupling pattern of spinous rotation to the convexity of bend. B, Right lateral bending. The reader is encouraged to review each level for lateral flexion (or lack of) and the normal coupling pattern of spinous rotation to the convexity of bend.
the prone position on a typical flat table, use of a posterior to anterior thrust applies compression to the rib cage. The resultant reactive force from the rib cage is counterproductive to posterior to anterior adjustments. The unrestricted torso posture in the knee-chest position allows greater flexibility of the spine during the adjustment; therefore, relatively less force is needed to accomplish vertebral movement.

The patient set-up for a thoracic adjustment is quite similar to that of the lumbar spine. The headpiece is kept at a slight angulation with the most cephalad portion slightly higher while trying to maintain the lower thoracic spine at the approximate height of the upper spine. The doctor faces perpendicular to the long axis of the patient (Fig. 8.18).

Name of technique: Gonstead

Name of technique procedure: PRS \((-\theta Z, +\theta Y, -\theta Z)\) T12 Knee Chest Pisiform Contact Adjustment (Fig. 8.19).

Indications: Retrolisthesis of T12 with decreased \(+ Z\), \(-\theta Y\) and \(+\theta Z\) motions.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the neural arch or spinous process, infection of the contact vertebra.
Patient position: The patient should be positioned on the knee-chest table so that the thoracic spine is slightly higher than the lumbar spine. There should be a slight incline on the chest support to allow for anterior expansion of the thoracic spine when the posterior to anterior (+Z) thrust is given. The knees should be placed so that the femurs are nearly perpendicular to the floor (See Chapter 7) to accommodate the anterior movement of the stomach.

Doctor's position: Standing on the right side of the patient.

Contact point: The posterior, inferior and right lateral border of the spinous process of T12 is contacted with the cephalad (right) pisiform.

Supporting hand: Placed over the contact hand.

Pattern of thrust: Posterior to anterior (+Z), with a quick arcing motion (+θX) at the beginning of the thrust. This is especially important at the thoraco-lumbar junction because extension of the segment will be painful for the patient. Lateral to medial (−θY), with an inferiorward arcing motion (+θZ) toward the end of the thrust.

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: PRI-t (−Z, +θY, +θZ) T9 Knee Chest Pisiform Contact Adjustment (Fig. 8.20).

Indications: Retrolisthesis of T9 with decreased +Z motion and decreased −θY and −θZ motion.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the neural arch or transverse process, infection of the contact vertebra.

Patient position: The patient should be positioned on the knee-chest table so that the thoracic spine is slightly higher than the lumbar spine. There should be a slight incline on the chest support to allow for anterior expansion of the thoracic spine when the posterior to anterior (+Z) thrust is given. The knees should be placed so that the femurs are nearly perpendicular to the floor (See Chapter 7) to accommodate the anterior movement of the stomach.

Doctor's position: Standing on the side of spinous laterality (R) directly over T9 reaching across the spine to the transverse process being adjusted. The patient is further stabilized with the doctor's knees.

Contact point: Left transverse process of T9 with the right pisiform.

Supporting hand: The left pisiform is placed over the contact hand.

Pattern of thrust: Posterior to anterior (+Z), lateral to medial, with an inferiorward arcing motion toward the end of the thrust (−θZ).

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: PRI-t (−Z, +θY, +θZ) T8 Knee Chest Thumb-Pisiform Adjustment (Fig. 8.21).

Indications: Retrolisthesis of T8 with decreased +Z motion and decreased −θY and −θZ motion.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the neural arch or transverse process, infection of the contact vertebra.
Patient position: The patient should be positioned on the knee-chest table so that the thoracic spine is slightly higher than the lumbar spine. There should be a slight incline on the chest support, to allow for anterior expansion of the thoracic spine when the posterior to anterior (+Z) thrust is given. The knees should be placed so that the femurs are nearly perpendicular to the floor (see Chapter 7) to accommodate the anterior movement of the stomach.

Doctor’s position: Standing on the right side of the patient.

Contact point: The posterior, inferior and right lateral border of the spinous process of T8 is contacted with the cephalad (right) pisiform.

Supporting hand: Placed over the contact hand.

Pattern of thrust: Posterior to anterior (+Z), with a quick arcing motion (+θX) at the beginning of the thrust. This is especially important at this level due to the imbrication of the spinous processes. Lateral to medial (−θY), with an inferiorward arcing motion (−θZ) toward the end of the thrust.

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: PRS (−Z, +θY, −θZ) T8 Knee Chest Pisiform Contact Adjustment (Fig. 8.22).

Indications: Retrolithesis of T8 with decreased +Z, −θY and +θZ motions.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the neural arch or spinous process, infection of the contact vertebra.

Patient position: The patient should be positioned on the knee-chest table so that the thoracic spine is slightly higher than the lumbar spine. There should be a slight incline on the chest support to allow for anterior expansion of the thoracic spine when the posterior to anterior (+Z) thrust is given. The knees should
be placed so that the femurs are nearly perpendicular to the floor (see Chapter 7) to accommodate the anterior movement of the stomach.

Doctor’s position: Standing behind the patient.

Contact point: Spinous process of T8. The thumbs are placed on the lateral, posterior, inferior borders of the spinous process.

Supporting hand: Not applicable.

Pattern of thrust: Posterior to anterior (+Z), with a quick arcing motion (+90X) at the beginning of the thrust.

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: PRS (-Z, +θY, -θZ) T4 Knee Chest Pisisform Contact Adjustment (Fig. 8.24).

Indications: Retrolisthesis of T4 with decreased +Z, -θY and +θZ motions.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the neural arch or spinous process, infection of the contact vertebra.

Patient position: The patient should be positioned on the knee-chest table so that the thoracic spine is slightly higher than the lumbar spine. There should be a slight incline on the chest support to allow for anterior expansion of the thoracic spine when the posterior to anterior (+Z) thrust is given. The knees should be placed so that the femurs are nearly perpendicular to the floor (see Chapter 7) to accommodate the anterior movement of the stomach. The stabilization strap for the head may be used for this adjustment.

Doctor’s position: Standing on the right side of the patient.

Contact point: The posterior, and right lateral border of the spinous process of T4 is contacted with the cephalad (right) pisisform. The hand will cross the spine.

Supporting hand: Placed over the contact hand.

Pattern of thrust: Posterior to anterior (+Z), lateral to medial (-θY), with an inferior forward arcing motion (+θZ) toward the end of the thrust.

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: PLI-t (-Z, -θY, -θZ) T3 Knee Chest Pisisform Contact Adjustment (Fig. 8.25).

Indications: Retrolisthesis of T3 with decreased +Z motion and decreased +θY and +θZ motion.
Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the neural arch or right transverse process, infection of the contact vertebra.

Patient position: Knee-chest position. The upper thoracic spine should be slightly higher than the rest of the spine.

Doctor’s position: Facing the patient’s right side, provided the patient is stable in this position.

Contact point: Right transverse process of T3 with a soft pisiform contact. The contact hand does not cross the spine.

Supporting hand: The left hand is placed on top of the right.

Pattern of thrust: Posterior anterior (+Z) with a clockwise torque (+θZ) toward the end of the thrust.

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: PRS (−Z, +θY, −θZ) T1 Knee Chest Pisiform Contact Adjustment (Fig. 8.26).

Indications: Retrolisthesis of T1 with decreased +Z, −θY and +θZ motions.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the neural arch or spinous process, infection of the contact vertebra.

Patient position: The patient should be positioned on the knee-chest table so that the thoracic spine is slightly higher than the lumbar spine. There should be a slight incline on the chest support to allow for anterior expansion of the thoracic spine when the posterior to anterior (+Z) thrust is given. The knees should be placed so that the femurs are nearly perpendicular to the floor (see Chapter 7) to accommodate the anterior movement of the stomach. The stabilization strap for the head should be used for this adjustment (not shown).

Doctor’s position: Standing on the right side of the patient.

Contact point: The posterior, and right lateral border of the spinous process of T1 is contacted with the caudal (left) pisiform. The hand will cross the spine.

Supporting hand: Placed over the contact hand.

Pattern of thrust: Posterior to anterior (+Z), lateral to medial (−θY), with an inferiorward arcing motion (+θZ) toward the end of the thrust.

Category by algorithm: Short lever specific contact procedure.

Cervical Chair

The first two or three thoracics may be adjusted in a manner similar to the cervical spine. The wrist is kept fairly neutral as there is less of the radial flexion used in the thrust. The thrust tends to be more from the shoulder. The contact point with the distal end of the first finger is the inferior tip of the spinous process or the transverse process as determined by the listing.

Name of technique: Gonstead

Name of technique procedure: PRI-t (−Z, +θY, +θZ,) T2 Cervical Chair Adjustment (Fig. 8.27).
Indications: Retroisthesis of T2 with decreased +Z motion and decreased −θY and −θZ motion.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the neural arch or left transverse process, infection of the contact vertebra.

Patient position: Seated in the cervical chair. The stabilization strap should be over the right shoulder unless the patient is of a heavier build.

Doctor’s position: Standing behind the patient, favoring the left side.

Contact point: Palmar surface of the left distal phalanx of the index finger placed on the spinous lamina junction of T2 vertebra. The middle finger should be directly adjacent to the index finger to give the index finger stability. The contact hand (L) is stabilized by placing the thumb (not shown) on the ramus of the mandible or the sternocleidomastoid muscle (if the doctor’s hand is too small). When the contact hand is properly placed, an arch is formed by the lateral position of the thumb and index finger.

Supporting hand: The right hand is placed so that the palmar surface supports the cervical spine. This will bring the thenar eminence on the sternocleidomastoid muscle and the thumb facing anterior and inferior at a 45° angle. The stabilization should attempt to restrict movement of the foundation for the adjustment (i.e., T3) and segments above the level of subluxation. The illustration shows the doctor stabilizing the head with his chest and stabilization of the middle and upper neck. No thrust, especially posteriorward, should be made with the supporting hand.

Pattern of thrust: Posterior to anterior through the plane line of the disc, slightly medialward, with an inferiorward arcing motion toward the end of the thrust.

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: PLS (−Z, −θY, +θZ,) T2 Cervical Chair Adjustment (Fig. 8.28).

Indications: Retroisthesis of T2 with decreased +Z motion and decreased +θY and −θZ motion.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the neural arch or spinous process, infection of the contact vertebra.

Patient position: Seated in the cervical chair. The stabilization strap should be over the right shoulder unless the patient is of a heavier build.

Figure 8.28. T2 PLS cervical chair adjustment.

Doctor’s position: Standing behind the patient, favoring the left side.

Contact point: Palmar surface of the left distal phalanx of the index finger placed on the left posterior portion of the spinous process. The middle finger should be directly adjacent to the index finger to give the index finger stability. The contact hand (L) is stabilized by placing the thumb (not shown) on the ramus of the mandible or the sternocleidomastoid muscle (if the doctor’s hand is too small). When the contact hand is properly placed, an arch is formed by the lateral position of the thumb and index finger.

Supporting hand: The right hand is placed so that the palmar surface supports the cervical spine. This will bring the thenar eminence on the sternocleidomastoid muscle and the thumb facing anterior and inferior at a 45° angle. The stabilization should attempt to restrict movement of the foundation for the adjustment (i.e., T3) and segments above the level of subluxation. The illustration shows the doctor stabilizing the head with his chest and stabilization of the middle and upper neck. No thrust, especially posteriorward, should be made with the supporting hand.

Pattern of thrust: Posterior to anterior (+Z) through the plane line of the disc, medialward (+θY), with an inferiorward arcing motion (−θZ) toward the end of the thrust.

Category by algorithm: Short lever specific contact procedure.

Rib Adjustments

A rule of thumb for adjustments from the posterior is to adjust the upper half of the rib cage lateral to medial and
superior to inferior; the lower half is adjusted somewhat medial to lateral and inferior to superior. The contact point is the rib just lateral to the spine, and a light, quick thrust is used. Occasionally, the contact is the anterior rib at the costochondral junction (See Chapter 16). Rib subluxations are typically found by palpation. An awareness of the condition of the ribs is important before adjusting one, and the rib should be adjusted only after reduction of spinal subluxations has failed to reduce the fixation or symptoms.

**ADJUNCTIVE THERAPIES**

Additional therapeutic procedures are used as necessary to aid in the reduction of the thoracic subluxation complex. In acute cases, ice may be used. It must be removed when the area feels numb (usually one half hour). Exercises, especially in extension, and postural maneuvers designed to restore normal patterns of motion, may be beneficial. These need to be individually designed to offer optimal biomechanical efficiency. Nutritional support may be necessary, especially in trauma cases requiring repair of damaged tissues. In certain cases of instability, especially in a patient engaged in physical activity that adversely affects the thoracic spine, a back support may be required.

In cases where physical activities exacerbate the thoracic spine subluxation complex, activity retraining to biomechanically efficient activity or even abandonment of the patient's particular occupation or recreational activities may be required. In some acute cases, short-term use of appropriate electrotherapeutic modalities can be beneficial for some patients who otherwise may be unresponsive to care.

In cases of nonresponse or worsening of the condition, referral to another chiropractor, such as one versed in a particular adjunctive technique or specializing in internal disorders, neurology, radiology, or orthopaedics, or a medical specialist may be required, particularly in light of the intimate connection between the viscera and the thoracic spine.

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Hippocrates first described the type of deformity whereby the spine deviates laterally; however, it was Galen (A.D. 131–201) who actually coined the term *scoliosis*. Galen also created the terms lordosis and kyphosis to describe postural deviations in the sagittal plane. Today, *scoliosis* is defined as being an appreciable lateral curvature of the spine in the coronal plane. Most authors consider a deviation greater than 10° (Cobb's method) to be a scoliosis, and a curve less than 10°, a convexity. This chapter will provide a literature review of scoliosis, especially scolioses afflicting the adolescent, classifications of curvatures, and, treatment and management strategies that may prove beneficial for this often crippling disorder.

**BACK PAIN**

Back pain associated with adolescent scoliosis appears not to have a higher incidence than the population of adolescents as a whole; however, adult scoliotic patients do seem to have a higher incidence of back pain (1). With age, many curvatures progress, albeit slowly, possibly explaining the higher incidence of back pain in adult scoliotics.

**VISCERAL DISTURBANCES**

It has been hypothesized that scoliosis is associated with visceral disturbances (2). The osteodegenerative changes that occur around the nerve roots in patients with scoliosis may affect visceral function through somatovisceral reflexes. Whether scoliotic individuals have higher incidences of visceral pathology has not yet been determined. Severe curvature, however, especially in the thoracic spine, has been associated with cardiac and pulmonary complications caused by compression of the lungs and vessels of the heart (3,4).

**EARLY DEATH**

Autopsy studies have revealed an interesting correlation between severe curvature and the average age of death. More severe curvature is related to earlier death. Moreover, the mean age of death (30–50 years) was especially correlative if the curves had started during adolescence (5–7).

In the long-term, patients with scoliosis show a marked increase in mortality, with the cause of death in 60% of cases being cardiopulmonary complications (8).

Another long-term follow-up study (9) revealed similar results with a population of severe scoliotics. It is noted, however, that no radiographs were obtained during this study; therefore, the exact amount (degree) of curvature was not determined. It was concluded that the mortality rate of a patient with a severe scoliosis (> 80°) is well over 100% when compared with the general population. Thoracic, congenital and neurogenic scoliosis were found to have a worse prognosis when compared with the idiopathic, rachitogenic or poliomyelitic types of scoliosis. Nachemson's study (9) revealed the cause of death in 80% of cases to be kyphoscoliotic cardiopathy with cor pulmonale.

**COSMETIC DEFORMITY**

Scoliosis is also an obvious cosmetic deformity that may have an effect on the personality of the individual. Specific psychological disorders or behaviors associated with scoliosis are not known. In one study (8) it was noted that 76% of the females involved in the investigation did not marry.

**ETIOLOGY**

There are many different causes for scoliosis. Most authors identify scoliosis as a multifactorial disorder involving mostly genetic and growth factors. It has been estimated that 80% of all scolioses have no singular identifiable cause (10). Idiopathic scoliosis is the major focus of this chapter.

**Structural vs. Functional**

Structural scolioses are those that remain in a curved position during forward bending. Nonstructural or functional scolioses are those curves that remit or improve during forward bending. Functional scolioses are commonly associated with leg length inequality. Lateral bending should improve a functional curve, whereas, in using the same movement, a structural curve will remain. There may be levels of the functional curve, however, which will exhibit some asymmetry of motion due to the beginning effects of ligamentous creep at the motion segment. Although the adolescent idiopathic scoliosis is commonly referred to as a structural curve, this may not be the case during the beginning stages of the disorder. A functional