Knowledge gained from studying the spinal column in sections is inherently weak. The spine exists and functions as one integrated whole, one area of the spine often being affected by other more distant regions. Similarly, the spinal column and pelvis are supported and acted on by the lower and upper extremities, thus influencing them in diverse and complex interactions.

The lumbar spine is unique for a variety of reasons. Because each region of the spine supports the weight of the body in increasing amounts as one moves caudal, the lumbar column is especially susceptible to extreme axial loads and external bending torques or moments. This may be the reason there is an increase in lumbar spinal dysfunction among truck drivers and hard laborers (1,2). The lumbar spine is a point of transfer of forces from the strong bony pelvis to the flexible axial motion segments.

As with the more caudal structures of the body, dysfunction in the lumbar spine will have direct mechanical reactions in the joints above, a continuation of the foundation principle discussed in Chapter 6. This is the reason a pronated foot can influence pelvic list and the posture of the torso, or an increase in the lumbar lordosis with hyperextension of the upper lumbar motion segments, may reduce the cervical lordotic curve (Fig. 7.1).

This chapter covers the dysfunction and management of disorders afflicting the vertebral joints of L1 to S1. The mechanical lesion is emphasized, although some attention is given to organic and visceral conditions that may impact on the decision making processes of the astute clinician. A few aspects of the clinical anatomy and biomechanics of the lumbar spine are presented here. This subject, however, is covered in more detail in Chapter 2, which the reader is encouraged to review before proceeding. The pathomechanics of the lower spine and its relationship to the vertebral subluxation complex is covered. The chiropractic management of mechanical disorders of the low back is thoroughly discussed.

**CLINICAL ANATOMY AND BIOMECHANICS**

**Central Joint**

The central joint is composed of two vertebral bodies, their associated end-plate structures and their common intervertebral disc, which is composed of the annulus fibrosis and the nucleus pulposus.

**END-PLATE**

The hyaline cartilage end-plate acts as the transition zone from vertebra to disc. Rather than herniate the intervertebral disc, a compressive overload will fracture the end-
plate. Fractures of this structure are one of the most common findings on cadaver dissection (3). Callous formation in the area after injury will inhibit diffusion of nutrients to the avascular disc, thus leading to degeneration. Compression overload, causing fracture and eventual degeneration of the soft tissue elements with bone proliferation, can lead to central canal stenosis. Instability is rare however, unless it is combined with torsional injuries of the annulus.

ANNULUS FIBROSIS

The annulus is composed of concentric lamellae that tend to resist various loads applied to the motion segment. There is great resistance to compression and shear. Resistance to flexion and extension is also high. Because of the anisotropic properties of the annulus (See Chapter 2) however, it cannot resist all loads in an equal manner. Applications of axial torque will tend to compromise the annular fibers, especially if they are distracted, as happens in the forward bent position. Micro-failure of the annulus begins to occur at approximately 3° of axial rotation. Torsional loads will affect the posterior joints as well, leading to synovitis and degeneration. With time, torsional injuries can cause instability of the motion segment.

NUCLEUS PULPOSUS

The nucleus pulposus has a high water content that tends to decrease with age. In the nondegenerated disc, the nucleus is a highly pressurized structure that will deform when loaded. When compressed, the nucleus will bulge peripherally transferring forces to the annulus. During forward flexion, the nucleus bulges posteriorly.

The disc’s ability to swell is great in the lumbar spine. In the degenerated disc, where it is difficult to differentiate the annulus from the nucleus, the disc’s ability to swell is reduced. Schmorl’s nodes are a result of nuclear protrusion into the end-plate from compressive overload.

Disc Pressure

The pressure within the intervertebral discs of the lumbar spine has been studied by Nachemson (4). Table 7.1 demonstrates the different forces that develop within a lumbar L3 disc during different activities and postures. This table is of help in managing the patient who has disc trauma because certain activities will most likely cause further injury. It must be kept in mind however, that these measurements are taken with the subject in a quasistatic position. This may not be reflective of how pressures would develop in a person executing a dynamic lift (See Chapter 2). Nonetheless, they are important for understanding relative differences in disc pressure.

| Table 7.1. Approximate Load on the L3 Disc in a 70-kg Subject* |
|---------------------------------|-----------------|
| Position or Activity | Newtons of Force (N) |
| Supine, traction of 500 N | 0 |
| Supine, semi-Fowler position | 100 |
| Supine | 250 |
| Supine, tilt table at 50° | 400 |
| Sitting, with lumbar support, 110 degree inclination | 400 |
| Supine, arm exercises | 500 |
| Standing, at ease | 500 |
| Coughing | 600 |
| Straining | 600 |
| Forward bend, 20° | 600 |
| Upright sitting, without support | 700 |
| Bilateral leg lift | 800 |
| Forward bend, 40° | 1000 |
| Forward bend, 20° while holding 20 kg | 1200 |
| Sit-up exercises | 1200 |
| Lifting 10 kg with back straight and knees bent | 1700 |
| Lifting 10 kg with back bent | 1900 |
| Holding 5 kg with arms extended | 1900 |
| Forward flexed and rotated 20° while holding 10 kg | 2100 |


Posterior Joints

ORIENTATION

The anatomy of the facet joints is important in understanding the biomechanical function of the three joint complex. Dysfunction at the posterior joints usually occurs secondary to, or simultaneously with injury at the central joint (5). The zygapophyseal joints are richly innervated with pain fibers (6) and can be a source of pain if inflammation is present, or a synovial fold becomes entrapped between the two facet surfaces.

Radiographic methods have been used to determine the spatial orientation of the lumbar facet planes. The AP radiograph is helpful in determining the facet planes but the CT scan is preferred, because of its cross sectional capability. From L1 to L4 the facets are “J” shaped. Posteriorly, they begin in the sagittal plane while turning medialward at the anterior (Fig. 7.2A). This configuration limits Y axis rotation (7) and provides some resistance to anterior shear. At L5-S1 the facets can best be described as being in the coronal plane. This orientation is present to counteract the tremendous anterior shear component at that level (Fig. 7.2B).

Although the facet orientation at L5-S1 would seem to allow more rotation around the Y axis, this is controlled by the strong iliolumbar ligaments that tend to inhibit the amount of Y axis rotation the joint actually undergoes. The maximal amount of axial rotation (Y axis) is approximately 1° to each side at L1 through L4 and 2° in each direction at the lumbosacral junction (8). Keep in mind, however, that this is axial rotation of joints without posterior displacement. When a large amount of retrolis-
thesis is present, as is often the case in a torsionally injured lumbar spine, the subsequent separation of the facets allows more intersegmental axial rotation to occur. Correction of the axially rotated segment with an adjustment often will not occur if the doctor fails to consider the posterior displacement.

TROPISM

The incidence of asymmetry of the articular processes is quite high. In their investigation, Ho and Chace (9) report that asymmetries in at least one lumbar spine facet occurred in 58% of the subjects tested. The asymmetry is lowest at L1. The total asymmetrical frequency rises in the lower segments, reaching a peak at L4 and then decreasing at L5. Hagg and Wallner (10) similarly found a high incidence of facet asymmetry, occurring in about 50% of patients with lumbar disc herniation.

Farfan and Sullivan (11) report an apparent correlation between facet joint asymmetry and dysfunction of the intervertebral disc. The more oblique facet often is associated with the side of sciatica in patients presenting with radicular pain into the lower extremity. The study by Hagg and Wallner (10), however, found no correlation between the side of asymmetry and protrusion of lumbar intervertebral discs.

The high incidence of facet asymmetry illustrates the importance of analyzing the kinematic behavior of the motion segment from a structural standpoint. Any examination that analyzes lumbar spine motion, radiographic or palpatory, must be supplemented with a static antero-

Figure 7.2. A, Facet planes of the lumbar spine. Horizontal (X-Z) plane. B, Frontal (X-Y) plane.

posterior radiograph, unless contraindicated (See Chapter 5), to determine facetal geometry qualitatively.

COMPRESSIVE LOADS

The angle of the facet joints enable them to respond to external forces and at the same time guide the type of motion the spine is able to perform. Compression forces (Y axis) are counteracted in part by the facets. Approximately 16% of this compressive load is taken up by the facet pillars themselves when in the standing position. The facets at the L2-L3 level share a higher percentage of the axial compressive loads than the facets at the L4-L5 level (12). As the spine is flexed, such as occurs in the sitting posture, the facets resist little compressive load (13). Facet load remains relatively constant with increasing segmental compressive loads, such that the facet load expressed as a percent of load applied to the segment, decreases with increasing axial forces (12). When compressive loads become great, the end-plate is the first to fail (5). Very little injury is sustained by the facet joints or the annulus.

Miller (14) summarizes the role of the apophyseal joints in various loads. During axial compression (Y axis) and lateral flexion (Z axis), the facets are not heavily burdened. However, the facets can be more stressed during shear forces. When the motion segment is flexed, extended or anteroposteriorly sheared, the facet joints relieve some of the load taken by the disc. The facet joints resist approximately ½ of the shear force of the motion segment with the disc resisting the remaining ½ (15).

Motion Patterns

CORONAL (X-Y) PLANE

The coupling pattern of the lumbar spine is axial rotation (Y axis) with lateral flexion (Z axis). As the spine is laterally flexed, the spinous process of that segment rotates towards the same side (Fig. 7.3A-B). Coupling of the lumbar spine occurs in three dimensions. A slight amount of flexion occurs in addition to the axial rotation. This is true however, only when the lumbar lordosis is present. If the lordosis is flattened such as during the sitting posture, then a slight amount of extension occurs at the joint in addition to the axial rotation (16).

It is important to analyze both lateral flexion and axial rotation motions when studying the kinematics of the spine with stress radiography. Lateral bending radiographs can show a joint that is laterally flexing normally but is not exhibiting proper coupling characteristics. Normal lateral flexion behavior is called Type 1 (Fig. 7.4). Type 2 indicates the spine is laterally bending but not axially rotating. Type 3 motion describes a motion segment that is not laterally flexing but has normal coupling of
axial rotation (17). Type 4 dysfunction describes a motion segment that is not laterally bending nor axially rotating during lateral flexion of the lumbar spine. Figure 7.4 illustrates the various motion patterns of the lumbar spine during lateral bending.

The amount of lateral flexion at a motion segment is dependent on the level. Two to three degrees are allowed at L5-S1; five to ten at L3-L4; three to nine at L2-L3 and from three to eight at L1-L2 (8). The ranges cited represent common ranges of motion. Many studies are in vitro analyses. They are not necessarily reflective of an in vivo normal motion segment (i.e., absence of degeneration).

SAGITTAL PLANE

Flexion and extension (X axis rotation) is quite large when compared with the other degrees of freedom. The average (mean) amount of combined flexion and extension for the lumbar motion segments are as follows: L1-L2, 7.5°; L2-L3, 7.5°; L3-L4, 18°; L4-L5, 22°; L5-S1, 18° (18). Maximal flexion is restricted by the posterior soft tissues and extension is restricted by the anterior soft tissues.

The analysis of patterns of motion during flexion and extension has only been performed on patients with low back pain. In a study by Putto and Tallroth (19), they found that during flexion all segments rotated forward (+θX) but that coupling of translation along the Z axis varied depending on the level. From L1 to L4 there was a slight anteriorward translation (0.85–2.8 mm) but at L5 the translation is posteriorward. This is due to the pull of
the lumbodorsal fascia when there is a small spinous process at L5 (See Chapter 2). Translation, either anterior or posterior, is most likely a reflection of disc injury at the motion segment. The patient with lumbar spine injury should always be cautioned against any activities that cause flexion of the low back. The exact amount of in vivo translation that is possible is difficult to determine from the study by Putto and Tallroth of patients with chronic low back pain because no details of the radiographic technique (i.e., film focal distance) are provided. It is known that radiographic magnification varies with the focal film distance and the object film distance, and that this would effect millimetric measurements. Normal lumbar flexion is illustrated in Figure 7.5.

A study by Yoshioka et al. (20) determined the motion characteristics of the lumbar spine in the sagittal plane in a group of pain-free young Japanese adults. Of interest was the fact that during sagittal plane motion the L4 segment showed primarily a translational strategy (±Z), and the L5 segment, a predominantly rotational (±θX) motion characteristic. The reduced amount of translation at L5 could be due to the restraining aspect of the iliolumbar ligaments (20). The increased translation at the L4-L5 level may be due to early disc degeneration. There is no way to know however, because the radiologic analysis was not correlated with MRI findings. The average ranges of motion (θX) from maximal extension to maximal flexion for each lumbar level were as follows (20):

- L1 = 12.7°
- L2 = 16.6°
- L3 = 16.7°
- L4 = 18.3°
- L5 = 19.6°

**Posture**

The posture of the lower spine in the sagittal plane is a lordotic configuration (Figures 7.6A-B). The curve is acquired and is developed when the toddler begins to walk. The wedge shape of the intervertebral discs and the vertebral bodies, especially L5, primarily form the lumbar lordosis. The human lordosis is vital to providing the maximal strength vs. flexibility compromise. It represents a highly evolved structure and is responsible for the body's ability to lift great loads, in contrast to other primates (21). There are many anatomic factors that determine the extent of the lumbar curve.

It is generally agreed that the L3 vertebral body should be the most anterior vertebra in the lumbar lordosis. Many investigators have attempted to quantify the normal lumbar curve. While most investigations have been performed with the subject in the recumbent position, one report (22) used patients who had films taken in the standing position. These patients were considered to have relatively normal static radiographic posture. The range of the lumbar lordosis was 35° to 54°. The lordosis angle was constructed with L1 and L5 used as the end vertebrae. In another study (23), the standing lumbar lordosis was evaluated in a series of patients presenting to an outpatient chiropractic clinic. The lumbar lordosis angle was found to have a mean of 59.4° (SD: 10.4). This measurement however, used L1 and SI for the end vertebrae. Lumbar curves outside of the ranges cited should be considered either hypo or hyperlordotic. The patient's posture can then be compared to the clinical assessment. It is important to keep in mind that the lumbar lordosis is a compound curve with the steepest angulation at the lumbosacral junction. It may be unlikely that a single angle is best representative of the lumbar lordosis (18).

**LUMBAR SPINE DYSFUNCTION**

**Risk Factors**

Heliovaara (24) found that obesity and increased body height (men: > 180 cm; women: > 170 cm) increased an individual's risk for development of a lumbar disc herniation. Genetic factors are also at work in the etiology of this disorder. The relative risk of developing a disc herniation before the age of twenty-one is approximately five times greater in patients with a family history (25).
Pathomechanics

The relaxation phenomenon is seen when the lumbar spine and pelvis are forwardly flexed 45° or more (27). The paraspinal muscles become myoelectrically silent in this posture. Freefall is prevented because of the tension in the midline ligaments and the lumbodorsal fascia. The relaxation phenomenon also exists on maximal lateral bend (28). It is easy to see why most lumbar spine injuries occur when the spine is flexed forward and laterally bent. In this posture, the ligaments take the majority of any load applied, which usually leads to failure of the system.

Most injuries to the lumbar spine happen because of a failure in the ligamentous and muscular systems in providing a sufficient response to external forces or moments. These are usually either of a compressive nature (Y axis translation) or torsional (Y axis rotation). A macro-traumatic event often precipitates lumbar spine injury. Certain situations may arise however, where an accumulation of micro-traumatic episodes leads to a failure of the joint. The classic example of this is the truck driver. The driver is subjected to repeated compression and vibratory forces with the spine in a relatively flexed position. It is widely known that truck drivers suffer from a higher incidence of low back pain when compared to the population as a whole (29). The posture of the single traumatic injury is most often associated with flexion (compression) in combination with lateral bending and axial rotation (Fig. 7.7) (8,30–32). In vitro hyperflexion of motion segments results in 43% of the discs sustaining prolapse (33).

COMPRESSION OVERLOAD

Purely compressional overload (±Y) results in damage or fracture of the end-plate. The annulus and the facet joints receive little injury during compressional overload (3). The fractured end-plate is one of the most common pathologic findings during lumbar dissections (3). Farfan lists four different types of laboratory injuries that can occur at the end-plate (Fig. 7.8):

1. Sub-endplate compression fractures of cancellous bone. The overlying end-plate and cartilage are intact and still maintain the normal fluid barriers between disc and vertebral body.

2. Fractures of the end-plate and cartilage which open a communication between the disc and vertebral body. These fractures are of three types:
   a. fissure fractures of the end-plate
   b. depressed fractures of the end-plate
   c. fissure or depressed fractures with disc material forced into the vertebral body

Once the end-plate has been fractured, a significant weakness exists in the central joint. Normally the end-plate can withstand high intradiscal pressures. The fractures however, greatly decrease the end-plate's ability to support these high pressures (18). The vertebral body is the structure that acts as the great shock absorber for the spinal column. This is accomplished through a sensitive hydraulic system that depends on the rate of loading (5) (See Chapter 2). With fractures of the end-plate or the peripheral cortex, this hydraulic shock absorbing function is impaired (3).

**TORSIONAL OVERLOAD**

Torsional overload usually occurs when the spine is anteriorly flexed. During flexion, the posterior annulus becomes stretched (See Chapter 2). There is a more vertical arrangement of the collagenous fibers in the outer annulus when the joint is flexed. The strength of collagen is greatest along the orientation of the fibers. This arrangement is present so that the spine can resist the force of flexion and extension and lateral bending. This distribution is least suited to resistance of forces perpendicular to it, such as axial torsion. Additionally, the facets become separated to some extent during flexion, allowing more axial rotation at the joint (34). Torsional forces damage simultaneously both the facets and the annulus (35), because they are the elements that resist this motion (36). Rotations greater than 3.0° begin tearing the outer fibers of the annulus (18). Subchondral fractures occur at the posterior joints with resultant effusion, synovitis and motion limitation after forced rotation (3).

Repeated torsional overloads gradually damage inner fibers of the annulus until eventually a communication will exist between the nucleus and annulus. These tears are most often at the posterolateral angles and are called radial fissures.

**RADIOGRAPHIC EVALUATION**

After the joint has been injured in torsion, the radiograph usually shows a posterior displacement (retrolisthesis) on the segment below (18). This – Z translation of the vertebra on the segment below is a common radiographic and dissection finding in the lumbar spine (23,37–39) (Fig. 7.9A-F). Accompanying the – Z displacement, the A-P radiograph may also show rotational (Y axis) distortions, and/or lateral flexion positional dyskinesias (Z axis rotation) (Fig. 7.10) (37,38).

As the intervertebral disc and other soft tissues are moved beyond their physiologic range, two things occur simultaneously. The ligaments fail (disc, articular capsules, paravertebral ligaments) and the joint assumes a position outside of its physiologic range (40). The amount of displacement is usually quite small, but as the ligaments become more stressed from repeated injuries, and as the creep properties of the joint increase, the amount of positional change can be quite large.

Torsional force, with its concomitant rotational deformity of the intervertebral joint, is capable by itself of causing nerve root dysfunction. As the pedicle is moved medially on the opposite side of the torsional movement, the nerve root is deformed. With a rotation of 9°, the nerve root can be stretched approximately one centimeter. By reversal of the rotational deformity through spinal adjustments, the nerve root can be restored to a less tensile state (3). Adjustments can also be made to reduce retrolisthesis if present (23).

**Disc Nomenclature**

The names that have been ascribed to different dysfunctional states of the intervertebral disc are numerous. There seems to be little consistency among authors when describing identical lesions. To clarify the terminology problem, illustrations have been provided (Fig. 7.11 A-D). The different types of disc pathologies are not necessarily
progressive stages of injury. One dysfunctional state may not lead into the next.

Pain can arise from just about any injured area in the lumbar spine except the nucleus pulposus (Fig. 7.12). The outer annulus, facet joints, periosteal structures, muscle and fascial elements, are all richly innervated with pain fibers (8).

Rydevik et al. (41) determined that a herniated lumbar disc might be expected to reduce blood flow to the sensory cell bodies in the dorsal root ganglion, which may produce pain. This is a relatively new theory on the production of pain in patients with lumbar disc herniation.

Mechanisms of the Positional Dyskinesia

A positional dyskinesia of the motion segment is that situation where a vertebra has moved into a position that is not within the physiologic range of the joint. This malalignment, when present, is usually visible on standard plain film radiographs.

When the ligaments of the three-joint complex are damaged, one can assume that the vertebra was moved beyond its physiologic range (40). Torsional injuries may produce rotation (θY), wedging (θZ), inferiority (−θX) and posteriority (−Z). Because the positional state of the joint is reflective of the injury to the soft tissues, great care must be exercised when introducing a force into the motion segment. Already damanged ligaments should not be compromised further, as this will precipitate an inflammatory reaction, accelerating the degenerative process. The pattern of thrust of the adjustment should be exactly opposite the direction of ligamentous damage.

The adjustment is designed to reduce the dyskinetic position of the segment. This will normalize the axis

![Figure 7.9](image-url)

Figure 7.9. A, Radiograph of cadaver specimen. Notice the retrolisthesis at the L4 level. B, Cadaver specimen of A. There is internal disc disruption at the L4-L5 and L5-S1 interspaces. C, Radiograph demonstrating retrolisthesis and the vacuum phenomenon (See Chapter 5). D, Specimen showing signs of internal disc disruption at both levels. E, Radiograph demonstrating retrolisthesis at L4 and L5. Traction osteophytes indicative of instability are present at the anterosuperior margin of L5 and the anteroinferior margin of L4. F, Specimen showing annular bulging at multiple levels with retrolisthesis of the vertebral bodies.
of motion around which joints move and decrease tension in the stressed soft tissues.

Normalization of position of individual segments may have an effect on the posture of the lumbar spine as a whole. A return to the normal range of lordosis of the lumbar spine will logically place less stress on individual segments of the curve. Similarly, normalization of the posture of the lower spine will have a positive effect on the thoracic and cervical sagittal curves. The sagittal curves of the spinal column are all interdependent (42).

**Mechanisms of Fixation Dysfunction**

Fixation dysfunction is that state of restricted motion at the pathologic joint. Hypomobility is a nonspecific term that may or may not indicate a pathology. For example, asymmetry of the articular pillars and other anomalies can restrict motion in one or more directions, but by itself is not reflective of a pathomechanical process occurring at the motion segment. Anomaly of the zygapophyseal joints of the lumbar spine, especially L4-L5, is common. Plain film radiography should be used to assess the presence of facet joint anomaly, although CT is preferred.

Patients with low back pain often have absence of motion (43) or abnormal coupling patterns of the lower lumbar spine. The etiology of fixation dysfunction is most likely multifactorial (44). An entrapped meniscoid within the facet joint that causes pain has been proposed as a mechanism that reduces motion at a joint via a secondary reflexive muscular contraction. Other mechanisms include displacement of the nucleus and hard annular fragments, periarticular connective tissue adhesions and segmental muscular contraction (44). Disc displacement and dysfunction is most likely a major cause of fixation dysfunction in the lumbar spine. An adjustment may be able to move displaced nuclear or annular material (Fig. 7.13).

Regardless of the mechanism by which the joint becomes fixated, a restriction of mobility is pathologic and should be remedied. In the acute stage of injury, both the facets and disc may restrict motion at the joint because of swelling within the capsule or disc. A joint that is left in an immobilized state will show the following changes under biochemical assessment (45):

1. A reduction in glycosaminoglycans and water
2. An increase in intermolecular cross-linkages

Collagen cross-linkages may be broken with an adjustment, thus restoring mobility. The reduction of inflammatory edema within the disc or apophyseal joints would remainder of the disc. This type of pathology is unlikely to respond favorably to manipulative procedures. Modified from White AA, Panjabi MM. Clinical biomechanics of the spine. 2nd ed. Philadelphia: JB Lippincott, 1990:393–394.
likely increase mobility and decrease pain by decreasing tension on the pain sensitive periphery of the disc and the pain sensitive articular capsule. A global decrease in mobility is relatively common in patients with low back pain. Mellin (46) suggests that this is due to ligamentous or capsular stiffness of the involved articulations. Range of motion exercises for the lumbar spine should be encouraged as the patient begins to regain function from improvement in the intersegmental fixation dysfunction. Stokes et al. (47) found that movement in laboratory animals tended to help the joint to recover from experimental injury.

ADJUSTMENT EFFECTS

Pearcy et al. (48) showed that conservative measures (abdominal strengthening exercises, pelvic tilt exercises and back school) were unable to normalize abnormal coupling patterns of the lumbar spine. Carrick (49) however, has shown that lateral flexion fixation dysfunction and abnormal coupling patterns of the lumbar spine respond readily to spinal manipulation.

Bronfort and Jochumsen (50) documented increased intersegmental motion in patients with fixation dysfunction after a course of specific spinal manipulation. In their study on radiographic analysis of vertebral motion disturbances, they found a high correlation between plain film assessment and the cineradiographic procedure. Their recommendations were that stress plain film analysis be used to evaluate accurately, motion dysfunction of the lumbar spine.

Because the adjustment introduces motion at the joint, a reduction in the fixation dysfunction may occur (7.14A-D). An acute subluxation can cause global restrictions in motion (Fig. 7.14E-G). Fixation caused by chronic mechanisms, such as periaricular adhesions may take multiple adjustments to remedy. Adjustments can be supplemented with specific postural isometric exercises or maneuvers (51). In situations where the extent of degenerative processes in the joints is severe, a complete normalization of mobility seems unlikely (Fig. 7.15). This may also be true of the positional state of the segment. The more damaged the ligaments are, the less likely they will be able to shorten and heal, thereby counteracting progressive creep properties of the articulation.

Degeneration

Degeneration has been covered extensively elsewhere (See Chapter 2). Disc degeneration of the lumbar spine occurs in response to trauma. These traumatic injuries (compressive and torsional overload) most likely occur at a very early age. Paajanen et al. (52) used magnetic resonance imaging to study disc degeneration in young low back pain patients. The average age of the patients was 20 years. Fifty-seven percent of those suffering from low back pain had one or more abnormal lumbar discs. A control group of pain-free individuals was also analyzed with MRI. Approximately 35% of these individuals showed signs of degeneration. End-plate changes, detected radiographically, were clearly associated with disc degeneration. Therefore, damaged end-plates are likely one etio-
logic and/or associated factor in the development of disc degeneration. Many of the MRI detected abnormal joints had no radiographic changes. Early degenerative disc disease may exist long before there is loss of disc height or other obvious radiographic findings of degenerative joint disease (53). MRI is an excellent clinical and research tool for identifying early biochemical changes in the intervertebral disc (Fig. 7.16). These changes are likely to occur even before there is histologic evidence of degeneration (54).

Figure 7.14. A, Abnormal patterns of motion of the lumbar segments during lateral bending. Notice failure of the spinous processes to rotate towards the concavity of bend. B, Post-treatment radiograph. C, Radiograph demonstrating abnormal coupling patterns. D, Post-treatment radiograph demonstrating a more normal coupling pattern. The two patients in Figures 7.15A-D received a combination of spinal adjustments to the lower lumbar level(s) and specific isometric exercises or maneuvers. E, Neutral radiograph demonstrating retroolisthesis at L5 with slight disc thinning at that level. F, Flexion showing marked limitation in forward bending. G, Post (30 min.) radiograph after an L5 adjustment.
Disc degeneration at the central joint will lead to greater loads borne by the posterior joints. A consequence of this high stress may be pain from subchondral bone, or soft tissue nipped between the facets (31). The pattern of disc degeneration begins with nuclear dehydration, followed by greater and greater internal disruption. Resorption of disc material occurs in the late stage. Osteophytic ridges also narrow the contents of the lateral recess and IVF (55).

**Compensation Reactions**

Gonstead was one of the first chiropractors to recognize compensation as a reaction to the subluxation (56). Static and dynamic reactions to primary lesions of the lumbar spine are termed compensation reactions. When a motion segment becomes restricted in a particular direction of motion, adjacent articulations will compensate with increased mobility, in order that the total global range is preserved. This hypermobile compensation is usually benign and a normal reaction to a fixation. If the primary lesion is allowed to be present for an unnecessary length of time, the secondary reaction can become pathologic. The hypermobile state can induce injury to the supportive tissue and neurovascular bundles. The signs of inflammation and altered neurologic function may be present at the secondary lesion and can be a primary source of symptomatology for the patient. Because the secondary lesion can often times be more symptomatic than the primary lesion, objective criteria, such as stress radiography should be used exclusively to identify the primary site. Management protocols based on the symptom-
There is some controversy regarding the usefulness of plain radiographs in identifying instability, because of the fact that many pain-free individuals exhibit somewhat large translational displacements during sagittal plane motion (59). It is regarded however, as the examination of choice. The controversy mostly stems from categorizing pain-free individuals as normal without regard to underlying silent pathology that may be present.

Traction compression radiography appears also to be a useful indicator of lumbar segmental instability (60). In this procedure, lateral radiographs are taken with the patient under traction (hanging from a horizontal bar) and under compression (addition of a 44 lb rucksack or backpack in the standing position).

Weiler et al. (61) have used a computerized analysis that appears to be more sensitive in identifying individuals with instability. Bi-planar radiography can also be used, but because of equipment requirements, this has been primarily confined to the research setting. The plain radiographic analysis provided, describes instability of the lumbar spine at its most common level of involvement, the L4-L5 motion segment (Fig. 7.17A-B).

The vacuum phenomenon, from severe internal disc disruption is a sign that instability is present. The extension radiograph displayed the vacuum phenomenon in about half of the 52 symptomatic patients studied by Goobar et al. (62). The author hypothesizes that in the absence of a precipitating singular traumatic episode at the L4-L5 level, instability begins as a relatively benign hypermobility caused by fixation dysfunction below (Fig. 7.17C-G). In this respect, instability can be thought of as a chronic condition.

Some discussion must be given here to the “Three Phases of Degeneration” outlined by Kirkaldy-Willis (55,63). Dysfunction, the initial phase, is characterized by hypomobility and/or abnormal coupling patterns of the spine. The second phase is termed instability. Here, the motion segment has increased translational movement caused by internal disc disruption. The final phase of the process is termed stabilization. The motion segment gradually is stabilized through a decrease in disc space height and other signs of degenerative joint disease, such as osteophyte formation. While Dr. Kirkaldy-Willis does not state that each phase runs serially into the other at the same segmental level, this notion is somewhat implied, leading to some confusion in the literature (64). If hypomobility were to lead to instability, the joint would necessarily have to pass through a stage of normal movement. There would clearly be no need to adjust these patients. Their fixation dysfunction will normalize as time passes. This is not the case however. The dysfunction phase at one level more likely leads to hypermobility at another level that then becomes unstable. This unstable articulation, then gradually restabilizes with time. The fixated joint as well will undergo degeneration and stabilization,
Figure 7.17. Instability combined with fixated or persistent retrolisthesis. A, Neutral. Retrolisthesis of L5 and L4. B, Flexion. Notice the reduction of retrolisthesis at L4. C, Neutral. Retrolisthesis at L5. D, Flexion. There is hyperflexion (+6X) at L4. The dot represents the George’s line of S1, demonstrating the retrolisthesis at L5. E, Neutral. Retrolisthesis at L4 only. Notice the traction osteophyte at the anterosuperior margin of L4, indicative of instability at L3-L4. F, Flexion. There is persistent retrolisthesis at L4 and hyper flexion at L3. G, MRI of patient in Figures 7.17E-F One year later. The patient now has acute symptomatology. There are annular protrusions at multiple levels. Notice also the decreased signal intensity of the nucleus, especially L4-L5.
primarily because of the loss of motion (See Fixation Dysfunction). It may not pass through an unstable phase during this process.

**TREATMENT**

Frymoyer and Selby (65) have advocated surgical fusion with the joint in flexion as the treatment for lumbar retrolisthesis. This treatment is not valid in light of conservative measures that have shown merit. Plaugher et al. (23), in a retrospective consecutive analysis of 49 patients, demonstrated that lumbar retrolisthesis was reduced an average of 34% while the patient was under chiropractic care. Assessments were made after an average of eight treatments. The adjustments were performed in the side posture position, emphasizing a posterior to anterior (+ Z) pattern of thrust followed by a “holding” of the segment for 1–2 seconds.

Lehmann et al. (66) evaluated the long-term results in patients undergoing lower lumbar fusion. Follow-up ranged from 21 to 52 years; the median was 33 years. Forty-four percent of the patients were still experiencing low back pain and 57% had had low back pain in the past year. Fifty-three percent were using medication to control pain. Segmental instability above the level of fusion occurred in 45%, and 42% had developed central spinal canal stenosis. The interesting aspect of this study was that most patients were generally satisfied with the results of their surgery. Perhaps their expectations were not high from the onset.

Lopes et al. (67) report two cases with lumbar retrolisthesis which were reduced after a + Z thrust technique. In one of the cases, motion studies were performed in flexion and extension. Improvement in fixation dysfunction and paradoxical motions were also observed. The other case showed a reduction of approximately 35% after one treatment. Prospective studies are needed in the area of closed reduction of lumbar retrolisthesis. The practitioner needs to know how many adjustments are required to effect a reduction and when should treatment be tapered. More study is needed to determine the effects of retrolisthesis and its amelioration on the neurophysiology of the individual, and their future level of degeneration at that level and adjacent segments. Preliminary evidence thus far is promising.

No adjunctive thrusts should be administered to the hypermobile segment, and if performed, may be a cause for increased symptomatology in the patient. Because the hypermobility usually occurs above the fixated level, an adjustment at the segment above the fixation may cause the patient’s condition to remain unchanged or temporarily worsen symptomatically. The primary lesion should be addressed and once mobility is restored or improved at the restricted level, the hypermobile compensation reaction hopefully will begin to restabilize.

**Static Compensation Reaction in the Sagittal Plane**

Static compensation reactions of the lumbar spine are common. A change in the lordotic configuration of the lumbar spine can often be detected by x-ray. It is important to remember that the lumbar lordosis is a compound curvature. One angle for the entire lordosis does not adequately describe the static mechanical configuration of
the region. Normally, there is a steeper angle between L4, L5 and S1. The lordosis diminishes in the upper lumbar segments as the lordosis turns to kyphosis in the thoracolumbar and thoracic regions of the spine.

An increase in the lower angle of the lordosis is usually best described by Ferguson’s sacral base angle measurement. When posteriority (retrolisthesis) of a lower lumbar segment, especially L5, is accompanied by an extreme inferi orward tipping of the vertebral body (−θX), an increase in the sacral base angle can usually be detected (Fig. 7.18).

A lesion at the L5-S1 disc space in which the sacral base has moved into a position of −θX and a sligh t amount of −Z translation, has been termed a sacral base posterior (S6) (Fig. 7.19). In this situation, the disc space at L5-S1 is parallel or widened at the posterior. This is different from the usual slightly wedge-like configuration of the disc. Because of the posterior opening at the lumbo sacral, the L4-L5 region will often become hyperextended (−θX) in a compensation reaction for the flexion of the lower motion segment (Fig. 7.19).

In the case of a herniation of the nucleus pulposus in either a posterolateral or central direction, the patient will often present with a hypolordotic posture of the entire lumbar spine. This flexion compensation is an effort to open the posterior aspect of the disc and decrease pressure on the nerve roots. There is usually an associated muscle spasm that guards and splints the injured area. The hypolordosis has sometimes been erroneously ascribed to the presence of the muscle spasm. This is probably not the case. The posterior muscle groups lie posterior to the ceter or apex of the normal lumbar lordosis. If contracture or spasm of the muscle groups did affect the posture, then they would tend to pull the two ends of the lordosis together, thereby producing a hyperlordotic configuration (18).

**Static Compensation Reaction in the Coronal Plane**

The antero-posterior radiograph is also of help in detecting compensation reactions. A posterolateral protrusion of the nucleus pulposus will usually produce a wedging malposition of the involved segment. Also, while not caused by the protrusion directly, a unilateral protrusion may affect one nerve root and thereby initiate an antalgic lean of the patient away from the side of involvement (8). This would occur in protrusions lateral to the nerve root. Herniations that are medial to the nerve root may produce an antalgic lean towards the side of leg pain (the side of nerve root involvement) (See Examination of the Acute Low Back).

Disc protrusions lateral to the nerve root tend to cause a rotatory scoliosis (spinous process deviation to the concavity of the curve) above the level of involvement. Protrusions medial to the nerve root tend to cause a simple scoliosis (spinous towards the convexity). These are extreme generalizations. Their usefulness in the clinical assessment of the patient is unclear. Accurate determination of the direction of protrusion, is achieved through CT or MR imaging (68).

On the A-P radiograph, the probable site of subluxation will often wedge off the horizontal and deviate away

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**Figure 7.18.** Retrolisthesis (−Z) and extension (−θX) positional dyskinesia of L5. There is an associated increased sacral base angle.

**Figure 7.19.** A base posterior sacrum with compensation in hyperextension of L4 (−θX).
from the center of gravity. The compensation however, will tend to wedge towards horizontal and back towards midline (See Chapter 5).

**SPONDYLOLISTHESIS**

Spondylolisthesis is defined as a slippage anterior of one vertebra on the segment below. This forward displacement can happen in any area of the spine, occurring most frequently at L5 (Fig. 7.20).

Spondyloysis is a lysis of the neural arch at the pars interarticularis. It often occurs in conjunction with spondylolisthesis.

**Classification**

There are five classifications of spondylolisthesis, depending on the etiology of the slippage (34). Type 1 is called isthmic and refers to either a stress fracture in the pars, or an elongation without separation. Lysis of the pars from fracture is the most common cause for anterior slippage. The stress fracture usually develops shortly after the child begins to learn to walk. There is no evidence that lysis of the pars is congenital, because autopsies of stillborns and fetuses have never shown the defect. There may be however, a genetic weakness in the pars, such as a thin cortex, which makes it susceptible to stress fracture (69).

Most patients with isthmic spondylolisthesis of L5 have a prominent spinous process at that level and a steep sacral base angle (70). The steep sacral base angle will place more anterior shear at the articulation possible leading to elongation or the development of a stress fracture. The prominent spinous process may also be implicated in the development of this disorder. Gracovetsky (71) (See Chapter 2) points out that a small spinous will be pulled posteriorward by the lumbodorsal fascia (LDF) during forward bending. This is a protective mechanism to resist the tremendous anterior shear that occurs at that level. A large spinous process will cause the opposite effect. Here, the LDF will exert an anterior shear force heightening the possibility of the development of a stress fracture at the pars.

Type 2 spondylolisthesis is termed congenital and refers to congenital malformations of the posterior elements. This condition is rare and may be manifested by aplasia of the articular facets (Fig. 7.21).

When the three-joint complex undergoes severe degenerative changes due to previous trauma, the supporting ligaments can be lax enough so as to allow forward slippage. In the case of an L4 degenerative spondylolisthesis, the main pathologic finding is marked erosion of the superior articular processes of L5 (55). The amount of
forward slip is usually small. This scenario is called a degenerative spondylolisthesis or Type 3 (Fig. 7.22). If the degeneration occurs concomitantly with an elongation of the neural arch, the anterior slippage can be quite large.

Type 4 spondylolisthesis is characterized by elongation of the pedicles. This could be called an isthmic type of spondylolisthesis. Traction forces (+Z) cause elongation of the neural arch.

Type 5 spondylolisthesis is anterior movement of the vertebra caused by a destructive process in the neural arch. Tuberculosis, metastasis, and other diseases that compromise the structural integrity of the bone are included in this category.

A forward displacement of the vertebral body will lead to more nuclear pressure on the posterior end-plates. Through Heuter-Volkmann’s Law (8), this increased pressure at the posterior will retard the growth of the epiphyseal plate, thereby creating a wedge-like appearance of the vertebral body on the lateral radiograph (See Fig. 7.20). This is a common finding in patients with spondylolisthesis.

Instability

In an experiment by Pearcy (72), it was shown that grade one and two spondylolistheses do not show increased mobility during flexion and extension stress radiography. These patients were in pain however, and the lack of signs of instability, could have been related to overall reduction of motion due to protective muscle spasm. Penning and Blickman (73) found no abnormal translation at the site of the spondylo, but did see increased motion one segment above. Instability of a joint with spondylolisthesis cannot be assumed.

An interesting report by Friberg (74), has shown that axial traction tends to reduce the slippage of spondylolisthesis by lessening the anterior shear component across the S1 superior end-plate (Fig. 7.23). Compression of the spine tended to increase the anterior slippage. In contrast, retrolisthesis increased during traction and decreased during compression (Fig. 7.24).

Figure 7.22. A degenerative spondylolisthesis of L4.

Figure 7.23. Traction reduces a spondylolisthesis, and compression increases the forward displacement.

Figure 7.24. Traction will further displace a retrolisthesis, and compression tends to reduce it.
Management

Dysfunction at a joint with spondylolisthesis is just as common as in other areas without defects. Treatment however, is somewhat different from other lumbar levels. The patient with a symptomatic spondylolisthesis will usually present with moderate to severe pain on extension of the lumbar spine. A hyperlordosis may be noted, as well as a prominent spinous process at the level of the defect. The lateral and oblique radiograph will confirm the clinical impression.

The sacrum will tend to be restricted in posterior to anterior motion (+ Z translation) in relation to L5 during motion examination of a fixated L5-S1 spondylolisthesis. If instability or normal motion is present, then adjustments are contraindicated. Spondylolisthesis, by itself, is not a contraindication to prudent manipulation (75). The adjustment is designed to restore the restricted mobility at L5-S1 while using the S2 segment of the sacrum as the short lever arm. Improvement of the forward slippage rarely occurs.

In most cases, the adjustments are curtailed after symptomatic improvement, because this region of the spine affords less structural stability. If the dysfunction persists however, and affects other motion segments above, then corrective measures should be used.

For the acute patient, a lumbar support is often helpful. It should be worn for the first few days after trauma to provide support for healing to occur, and for reduction of symptomaticity due to decreased stretching of the compromised soft and hard tissues.

LATERAL RECESS STENOSIS

The lateral recess is an area bordered laterally by the pedicle, posteriorly by the superior articular facet, and anteriorly by the posterolateral surface of the vertebral body and the adjacent intervertebral disc (76). The lateral recess can become narrowed and lead to entrapment of the nerve (Fig. 7.25). Degeneration is the primary etiology. Disc injury will lead to posterior displacement of the vertebra (retrolisthesis) which narrows the lateral recess. Disc displacement (e.g., annular bulge) can also narrow the recess. Soft tissue scarring in the area will further occlude the foramen (77).

The radiograph will usually show degeneration of the central joint with retrolisthesis of the superior segment. The CT scan can demonstrate the bony encroachment conclusively.

If the joint is unstable, symptomaticity may only be detected during certain postures, such as hyperextension. Straight leg raising is usually only slightly limited. Back pain, though often present, is not necessary for the diagnosis. Referral pain patterns can occur in the buttock, trochanter, posterior thigh, calf, ankles, and toes (63). Signs of nerve root compression at the affected level will usually be present.

Kirkaldy-Willis (78) has outlined three tests helpful in making the diagnosis of dynamic lateral nerve entrapment (Fig. 7.26A-C). The entrapment can be dynamic or fixed, so different body positions must be tested. Persis-


Figure 7.26. A, Patient lying in the lateral recumbent position on the examination table with the painful side down. The doctor then holds the upper body and pushes the hip away from them. This procedure can sometimes accentuate left sided pain. B, Patient standing erect. The doctor can hold the patient's pelvis while an assistant rotates the shoulders from one side to the other. This will sometimes cause leg pain. C, Patient prone on the examination table, the knees are flexed and compression is applied to the lumbar spine. This will cause hyperextension in the area and possibly accentuate symptomaticity in some patients. Modified from Kirkaldy-Willis WH. The site and nature of the lesion. In: Kirkaldy-Willis WH, ed. Managing low back pain. New York: Churchill Livingstone, 1983:100.
tent or fixed retrolisthesis leads to entrapment of a constant nature, because the joint is not periodically moving away from the nerve. Fixed lateral recess entrapment commonly occurs as a sequel to degeneration of the central and posterior joints.

The combination of loss of disc height, retrolisthesis, and hypertrophy of the posterior articulations will lead to severe narrowing of the recess. This situation, commonly seen in the geriatric patient due to the pronounced degeneration, holds the worse prognosis for conservative management. Chiropractic treatment in the preceding scenarios consists of moving the posteriorly displaced segment forward to open up the recess, and to reduce subluxation of the posterior joints (79). If instability is present at that level, then adjustments may be indicated at a fixed motion segment, usually below.

Narrowing of the recess can also be brought on by a protruding annulus in the area. An adjustment may have the effect of moving the annular material forward, away from the nerve, if the posterior displacement can be reduced. If there is inflammation in the area, adjusting the articulations may dissipate some of the inflammatory edema, thus decreasing nerve root compression.

There is some clinical research evidence that manipulation is effective for patients with lateral recess stenosis (80). Relatively few individuals will require surgical decompression of lateral recess stenosis (68).

**CENTRAL CANAL STENOSIS**

Central canal stenosis is caused by advanced structural changes and is most common in older patients. These individuals usually present a symptom pattern of altered sensation with pain in one or both legs. If compression is of a long duration, motor weakness may be present (78). Pressure on the cauda equina comes from a narrowed central canal, primarily due to enlarged posterior joints, posterior osteophytes of the vertebral body, and sometimes a small disc herniation (Fig. 7.27). Occasionally, signs of central stenosis can occur in the young if there is a congenitally small spinal canal. The presence of a central disc herniation in these cases, can lead to symptomatology characteristic of central stenosis (Fig. 7.27).

The back pain associated with central stenosis is usually not severe. Leg pain patterns can border on the bizarre. Patients may complain that their legs feel cold, or that they feel like they are made of rubber (78).

Restriction of lumbar movement depends primarily on the extent of degeneration in the joints. Nerve compression tests will usually be positive with multiple dermatomal levels involved. The straight leg raising test may only be moderately positive.

Neurogenic claudication (NC) can occur. The patient will report being able to walk only a short distance before resting because of accentuation of the leg pain. Neurogenic claudication can be differentiated from the vascular form (VC). If the patient can ride a stationary bicycle (lumbar spine in flexion) for several minutes without pain, this differentiates NC from VC. Vascular claudication will be provoked when greater circulatory demands are placed on the leg muscles (78).

The radiograph will usually show moderate to severe levels of degeneration, unless it is of a young patient with a congenitally small spinal canal. The CT scan is generally
used to accurately evaluate the dimensions of the canal. A method described by Dailey and Buehler (81), for use on lateral lumbar radiographs compares well with CT scan measurements.

Treatment consists of adjustments to the fixed motion segment. If retrolisthesis is present, then this should be reduced. An obese patient will require dietary consultation or referral. If severe degenerative changes are present and the patient does not respond to conservative measures, then surgical consultation may be indicated. Advancing neurologic deficits also require neurosurgical consultation or referral. In a study on the natural history of central stenosis (82), it was found that most patients did not deteriorate (i.e., symptomatology) at two to three years follow-up. These authors also evaluated the effects of decompression for central stenosis. They found that 60% of the patients improved and 25% deteriorated. Neurogenic claudication was significantly reduced. In a group of untreated patients, 30% improved and 60% were unchanged. The operation did not prevent neurophysiologic deterioration.

ACUTE LOW BACK SYNDROME

The acute low back syndrome can be an extremely disabling condition. The patient is usually severely impaired with regards to movement, and may experience excruciating pain. The clinical presentation can be somewhat unnerving to the inexperienced practitioner. Chiropractic care can usually offer dramatic relief provided the doctor is sure of the diagnosis and confident in the application of treatment. Hesitance to take action is usually caused by uncertainty in the diagnosis and fear of further traumatizing the patient. If the doctor strives to do a thorough and clinically meaningful examination for all patient presentations, the acute patient can be easily accommodated. It is typical of individuals not well versed in the management of the acute low back patient, to treat by “avoiding the lesion.” Here, the doctor will go to great lengths to achieve a proper diagnosis (e.g., CT, MRI, etc) of an L5-S1 disc herniation, and then do everything possible to avoid adjusting the patient at the involved level. Such avoidance may result in adjusting a fixed sacroiliac joint and/or the thoracolumbar junction, in hopes of providing some relief without addressing the acute spinal level. Attempting to adjust levels near the acute disc may actually cause a worsening of the patient’s symptomatology. Only experience in managing patients with acute symptomatology will provide the necessary tools for clinical prowess. The information in this section will hopefully facilitate the appropriate management of such cases.

Acute vs. Chronic

Most acute presentations of the low back are an acute exacerbation of a chronic condition. The patient will usu-

ally relate in the history of several episodes of back pain over the preceding years. The fact that many of these conditions have chronic overlays will facilitate the examination. The radiograph may show early signs of disc degeneration at a motion segment, alerting the clinician to a possible level of involvement. Figure 7.28 and 7.29 illustrates the effect of acute injury in a patient with retrolisthesis of L5.

EXAMINATION

Acute symptomatology of the low back is generally caused by subluxations of the lower lumbar levels, and rarely from one or both sacroiliac articulations. The doctor must keep in mind however, that an unbiased examination of the entire spine is requisite, to avoid overlooking levels of involvement which could be contributory (e.g., upper cervical region). The subluxation should be accepted where it is found. The doctor must avoid leading the examination with a bias.

The patient will usually relate a particular traumatic event preceding the pain, such as lifting a heavy object while in a stooped, awkward position. The flexed, laterally bent and axially rotated position, is a common mechanism of lumbar disc injury. In addition to pain in the

Figure 7.28. Radiograph demonstrating retrolisthesis at L5. The patient presented with chronic low back pain.
lower back, the patient may also complain of radiation into one or both extremities.

Flattening of the lumbar lordosis is often present. This may be due to pelvic flexion in an attempt by the patient to reduce contraction of the erector spinae through activation of the lumbodorsal fascia (See Chapter 2). A reduced lumbar lordosis may slightly pull an annular bulge away from the nerve root as well as increase the vertical dimensions of the lateral recesses. The patient can also “draw-up” one or both legs to decrease nerve root tension. Bogduk (83) has speculated that the flattening could be due to spasm of the multifidus or erector spinae muscles. Most of the paraspinal muscles in acute low back injury are in a sustained contraction. If the flattening was due to erector spinae spasm, it would likely pull in the lordosis, not reduce it, because the main function of the erector spinae muscles is to extend the lumbar spine.

Ambulation will usually be difficult and the patient may require assistance. After a history that includes checking for signs of cauda equina syndrome* (a surgical emergency), the patient should be prepared for a physical and radiographic examination (See Chapters 4 and 5).

Porter and Miller (68) found no correlation between the side of antalgic list and the direction of disc protrusion in 100 patients attending a back pain clinic. Because the CT scan and operation are performed in positions different from upright stance, this lack of correlation may be suspect. MRI and CT are the most important instruments available to the chiropractor for determining the nature of the disc lesion. In the absence of these tests, clinical assessment of trunk list in relation to the side of sciatica appears to be helpful in the management of the patient. With a disc protrusion medial to the nerve root, the patient will generally lean towards the side of leg pain (Fig. 7.30). With a protrusion lateral to the nerve root, the patient will lean away from the side of leg pain (Fig. 7.31). If the protrusion is beneath the nerve root (subzhizal), the patient will typically present in a forward bent position. A broad based central herniation may cause a forward lean as well as bilateral symptomatology. In general, clinical observations suggest that the central, medial, and subzhizal disc protrusions are somewhat more difficult to resolve (i.e., requires more frequent and prolonged addictive therapy), than protrusions lateral to the nerve root.

The physical examination will be modified somewhat when the patient is in severe pain. Effort should be made to use as few orthopedic tests as possible to obtain the desired information. Going overboard with ten or twenty tests, purely for documentation purposes, will simply put the patient through undue pain and distress. The adjustment will be more comfortable if the patient is less aggrivated during the examination. The cough impulse and

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* Cauda equina syndrome is defined as a dull pain in the upper sacral region with anesthesia or analgesia in the buttocks, genitalia, or thighs; accompanied by disturbed bowel and bladder function.
A base posterior sacrum will show a relatively parallel disc space at L5-S1. If severe, the disc space can be opened at the back. In some patients, swelling of the posterior joint space, makes it more difficult to determine which short lever arm to use to affect the segment (See Fig. 7.29).

From the AP radiograph, several observations can be made. Distortions in the pelvis such as a rotated sacrum, will usually show obvious measurement findings with a concomitant axial rotation of the lumbar spine. Proper patient positioning is critical to identifying pelvic positional dyskinesia (See Chapter 6).

A high intercrestal line with the L5 vertebra deep seated between the iliac crests will tend to protect the lumbosacral articulation. A relatively low intercrestal line, with absent or reduced iliolumbar ligaments, will tend to make the L5-S1 motion segment more vulnerable to injury (18). These are generalizations however.

An adjustment of a vertebra is usually specifically applied with respect to the segment below. A rare exception to the above, is an acute lumbar disc herniation at L4-L5 with L5 in a posterior position with respect to the sacrum. In this case, the L5 segment can be adjusted to the motion segment above (i.e., L4).

It is important to be aware that adjusting the motion segment with the herniated disc may be contraindicated, if the joint exhibits signs of hypermobility or instability. In general, more lesions at the L5-S1 motion segment will require adjusting (either an L5 or base posterior adjustment) than those at L4-L5 (L4 adjustment to L5 or L5 contact and set to L4). The incidence of disc herniation at both levels is roughly equal. An interesting study by Kortelainen et al. (84) attempted to correlate neurologic signs with the level of disc herniation. Four hundred three patients were studied. Fifty-six percent of the herniations occurred at L4-L5, however pain projection into the S1 distribution was most common. The traditional view point is that lesions at L4-L5 will tend to affect the L5 nerve root and that disc protrusions at L5-S1 will affect the S1 distribution. Multiple levels of involvement (e.g., L4-L5, L5-S1, S1 joint) are likely to be found in patients with a chronic condition.

**Release Phenomenon**

Various clinicians (85,86) have described a phenomenon whereby the patient may experience pain along the distribution of a nerve once compression has been released (release phenomenon).

A faint tingling and numbness appear when a nerve is first compressed; then nothing is noted until the pressure on the nerve has been released. A painful paresthesia will then develop some time after the pressure on the nerve trunk has ceased (86). When adjusting patients with an acute low back syndrome, it is important to advise them that after the adjustment there may be a dull aching sensation along the distribution of the nerve. The pain is usually mild, and can be abated with cryotherapy if needed.
Discussion of this issue with the patient before the pain occurs will increase the patient’s confidence in the care he or she is receiving. The decision to decrease or increase the frequency of adjusting should be based on the findings of the low back rather than extremity symptomatology. Nonetheless, as the pain moves below the knee, it is usually a sign to decrease the frequency of adjusting.

The release phenomenon must always be differentiated from peripheralization of pain caused by increased nerve root compression. The patient whose low back pain is suddenly relieved after a long lever rotational manipulation, but who now suffers from intense sciatica, most likely has consequently developed a ruptured disc. Sharp pain in the lower extremity is rarely a good sign.

Prone Reduction

The patient with an acute disc injury will typically present in a flexed posture. To achieve a more normal position, the assistance of a mechanical table is often needed. The hi-lo table can be put in the upright position with the pelvic and abdominal sections raised, to conform to the flexion position of the patient (Fig. 7.33). The patient can then be placed against the vertically positioned table. The hi-lo table can then be gradually lowered to a horizontal position.

Cryotherapy may be applied in the prone position for 15–20 minutes to reduce superficial inflammation, and anesthetize the skin so that more comfort can be afforded the patient when contact is made over the posterior tis-
sues. Gradually, the pelvic and abdominal sections are lowered until the flexion posture has been reduced as much as possible. This must be accomplished very gradually and to patient tolerance. It may take ten minutes or more to achieve a relatively flat position. The flexed posture can also be accommodated on the slot table (Figs. 7.34–7.35). The determined level of involvement can then be slightly translated forward in a "pumping action" (i.e., mobilization) to dissipate fluids in the area and encourage an anterior migration of bone and disc material. A slight pressure is first applied and then held for several seconds (85). From here, slightly more pressure is applied, then held (Fig. 7.36). The doctor should avoid bringing the joint to tension and then releasing it entirely before applying the next sequence. Patient tolerance will dictate how the procedure is applied. In some cases, the pressure may need to be completely released before another sequence of mobilization is begun. After 5–20 mobilization procedures are applied, the pressure should be carefully released.

Cryotherapy can be applied again while the patient is in the prone position. Although instant relief can sometimes occur, the patient’s level of symptomatology usually will not immediately change after the treatment.

Deterioration should not result however. If the leg pain becomes more severe or develops while the patient undergoes the procedure, then the mobilization should be ceased.

The doctor should always apply adjustments and mobilizations that tend to centralize the patient’s symptoms. If leg pain is worsened with a particular therapy, then this contraindicates the procedure. An adjustment can be made with the patient in the prone position on either the knee-chest or hi-lo table (87), however, reduction in the side posture position is often more comfortable for the patient.

Side Posture Reduction

Mobilization of the motion segment can be accomplished in the side lying position, which is used if the patient cannot tolerate being placed prone. The patient will usually need to lie on the side that is most comfortable. The doctor should not attempt to move the patient into the correct position on the table. Rather, the patient can be allowed to use the doctor’s body, to aid in movement. The patient’s tolerance to pain is something only they know, the doctor should avoid testing it, beyond offering an arm for stabilization. Occasionally, lifting the legs from the floor to the table as the patient moves into the side posture position may be helpful. After the patient is placed in side posture, ask if the leg pain, if any, is worsening. Peripheralization of symptoms during a particular position, is a
contraindication for that posture. If the protrusion is pos-
terolateral (i.e., medial, lateral or beneath the nerve root),
then the involved side should be placed “up” in the side
posture position. If the bent leg also has nerve root tension
signs, then positioning may be more difficult on this side.
Occasionally the involved side may need to be placed
towards the table. Care must be taken to modify the pre-
tensioning procedure before the thrust. Tension should be
developed by decreasing the lateral flexion component of
the listing.

Before attempting a thrust into a patient, the area
should be iced thoroughly so that there is little increase in
symptomatology when attempting to locate the contact
point of the involved segment. The spinous process con-
tact is generally preferred, because this contact point will
have a tendency to move the entire segment forward with
a posterior to anterior (+Z) thrust. Thrusting onto a
mamillary process will tend to “spin” the vertebra some-
what. After the thrust, it is especially important to hold
pressure on the segment (Fig. 7.37). Backing off rapidly,
or “recoiling,” can be extremely painful for the patient in
acute pain. The doctor will only get one attempt to make
a reduction, so the first should count.

As when getting onto the table, the patient should help
themselves up with only minimal assistance from the doc-
tor. The doctor should carefully guide the legs off of the
table while the patient pushes up with the arm (Fig. 7.38).
Moving the legs off of the table first, will act as a counter
weight for the upper body, thereby facilitating getting into
a vertical position. Once seated on the table, the patient
should be encouraged to stand as soon as possible,
because disc pressure will increase while in the seated
position. After the adjustment, the patient should be
couraged to walk as long as possible or until the pain
begins to increase. The patient can remain recumbent
after the treatment or may be encouraged to walk if pos-
sible. Sitting and forward bending should always be
avoided because of the increase in disc pressure.

A patient with an acute lumbar disc lesion can be
adjusted at six hour intervals although usually two adjust-
ments per day are all that is required (84). A positive
response is generally seen after only a few treatments. If
improvement is not observed, then a reevaluation should
be made.

Despite the localization and clear cut symptomatol-
ogy, the entire musculoskeletal system should be exam-
ined. The presence of upper cervical subluxation espe-
cially, should not be overlooked as a complicating
variable (85). Theoretically, neurologic tension in this
area leads to abnormal paraspinal muscle hypertonicity,
contributing to the patient’s dysfunction.

A study by Tich’ y et al. (88) showed a beneficial effect
on symptomatology of sciatica patients when their pos-
terior rib articulations from T5 through T7 received
manipulative therapy. This again illustrates the impor-
tance of examining the entire spine in the patient with an
apparently localized disorder such as an L5 disc
herniation.

Walking should be encouraged as a form of therapy.
Not only does this keep the individual from sitting, which
would place more stress on the lumbar spine, but it is
known that those individuals who walk more in their
occupation have a lower incidence of lumbar disc degen-
eration (89). The walking might create movement in the
area, without compromising the restraining elements,
especially the ligaments. Swimming is another excellent
therapy, which because of its antigravity medium, places
very little stress on the lumbar spine, while causing move-
ment at the various articulations.

The use of flexion distraction treatment as well as Wil-
liam’s flexion exercises, is not advocated here. Our goal is
to restore the lumbar lordosis, not reduce it. A study by
Ponte et al. (90) found that extension exercises were supe-
rior to those involving flexion in decreasing low back pain
and hastening the return to pain-free lumbar motion.
Considering the fact that 90% of the damage that occurs

![Figure 7.37](image1.png)

**Figure 7.37.** Set-hold characteristic of the adjutive thrust.

![Figure 7.38](image2.png)

**Figure 7.38.** Getting off of the pelvic bench requires pushing up
with the arm, while the legs provide the necessary counterbalance
to the upper body.
in low back injury is posterior to the nucleus pulposus, flexion therapies would most likely stretch already torn and sprained ligamentous elements. Long-term use of flexion and traction procedures could lead to ligamentous laxity, muscular stretch and weakness, as well as intervertebral joint instability (87). Schnebel et al. (91) studied the effects of flexion and extension on changing nerve root compression in experimental disc herniation. The amount of compressive force and tension in the nerve root increased with flexion of the spine and decreased with extension. This would also agree with the work of Brieg (92) on spinal cord tension (See Chapter 2). It is acknowledged however, that there is some empirical evidence (38) that flexion distraction therapy, in conjunction with a multitude of other therapies, appears to provide some measure of symptomatic improvement for patients with low back pain.

The ruptured lumbar disc, with a free fragment compressing the nerve root, may require operation. Surgical or expert consultation is recommended for patients unresponsive to chiropractic care, those with progressive neurologic deficits, and patients with cauda equina syndrome.

White et al. (93), in a prospective controlled study on patients with herniated lumbar discs, found that those patients treated with fusion, had a significantly longer average time to return to work after surgery, versus a group of patients who only underwent laminectomy. Their conclusion was that fusions were not necessary and that simple laminectomy would suffice. It is well known that fusion patients will likely develop instability at levels above the fusion site at a later date (66).

**CHRONIC LOW BACK PAIN**

Waagen et al. (94) have presented a double blind clinical trial of the effects of adjunctive therapy delivered by chiropractors on a group of chronic low back pain patients. The treatment group had significantly more pain relief compared to a control group as well as improvement in spinal mobility.

Meade et al. (95), in a randomized controlled trial, determined that chiropractic treatment was superior to hospital outpatient treatment in the management of low back pain. Seven hundred forty-one patients participated in the trial. Outcomes were primarily determined by a change in the Oswestry disability index. The authors concluded that for patients with low back pain in whom manipulation is not contraindicated, chiropractic almost certainly confers worthwhile long-term benefit, in comparison with hospital outpatient management. The benefit is more clearly seen in those with chronic or severe low back pain. The authors recommended that chiropractic care be included in the National Health Service of Britain based on the results of the study.

**Facet Syndrome**

Pain arising from the posterior joints of the lumbar spine appears to be quite common. Isolating two aspects of a three joint complex will often lead to ineffective management however. Facet injury likely does not occur in the absence of injury to the intervertebral disc (5,96). Nevertheless the “facet syndrome” has crept into the diagnostic jargon of physicians and therefore deserves some mention.

Perhaps as many as 80% of patients with chronic low back pain have some of their symptomatology arising from the posterior joints (97). Retrolisthesis and disc degeneration will lead to telescoping of the facet joints and the production of pain from nerve entrapment and stretched joint capsules (Fig. 7.39).

An increased sacral base angle or hyperlordosis can place additional compressive stress on the posterior joints (98). Pain is primarily due to stretching of the articular capsules, or bone to bone contact giving rise to periosteal pain. Hourigan and Bassett (98) have compiled the typical signs and symptoms of patients with lumbar facet syndrome (Table 7.2).

Because facet syndrome is often caused by facet overriding due to hyperextension and retrolisthesis of the segment, closed manipulative reduction is the treatment of

![Figure 7.39](image)
Table 7.2.
The Classic Symptoms and Signs of Lumbar Facet Syndrome*

<table>
<thead>
<tr>
<th><strong>Classic Symptoms</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hip and buttock pain</td>
</tr>
<tr>
<td>2. Cramping leg pain, primarily above the knee</td>
</tr>
<tr>
<td>3. Low back stiffness, especially in the morning or with inactivity</td>
</tr>
<tr>
<td>4. Absence of paresthesias</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Physical Signs</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Local paralumbar tenderness</td>
</tr>
<tr>
<td>2. Pain on hyperextension of the lumbar spine</td>
</tr>
<tr>
<td>3. Absence of neurologic deficit</td>
</tr>
<tr>
<td>4. Absence of root tension signs</td>
</tr>
<tr>
<td>5. Hip, buttock, or back pain on straight leg raising</td>
</tr>
</tbody>
</table>


choice. Banks(99) has shown that reduction of the hyperextension component of the lesion is readily attainable with side posture manipulation. A statistically significant decrease in the average disc angle at the involved level was detected in his sample of 13 patients with clinical diagnoses of facet syndrome.

Plaugher et al. (23), in a retrospective, consecutive case analysis study, detected an average (mean) reduction in retrolisthesis of 34% in 49 patients. The technique employed, emphasized posterior to anterior forces (+Z) in the side posture position. Post radiologic evaluations were made after an average of eight treatments.

LUMBAR KYPHOSIS

Lumbar kyphosis can be caused by a variety of subluxation patterns. A common cause is severe axial rotation of the lumbar spine or pelvis. Sacral rotation, or a rotated fifth lumbar could be contributory. If the patient also has an ipsilateral degeneration of the acetabulum, then an ASIn subluxation of the ilium may be involved (85).

BILATERAL SCIATICA

Bilateral symptoms in any patient should be a cause for concern. Carcinoma and diabetic neuropathy must be ruled out. Mechanical causes of bilateral sciatica include a large centralized disc herniation or extreme degeneration of the motion segment (85).

LIFESTYLE AND ERGONOMIC FACTORS

Deyo and Bass (100) have studied the potential risk factors of smoking and obesity on low back pain. Generally, greater obesity leads to a higher incidence of low back pain, especially in those grossly overweight. Back pain prevalence tends to rise with increased levels of smoking.

Videman et al. (101) studied patient-handling skills of a group of nurses and compared this with the incidence of back injuries. They discovered that poor patient handling skills, low number of repetitions in a sit-up test, and high work-load scores were major risk factors for having a back injury. It was concluded that back injuries could be prevented by the teaching of patient-handling skills.

The biomechanics of lifting without injury (See Chapter 2) should be explained to the patient. For those individuals with lumbar disc injury who must sit for long periods, the use of a knee-support chair may decrease symptomatology by increasing the lumbar lordosis, thus reducing internal disc pressures (102) (Fig. 7.40)

REHABILITATION

Muscle

Mayer et al. (103) determined flexion and extension strength of the lumbar spine in pain-free and symptomatic patients. Low back pain patients had decreased strength for both flexion and extension motion, and greater variability. Extensor strength tended to be more affected than flexor strength. The discrepancies between symptomatic patients and controls was more noticeable in females. High speed drop-off ratios were also much lower in the symptomatic group. Their conclusion was that strength deficits are a major factor in the deconditioning syndrome associated with chronic low back pain.

While it is unlikely that reduced strength is what caused the injury initially, it behooves the practitioner to consider rehabilitative exercises as part of the overall management approach, especially if the patient must return to an ergonomic environment where large demands are going to be placed on the muscular system.

In a study of the effects of modern rehabilitation on chronic low back pain and disability, disappointing results were observed (104). The four week program consisted of three to five training sessions a day, six days a week. The training employed ergometer bicycling, tread-
mill running, group training with aerobics, swimming, paddling, skiing, hiking, and riding. This type of program has been previously shown to increase muscle power by 14% and aerobic capacity by 30% (105). At 18 months follow-up, only 15 of the 66 (23%) low back pain patients had returned to work. It is clear from this report that rehabilitation alone has little effect on a person returning to work. Perhaps if chiropractic care were combined with the program, a more positive result would have emerged. This question remains unanswered until further research is performed.

A clinical trial by Donchin et al. (106), showed that a calisthenics program increased lumbar flexion more than back school, in a group of chronic low back pain patients. The trial attempted to determine if the therapies had a significant effect on prevention of pain in 142 hospital employees reporting at least three annual episodes of the condition. After three months of treatment, pain was also significantly reduced in the calisthenics group.

Stankovic and Johnell (107) evaluated the effects of McKenzie (108) extension exercises in a prospective randomized clinical trial on patients with acute low back pain. Comparisons were made between extension exercises and maneuvers designed to improve the lumbar lordosis, and a “mini back school” that consisted only of back care education. In this study, McKenzie’s treatment for acute low back pain was significantly better than patient education in a back school, with regard to return to work during the initial period, sick-leave during the initial episode, recurrences during the first year, pain, and spinal movement.

**UNUSUAL CAUSES OF LOW BACK AND LEG PAIN**

**Aneurysm of the Abdominal Aorta**

Vernon et al. (109) report on two patients with abdominal aortic aneurysms (AAA) that presented to chiropractors’ offices with a chief complaint of low back pain (Fig. 7.41A-B). The first case had radiographic evidence of a pulsating mass in the lower abdomen consisting of slight erosion of the anterior vertebral body of L4 and a faint curvilinear calcification to the left of L4. The patient was subsequently referred for a diagnostic ultrasound examination that confirmed the clinical impression. No other physical findings were present in this patient which would have indicated the possibility of AAA. The second case was initially diagnosed as a herniated nucleus pulposus and was referred for CT examination. CT findings suggested the possibility of AAA which was later confirmed with diagnostic ultrasound.

An excellent review of AAA has been provided by Hopkins (110). In England, an AAA is found in 3% of the population over age 50. It causes death in 1.5% of these cases (110). The incidence appears to be increasing in the U.S. This is due, in large part, by the use of modern scanning techniques that can detect much smaller aneurysms. Aneurysms grow at the rate of about 4 to 5 mm a year.
Small aneurysms can rupture. There are no reported cases of rupture of the abdominal aortic aneurysm after manipulation.

Calcification of the abdominal aorta can be easily seen on the lateral lumbar or oblique radiograph (Fig. 7.42). This sign is usually indicative of generalized atherosclerosis. By itself, calcification of the abdominal aorta is not a contraindication to manipulation or indicative of an aneurysm or weakened aorta. The calcified outline should be uniform throughout. An aneurysm is usually readily identifiable if calcification is present. Erosion of the anterior portion of the vertebral bodies is generally the only other radiographic finding.

**Peripheral Vascular Disease**

Peripheral vascular disease can create leg pain that may be difficult at times to differentiate from central canal stenosis. Rest will usually relieve the pain of vascular claudication, and exercises such as walking or bicycle riding will provoke it (111).

**Carcinoma**

Primary carcinoma of the spinal column or cord is extremely rare. MRI is useful in the differential diagnosis of these tumors (Fig. 7.43A-B).
The spine is the primary site for metastasis of cancer elsewhere. The pain associated with metastasis is unrelenting, intense, and progressive (111). Lytic metastasis to the spine can be extremely difficult to detect at times (Fig. 7.44A-B). Evaluation of the integrity of the neural arch with a CT scan is requisite before considering adjutant procedures. Metastasis is a contraindication to manipulation only if the specific metastatic site would be compromised with an adjustment.

EXAMINATION OF MECHANICAL DISORDERS

A review of the examination procedures in Chapter 4 may benefit the reader. This section represents only a synopsis.

Swelling or trophedema over the lesioned areas may be the most pronounced sign of dysfunction in the lumbar spine. The supraspinous ligament, being the furthest from the center of rotation of the motion segment, is damaged early on, and will present with edema, scar tissue formation, erythema, and tenderness. While the supraspinous ligament does not often extend over the L5-S1 area, damage to the soft tissue structures in the region, will present with the same findings.

A restriction of mobility (43) will be suspected through motion palpation but confirmed by stress radiography (Fig. 7.45A-B). Stress radiographs are an integral part of the lumbar examination because of the apparent unreliability of most lumbar end-play motion palpation procedures (112). Intersegmental range of motion palpation in lateral bending can be used as a means for assessing global and intervertebral motion, progress on a day to day basis, and to determine the momentary effectiveness of an adjustment. Global motion in lateral bending can be readily analyzed by looking caudally and observing an inflexion point (See Chapter 4) in the pattern of movement.

Skin temperature instrumentation can be used over the lumbar spine. A large linear heat stripe (113,114) can usually be detected if nerve root compression is present. Dermatomal analysis can be obtained with liquid crystal or telethermography (115). The thermocouples of hand-held instrumentation should be kept equidistant from the midline and over the peak portion of the paraspinal musculature during scanning (116). Motor function, reflexes and dermatomal assessments should be made for the lower extremities (Fig. 7.46A-C).

Plain Film Radiography

LATERAL RADIOGRAPH

The lumbar marking procedure is presented in Chapter 5. The static lateral radiograph is of help in localizing the level of involvement. The disc space shapes can be eval-
Figure 7.45. A, Left lateral flexion demonstrating failure of normal coupling motion at multiple levels. B, Right lateral flexion demonstrates fixation dysfunction at L5.

uated with this view. In addition, retrolisthesis and any associated hyperextension (−θX) of the vertebral body can be determined.

Posteriority of the segment is the major direction of positional dyskinesia of the lumbar spine (Fig. 7.47A-B). Retrolisthesis is common and is a sign of axial rotational injury (16). The vertebra must first subluxate posteriorward in order for any appreciable degree of axial rotation to occur.

The lumbar flexion view will rule out retrolisthesis caused by instability. If the segment moves anteriorward during flexion, then posterior to anterior adjustments are contraindicated at that level (See Instability).

AP RADIOPHGRAPH

Because the spinous process on an A-P film represents the tip of the spinous process (117), this structure is not used in the evaluation of axial rotation. Instead, a combination of the pedicle and articular process sizes, as well as the compensation above the level of involvement, are used. The compensatory curve will usually deviate initially in the direction(s) of the subluxation.

Because the vertebra can subluxate and become fixed in three dimensions, visualization of rotation in the coronal plane (wedge or lateral flexion) is important. Often times, protrusion of the intervertebral disc will be present on the open side of the wedge (Fig. 7.48A-B). Any adjustment should attempt to reduce this angular displacement. The annular protrusion can also occur on the closed side of the wedge (See Chapter 3).

Lateral bending radiographs will be helpful for diagnosing fixation and hypermobility. Abnormal coupling patterns can also be determined.

The treatment is designed to reverse the pathology of the joint through primarily the adjustment and other therapies such as postural maneuvers to affect the global ligamentous and muscular elements, exercises, and ergonomic instruction.

Listing System

A listing system is a short hand nomenclature to qualitatively describe the positional dyskinesia of a motion segment, taking into account all six degrees of freedom (56,118). The thrust of the adjustment is exactly opposite to the direction(s) of the positional dyskinesia. This is thought to lessen the likelihood that further ligamentous laxity will occur from forcing the vertebra in the direction of ligamentous injury (119). The International and the Palmer-Gonstead-Firth listing systems are presented here (118).

Because the main function of the listing system is to direct the thrust, all possible positional dyskinesias are not necessarily listed. For example, while a cervical vertebra or the sacral base can move anterior, they are not listed because there is no adjustment that is made directly from anterior to posterior (i.e., through the pharynx or the pel-

![Figure 7.47](image-url)  
**A**, Retrolisthesis of L5. There is a mild protrusion of the annulus posteriorward. **B**, Retrolisthesis of L5 with severe internal disc disruption.
vic organs). Rather, the fifth lumbar is said to be posterior to the sacral base and adjusted from posterior to anterior. A cervical vertebra may be anterior to the segment below. The inferior segment, if subluxated, can then be adjusted to partially remedy the situation.

Severe ligamentous laxity precludes a good prognosis for reduction of positional dyskinesia. There is little scientific evidence that adjustments can affect the positional dyskinesia component of the subluxation complex (23, 67, 99, 120). Nevertheless, the listing is used to maximize the potential for repositioning to occur.

A three-dimensional listing system is a good communication tool (provided others understand it) that assists in the reproducibility of adjustments, both between adjustments of a series performed by one doctor, and adjustments administered by different chiropractors.

The pattern of thrust must take into account the center of mass of the vertebra and be directed through it anteriorward. In most instances, an arcing motion upward will be made at the beginning of the thrust. This flexes the segment to decrease any hyperextension of the segment. The vertebra is then driven straight forward, through the plane line of the disc or perpendicular to the lumbar lordosis (Fig. 7.49).

The spinous process contact is usually preferred to the mamillary, because of the more direct contact that can be made. The mamillary contact is usually less able to reduce the posteriority of the segment, which may be a major component of the listing. Intersegmental axial rotation is usually relatively minor in the lumbar spine, unless a coronally orientated facet joint is involved. Lateral flexion can be a major dysfunctional direction. This is chiefly corrected by "kinking" the segment into lateral flexion during positioning and preload or "tension." Further lateral flexion can be attained by introducing a screw motion or torque during the thrust. The posterior to anterior vector is followed by an inferiorward or caudal arcing motion or torque (Z axis) that attempts to laterally flex the motion segment further. The segment is then held in this position for 1–2 seconds, or longer if the doctor wishes to take full advantage of ligamentous, muscular, and tendinous creep. These viscoelastic structures respond most favorably to constant loads applied over a long period of time. If a nuclear fragment is being directed centrally, then "holding" the segment is thought to accentuate this effect.
In some acute situations, it may be difficult to hold a sustained pressure.

Careful attention should be made to protecting the surrounding normal or hypermobile segments in an effort to minimize any harm to these articulations. The doctor should try to create a fulcrum at the articulation to be adjusted by stressing the spine at the involved level through prepositioning.

The amount of force involved in an adjustment in the side posture position is on the order of 80–100 lbs (119). The force would be much less for pediatric or geriatric patients and any other situation where less force is desired. The amount of the thrust is always to patient tolerance and should be as comfortable as possible. The acute patient situation may be exacerbated somewhat during a thrust, but pain should rapidly subside after the maneuver. An increase in symptomatology is a contraindication for further manipulation until a reevaluation is made.

When the vertebra has subluxated posterior it is listed with the letter “P”. This represents a \( -Z \) translational vector and is corrected in the adjustment by thrusting in a posterior to anterior direction. Other letters of the listing include “R” or “L” for listing either spinous rotation to the right \( (+\theta Y) \) or left \( (-\theta Y) \).

If the vertebra is also tilted in the coronal plane (wedge- ing) then this too is listed. When the spinous process of the vertebra \( (\pm \theta Y) \) has rotated to the higher side of the wedged disc, an “S” (superiority) \( (\pm \theta Z) \) is placed after the rotational component. If the spinous process has rotated to the inferior side of the wedge, then an “I” will follow the spinous rotation letter.

The contact point (mamillary or spinous) follows the listing as either an “m” or “sp.” PLI and PRI listings are adjusted using a mamillary contact (the exception is L5). P, PL, PR, PR5 and PLS listings are adjusted with a spinous process contact. If no wedging is present \( (\pm \theta Z) \), PL and PR may be adjusted with a mamillary contact, if the spinous process has rotated towards the concavity of a scoliosis (Fig. 7.50A-B).

The radiographs provided with the adjustment descriptions are not meant to represent the total examination, but rather a way to conceptualize the three-dimensional thrust. The radiograph is a two dimensional image of a three-dimensional patient. An artist’s rendition of some listings, from the perspective of the doctor before the thrust, is provided. This will hopefully orient the doctor from two dimensions to three. The displacements illustrated are not meant to be anatomically correct, and may be exaggerated somewhat, to illustrate the vectors of the thrust. Keep in mind, that the pattern of thrust may vary during the adjustment.

Simply achieving an audible is not the sole indicator of a successful adjustment. An audible should occur however, unless there is marked edema in the area.

Figure 7.50. A, A mamillary contact is used if the spinous has rotated towards the concavity of a scoliosis. The thrust of an adjustment should never be towards the concavity of a curve. B, The spinous contact can be used for the adjustment because it has rotated toward the convexity of the scoliosis.

Because the adjustment is a highly coordinated event, the doctor should refrain from thinking “cerebrally” during the actual thrust. The doctor should only conceptualize the movement of the vertebra towards a more normal position. In this way the fixation component is necessarily addressed, without traumatizing the joint by moving it into the direction of injury.

**Special Listings of L5**

In most instances the wedging of the disc is corrected by pretensioning and thrusting from the opened side of the wedge towards the center. It is generally not preferred, to attempt to open the closed side by making a superiorward arcing motion during the thrust. This is due to the freely movable nature of the segment below. The exception to this, is the case of L5, because the sacrum and pelvis can remain relatively stable during an adjustment. If a lumbar scoliosis is present, then this supersedes the requirement for adjusting from the open towards the closed side of the wedge if the contact segment is L5 (56). Essentially, the wedging of L4-L5 is used to determine if there is a special listing for L5. When there is wedging of L4, then the opened side is placed up in the side posture position (Fig. 7.51A-C). Doing this, may mean that the L5 segment wedging is opposite to the L4 level. To decrease the lateral flexion component of the listing, the L5 segment is torqued superiorly with a cephalad arcing motion towards the end of the thrust. If no scoliosis or wedging is present at L4, then conventional or simple listings are used for L5.

**ADJUSTMENT**

**Side Posture Position**

The side posture position is generally the preferred position for adjusting the lumbar spine (See Chapter 6) (Fig. 7.52). The doctor should first place the pillow at the
appropriate end of the table. The patient is then instructed to sit in the center of the table and then to lie on either the right or left side. The inferior leg is kept straight, in line with the rest of the spinal column. The superior leg is bent, with the patient’s foot tucked behind the popliteal fossa. The inferior foot should be allowed to roll forward when the patient is brought closer to the doctor. This can be accomplished by allowing the foot to hang off of the end of the table. The inferior shoulder should be pulled caudally.

The doctor then contacts the appropriate short lever arm by taking a tissue pull in the direction of correction (Fig. 7.53). When identifying the contact point, it is helpful to use the radiograph. The AP view can be used to determine the relationship of the spinous process to its mamillary process. The lateral view is of help in determining the shape of the spinous process in relation to others in the area. Wiggling the leg forwards and back should be avoided. Because L5 is the last freely movable vertebra, this method could theoretically be used to differentiate a movable L5 from an immovable S1. If L5 is fixated, as it should be if an adjustment is considered, there may or may not be movement at this level.

As can be seen in Figure 7.54 the patient is rolled over towards the doctor so that a posterior to anterior line of correction is easily attained. To be rolled forward this far, the patient needs to be prepositioned towards the center of the table. Different doctor and patient somatotypes prohibit broad generalizations for the side posture position. The key points to keep in mind are as follows:

1. The joint should be brought to tension by rolling the patient over with the contact on the spinous or mamillary process.
2. As the patient is rolled forward the shoulder should be allowed to roll forward as well, in order that the thoracic spine is not excessively rotated.
3. The body drop should be into the pelvis, directly opposite the thrusting vector of the contact hand (e.g., pisiform).
4. The segment contacted is held for several seconds after the thrust.
5. If a patient lifts the inferior leg before the thrust, it shows absence of relaxation. So, instruct the patient to let the leg go. Similarly, if the patient attempts to arch the spine anteriorward while rolled forward, this would necessitate contracted erector spine muscles. In some instances, the patient may need to be asked to flex the lumbar spine before the thrust. If this needed, it is important to not axially rotate the lumbar spine during the flexed posture because this is a vulnerable position for torsional injury.
Figure 7.53. Placing the contact hand on the spinous process of L5 while taking a tissue pull with the stabilization hand. The tissue pull should be similar to the pattern of thrust.

Figure 7.54. Set-up for a posterior L5 adjustment. Notice the lack of any twisting to the thoracic and lumbar spine. The patient is in a nearly prone position, which facilitates the posterior to anterior thrust without compromising the doctor’s spine.

Name of technique: Gonstead

Name of technique procedure: Posterior L5 ($-$Z) side posture adjustment (Fig. 7.55A-B).

Indications: Retroolisthesis of L5 with decreased anteriorward translation during flexion.

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: Right or left side posture position.

Doctor’s position: Standing at a 45° angle facing cephalad.

Contact point: Posterior, inferior border of the spinous process.

Supporting Hand: Contacts the anterolateral portion of the shoulder and axilla region with a slight cephalad distraction.

Pattern of thrust: A slight inferior to superior pattern followed with a marked posterior to anterior vector along the sacral base angle. It is important to keep in mind that the sacral base angle is reduced when the patient lies in the side posture position. It is further reduced when the patient’s thigh is flexed just before the thrust.

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: Posterior, inferior L5 ($-$Z, $-$θX) side posture adjustment (Fig. 7.56A).
Indications: Retrolisthesis of L5 (7.56B) with decreased anteriorward translation and flexion during forward bending.

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: Right or left side posture position.

Doctor’s position: Standing at a 45° angle facing cephalad. Contact point: Posterior, inferior border of the spinous process.

Supporting Hand: Contacts the anterolateral portion of the shoulder and axilla region with a slight cephalad distraction.

Pattern of thrust: A moderate inferior to superior pattern followed with a posterior to anterior vector along the sacral base angle. It is important to keep in mind that the sacral base angle is reduced when the patient lies in the side posture position. It is

Figure 7.55. A, Pattern of thrust for a posterior L5. In this example, the patient is kept in a side posture position during the thrust. Doing so, necessitates that the doctor lean over the patient to maximize the posterior to anterior vector. B, Pattern of thrust for a posterior segment.

Figure 7.56. A, The pattern of thrust for a posterior and inferior (P-inf) \((-Z, -\theta X)\) L5. B, Retrolisthesis of L5.
further reduced when the patient’s thigh is flexed before the thrust.

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: PLS (−Z, −θY, +θZ)L5 side posture adjustment (Fig. 7.57).

Indications: Retrolisthesis of L5 with decreased anteriorward translation and flexion during forward bending. Fixation dysfunction in right spinous rotation (+θY) and left lateral flexion (−θZ).

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: Right side posture position.

Doctor’s position: Standing at a 45° angle facing cephalad.

Contact point: Posterior, inferior, left lateral border of the spinous process. The tissue pull for the lateral flexion positional dyskinesia should be from superior to inferior.

Supporting Hand: Contacts the anterolateral portion of the shoulder and axilla region with a slight cephalad distraction.

Pattern of thrust: Posterior to anterior vector along the sacral base angle. It is important to keep in mind that the sacral base angle is reduced when the patient lies in the side posture position. It is further reduced when the patient’s thigh is flexed before the thrust. 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-inf (−Z, +θY, −θZ, −θX) L5 side posture adjustment (Fig. 7.58A-D).

Indications: Retrolisthesis of L5 with decreased anteriorward translation and flexion during forward bending. Fixation dysfunction in left spinous rotation (−θY) and right lateral flexion (+θZ).

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: Left side posture position.

Doctor’s position: Standing at a 45° angle facing cephalad.

Contact point: Posterior, inferior, right lateral border of the spinous process. The tissue pull for the lateral flexion positional dyskinesia should be from superior to inferior.

Supporting Hand: Contacts the anterolateral portion of the shoulder and axilla region with a slight cephalad distraction.

Pattern of thrust: Slightly inferior to superior and posterior to anterior along the sacral base angle. It is important to keep in mind that the sacral base angle is reduced when the patient lies in the side posture position. It is further reduced when the

Figure 7.57. PLS L5 adjustment.
patient’s thigh is flexed before the thrust. Lateral to medial \((-\theta Y)\), with an inferiorward arcing motion \((+\theta Z)\) toward the end of the thrust.

Category by algorithm: Short lever specific contact procedure.

Special listings of L5 can be adjusted in the side posture position (Fig. 7.59) using the Gonstead method. The torque, if applicable, will be superiorward.

Name of technique: Gonstead

Name of technique procedure: PRS-m \(L_5\) \((-Z, +\theta Y, -\theta Z)\) side posture lumbar adjustment (Fig. 7.60).

Indications: Retrolisthesis of L5 with left lateral flexion positional dyskinesia and left body rotation. Left convex scoliosis with right lateral flexion of the L4-L5 motion segment necessitates using the left mamillary process as the contact point (special listing).

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: In the right side posture position.

Doctor’s position: Standing at a 45° angle facing cephalad.

Contact point: Left mamillary process with the pisiform. The fingers should be oriented along the axis of the spine.

Supporting Hand: Contacts the anterolateral portion of the shoulder and axilla region with a slight cephalad distraction.
Figure 7.59. L5 PLI-sp special listing side posture adjustment. The contact point is the posterior, inferior and lateral aspect of the spinous process of L5 with the pisiform. The pattern of thrust is depicted.

Figure 7.60. L5 PRS-m special listing side posture adjustment. Contact is made on the left mamillary process of L5. The pattern of thrust is depicted.

Pattern of thrust: Posterior to anterior (+Z) with a superiorward arcing motion (+θZ) toward the end of the thrust.

Category by algorithm: Short lever specific contact procedure.

Technique: Gonstead

Technique procedure: L4 PL (−Z, −θY) side posture adjustment (Fig. 7.61A).

Indications: Retrolisthesis (−Z) of L4 (Fig. 7.61B) and left spinous rotation (−θY). Fixation dysfunction in flexion and right spinous rotation (+θY).

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

Patient position: On the right side.

Doctor’s position: Standing at a 45° angle facing cephalad.

Contact point: Posterior, inferior and left lateral border of the spinous process of L4.

Supporting Hand: Contacts the anterolateral left shoulder and axilla region with a slight cephalad distraction.

Set Up: With the patient on the right side, the contact hand (R) is placed so that the pisiform is over L4, with the fingers pointing at approximately a 45° angle from the longitudinal axis of the spine. The patient is then rolled over towards the doctor with the pisiform contact thereby moving the L4-L5 articulation into the paraspinal area. The patient’s left shoulder is allowed to roll forward minimizing axial rotation of the spine. The doctor stabilizes the patient’s pelvis into the table.

Pattern of thrust: Posterior to anterior (+Z) through the L4-L5 disc plane with a slight lateral to medial (+θY) vector of thrust.

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: PLS L3 (−Z, −θY, +θZ) side posture lumbar adjustment (Fig. 7.62A).

Indications: Retrolisthesis of L3 (Fig. 7.62B) with right body rotation right lateral flexion positional dyskinesia (Fig. 7.62C).

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: Right side posture position.

Doctor's position: Standing at a 45° angle facing cephalad.

Contact point: Posterior, inferior, left lateral border of the L3 spinous process with the pisiform of the doctor.

Supporting Hand: Contacts the anterolateral portion of the shoulder and axilla region with a slight cephalad distraction.

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

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: L3 PL1-m (−Z, −θY, −θZ) side posture adjustment with pisiform contact (Fig. 7.63).

Indications: Decreased anterior translation (+Z) motion of the segment, right lateral bending (+θZ) and left axial rotation (+θY). Retrolisthesis, lateral flexion malposition (−θZ) and left rotational (−θY) positional dyskinesia of L3.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the mamillary process or superior zygapophyseal joint of L3, infection of the contact vertebra.

Patient position: Left side posture position.

Doctor's position: Standing at a 45° angle facing cephalad.

Contact point: Right mamillary process with the left pisiform of the doctor. The AP radiograph should be used to determine the location of the mamillary process in relation to nearby structures. The fingers do not cross the spine.

Supporting Hand: Contacts the anterolateral right shoulder and axilla region with a slight cephalad distraction.

Set Up: The patient is rolled over towards the doctor with the pisiform contact, thereby moving the L3-L4 articulation from the neutral zone to the elastic zone (maximal preload or "tension").

Figure 7.61. A, L4 PL side posture adjustment. B, Retrolisthesis of L4. C, Pattern of thrust for a PL L4.
The patient’s shoulder is allowed to roll forward minimizing axial rotation of the spine. The doctor stabilizes the patient’s pelvis into the table.

Pattern of thrust: Posterior to anterior (+Z) 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: L2 PRI-m (−Z, +θY, +θZ) side posture adjustment with pisiform contact (Fig. 7.64).

Indications: Decreased anterior translation (+Z) motion of the segment, left lateral bending (−θZ) and right axial rotation (−θY). Retrolisthesis, lateral flexion malposition (+θZ) and left rotational (1 θY) positional dyskinesia of L2.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the neural arch of L2, infection of the contact vertebra.

Patient position: Right side posture position.

Doctor’s position: Standing at a 45° angle facing cephalad.

Contact point: Left mamillary process with the right pisiform of the doctor. The fingers do not cross the spine.

Supporting Hand: Contacts the anterolateral left shoulder and axilla region with a slight cephalad distraction.

Set Up: The patient is rolled over towards the doctor with the pisiform contact, thereby moving the L2-L3 articulation from the
neutral zone to the elastic zone (maximal preload or “tension”). The patient’s shoulder is allowed to roll forward minimizing axial rotation of the spine. The doctor stabilizes the patient’s pelvis into the table.

Pattern of thrust: Posterior to anterior (+Z) (along the L2-L3 disc plane) 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: Base posterior side posture adjustment (Fig. 7.65A).

Indications: Retrolisthesis (−Z) of sacral base and/or +θX positional dyskinesia of L5-S1 (Fig. 7.65B). Decreased extension of the lumbosacral junction.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture of the neural arch or S1 tubercle, infection of the contact vertebra.

Patient position: On either the right or left side depending on the doctor’s or patient’s preference. If a lumbar scoliosis is present, then the convexity of the curve should be placed up.

Doctor’s position: Standing at a 45° angle facing cephalad.

Contact point: First sacral tubercle with a soft pisiform contact (i.e., left hand).

Supporting Hand: Contacts the anterolateral right shoulder and axilla region with a slight cephalad distraction.

Set Up: With the patient on the left side the contact hand (L) is placed so that the pisiform is over S1, with the fingers pointing at approximately a 45° angle from the longitudinal axis of the spine. The patient is then rolled over towards the doctor with the pisiform contact thereby moving the S1-L5 articulation into the paraphysiological, elastic zone. The patient’s right shoulder is allowed to roll forward minimizing axial rotation of the spine. The doctor stabilizes the patient’s pelvis into the table.

Pattern of thrust: Posterior to anterior (+Z) through the lumbosacral articulation with a cephalad arcing motion (+θX) toward the end of the thrust.

Category by algorithm: Short lever specific contact procedure.

Name of technique: Gonstead

Name of technique procedure: Side posture L5 spondylolisthesis adjustment (Fig. 7.66A).

Figure 7.63. L3 P11-m side posture adjustment.

Figure 7.64. L2 PRI-m side posture adjustment.
Figure 7.65. A, Base posterior side posture adjustment. B, A base posterior sacrum.

Figure 7.66. A, L5 spondylolisthesis side posture adjustment. Contact is made on the S2 tubercle. B, Spondylolisthesis of L5.

Indications: L5 spondylolisthesis (Fig. 7.66B) (Grade one or two) with decreased anterior translation of the sacral base during motion analysis. Grade three and four spondylolistheses are usually adjusted in the prone position.

Contraindications: All other listings, normal FSU, hypermobility, instability, destruction or fracture or infection of the sacrum.

Patient position: On either the right or left side depending on the doctor or patient preference. If a lumbar scoliosis is present, then the convexity of the curve should be placed up.

Doctor’s position: Standing at a 45° angle facing cephalad.

Contact point: S2 tubercle with a pisiform contact.

Supporting Hand: Contacts the anterolateral portion of the shoulder and axilla region with a slight cephalad distraction.

Pattern of thrust: Posterior to anterior (+Z) followed by an inferiorward arcing motion (−θX).

Category by algorithm: Short lever specific contact procedure.

KNEE-CHEST TABLE

The knee-chest table was developed in the early 1900’s to facilitate adjustments of the spinal column (121) (Fig. 7.67). Originally used with upper cervical technique, Gonstead modified both the table, and the thrusting
action; a set-hold procedure (56). The table gets its name from the position the patient assumes when on the table (Fig. 7.68). The face and chest are supported by a head or chest piece and the lower trunk is left unsupported. The patient’s knees rest on the base of the table. The chest piece or knee position can be adjusted so that the patient obtains a comfortable position with the spine relatively level from front to back. The segment being adjusted should be at the highest point on the spine, if possible.

General Indications

Patients beyond the first trimester of pregnancy may find it difficult to assume a prone position because of the protuberant abdomen (121). Because most thoracic adjustive procedures involve translatory thrusts along the Z axis (posterior to anterior), the pressure on the fetus may be harmful or cause anxiety in the patient. It is for these reasons that the table is especially suited for the gravid patient (See Chapter 14).

The knee-chest table provides a mechanical advantage to the doctor when adjusting the thoracic and lumbar spines. The knee-chest position lessens the amount of work by the doctor, which becomes critically important in the large or obese patient. In the typical side posture position for lumbar adjustments, the doctor must use coordination and strength to position the patient correctly and keeping them stable during and after the thrust. As much as possible, the patient should be asked to move into the appropriate position.

The advantage of the knee-chest table for adjustments of the thoracic spine and lumbar spine is accomplished through the torso being allowed to move freely in an anteriorward direction during the thrust. This is not so
when a normal flat table is used for the prone adjusting position. In the latter, the rib cage and torso provide increased stiffness to the anteriorward thrust, thereby necessitating a proportional increase in the amount of force. The magnitude of force is much less in nearly all knee-chest adjustments, compared to side posture. Because less force is needed to accomplish the adjustment, from the lack of resistance offered by the unstrained torso, the table is well equipped to handle those patients sensitive to high force techniques, such as the geriatric with osteoporosis.

The table can be used for adjustments to all vertebral segments. The table is rarely used for adjustments to the sacroiliac articulations (See Chapter 6). Clinical experience has been that the more flexible and shallow the sagittal curvatures are, the more easily the patient is adjusted in the knee-chest position (85). Conversely, the hyperkyphotic patient may be more easily adjusted on a typical flat or contoured table with support for the torso.

**Adjustive Thrust**

Because the mechanical advantage of the doctor is increased when the patient is in the knee-chest position, great care must be taken when the actual thrust is given (121). The patient should be completely relaxed and not supporting the chest with the upper extremities. The doctor guides the patient towards maximal +Z “tension,” allowing the abdominal and pelvic area to protrude towards the knee-piece. “Tension” can be described as a preload of the motion segment which brings the articulations to the end of their physiologic range of motion, before the parapathologic zone. In this position, the bodies of the lumbar vertebrae are separated at the anterior, allowing for eased +Z translational movement of the segment. The thoracic spine is translated anteriorly, similar to the lumbar spine, though less +Z translation is permissible because of the stiffness of the kyphosis to compression.

Preload is applied to the spine by contacting the appropriate short lever arm (spinous, mamillary, transverse, or the cervical lamina) and translating the joint involved along the +Z axis to the limit of its physiologic range. The transverse process of L5 can be used as a contact point if it is large. Care must be taken to translate the segment by taking into account the plane lines of the bodies of the vertebrae and the orientation of the articular facets. The arcing motion of the thrust through the center of mass of the vertebra is described in Figure 7.69. Directing the thrust normally to the spinal sagittal curves while minimizing vectors that create flexion or extension moments of the segment lessens the amount of longitudinal force encountered by the adjacent motion segments (121,122).

Once the joint has been brought to maximal preload, a high velocity and short amplitude thrust is administered. At the end of the thrust (i.e., at maximal transla-
cerebral hand under the abdomen of the patient, instructing them to raise the abdominal area. This will cause the spinous processes to protrude, easing palpation. With the other hand, the doctor can then count to the appropriate segment they wish to contact for the adjustment. The spinous (preferred) or mamillary process is the short lever arm contact point. The transverse process of L5 can also be used for a contact point because it is much stronger at this level. The transverse process of the other lumbar vertebrae are thin and weak. They should not be used as a contact point. Fracture of a lumbar transverse process can occur (86) (See Chapter 12).

Name of technique: Gonstead

Name of technique procedure: Posterior L5 knee chest table adjustment (Fig. 7.71A).

Indications: Retrolisthesis of L5 (Fig. 7.71B) with decreased anteriorward translation during flexion.

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: Knee chest position.

Doctor’s position: On either side of the patient facing perpendicular to the long axis of the spine.

Contact point: Posterior, inferior portion of the spinous process with inferior pisiform.

Figure 7.71. A, Posterior L5 adjustment. The flexion (+θX) moment would be accentuated if there was extreme inferiority (−θX) of the segment. B, Retrolisthesis of L5.

Figure 7.72. L5 PRS adjustment.

Supporting Hand: Placed over the contact hand. The supporting hand’s pisiform can be placed over the pisiform of the contact hand.

Pattern of thrust: A slight flexion motion precedes the posterior to anterior thrust along the plane of the sacral base angle.

Category by algorithm: Short lever specific contact procedure.

The inferior hand is used for the contact point at the lower lumbar levels. Either hand can be used for L3 and the superior hand is used for the upper lumbar segments (Figs. 7.72–7.76). For mamillary listings, the doctor reaches across the spine and thrusts back toward the doctor during the adjustment. The patient is stabilized with
the doctor’s knees (Fig. 7.77). The doctor can stand behind the patient for double-thenar contacts. The thrust is made with only one hand (Fig. 7.78). The base posterior can also be adjusted in the knee-chest position (Fig. 7.79).

**Combination Long and Short Lever Rotational Manipulations**

Haney and Mootz (123) question the rationale for introducing a rotational force into a patient with a herniated disc. They present a case that responded very unfavorably to this type of treatment. Barrale (87) points out that although long lever manipulations of the low back are generally “safe,” and do produce joint cavitation, they also produce the damaging forces of flexion combined
with axial rotation, and would therefore not be the treatment of choice in patients suffering from a lumbar disc bulge.

Rotational maneuvers are usually accomplished with the patient in the side posture position. The leg and thigh are flexed to provide the long lever. A manipulation of the leg could easily attain 1000 inch-pounds of torque by applying a 50 lb force at the end of a 20 inch femur (124). The force travels from the femur to the acetabulum, the sacroiliac joint, the sacrum, and finally to the fifth lumbar disc and cephalad motion segments.

In a finger push or pull move, the torque of the lower leg actually rotates the torn disc before the contact vertebra. Because the direction of spinous rotation of the listing is customarily placed towards the table, the sacrum is rotated the opposite direction when a kick is made (Fig. 7.80). One simple way to make the procedure more safe, would be to place the spinous rotation “up.” The kick and the lateral to medial thrust on the spinous process, would “align” the motion segment and theoretically exert the least tension on the annulus (Fig. 7.81).

The finger push or pull move should be considered an alternative procedure. A maneuver to be used with extreme caution and careful technique. Ideally, a relatively light kick should be used. It is preferable to attempt to move the lumbar segment solely with the thrust of the hand, without aid from the leg kick.

Technique Preference

The short lever arm, side posture adjustment of the lumbar spine is the preferred method for adjusting the lumbar
spine. The patient can be placed on either side during positioning, with appropriate changes in line of drive or pattern of thrust.

The second choice, generally, is the knee-chest table. The knee-chest table is especially useful for adjusting the obese, large, or pregnant patient. Reductions can also be made in the prone position, either on the hi-lo or slot table. The abdominal piece on the hi-lo can be lowered, or a pillow placed under the pelvis on the slot table, to provide for anterior excursion of the lumbar spine.

The combination long and short lever arm adjustment is generally the third choice of treatment when the patient cannot be adjusted satisfactorily with the other methods. However, it is obvious to any seasoned clinician who uses the procedure, that long and short lever arm techniques for the lumbar spine have been very helpful for a number of patients. Some patients may achieve reduction of the lumbar disc bulge with a rotational manipulation (125). It appears reasonable that the rotational aspect of the "kick" should be performed with extreme caution. Discussion of the relative risks and merits of the finger push or pull move procedures using the consensus process, and biomechanical analyses of the forces involved during the maneuver, should be high research priorities for the chiropractic profession.

REFERENCES

TEXTBOOK OF CLINICAL CHIROPRACTIC


