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Low Back Pain: an Orthopedic Review of Sacroiliac Joint Etiologic Theories, Key Diagnostic Criteria, and Effective Manual Therapy Treatment

Michael J. Ressler
University of North Dakota

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Low Back Pain: An Orthopedic Review of Sacroiliac Joint Etiologic Theories, Key Diagnostic Criteria, and Effective Manual Therapy Treatment

By

Michael J. Ressler

Bachelor of Science in Athletic Training and Biology
University of Mary, 1993
Master of Science in Anatomy and Cell Biology
University of North Dakota, 1996
Bachelor of Science in Physical Therapy
University of North Dakota, 1998

An Independent Study
Submitted to the Graduate Faculty of the
Department of Physical Therapy
School of Medicine and Health Sciences
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in partial fulfillment of the requirements
for the degree of
Master of Physical Therapy

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1999
This Independent Study, submitted by Michael J. Ressler in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

(David Kelly)
(Faculty Preceptor)

(Graduate School Advisor)

(Chairperson, Physical Therapy)
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Title Low Back Pain: An Orthopedic Review of Sacroiliac Joint Etiologic Theories, Key Diagnostic Criteria, and Effective Manual Therapy Treatment

Department Physical Therapy

Degree Master of Physical Therapy

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ABSTRACT

Physical therapists commonly evaluate and treat patients with referral of low back pain. There still remains great controversy whether sacroiliac joint dysfunction produces significant pathological problems. It is imperative that the therapist providing the care posses skillful knowledge in the areas of anatomy, biomechanics, evaluation, and treatment of sacroiliac joint dysfunction. These characteristics are required in order to effectively treat patients with low back pain possibly resulting from sacroiliac joint dysfunction.

The purpose of this independent study is to review existing literature with primary focus on the anatomy, biomechanics, evaluation, and efficacious manual therapy treatment of sacroiliac joint dysfunction. Primary areas of emphasis will include reliable and valid evaluation techniques as well as appropriate manual therapy treatment for correction of sacroiliac joint dysfunction. This review will attempt to consolidate and simplify various sacroiliac evaluation procedures in order to hastily implement proper corrective techniques.
CHAPTER I

INTRODUCTION

One of the most common problems seen by primary care clinicians today is low back pain. It is the number one cause of lost productivity and disability in the work place, and is the second most frequent reason for granting sick leave. Workers lose 90 million work days at an annual cost of $5 billion dollars because of low back pain. There are 1.5 million new cases of low back pain diagnosed monthly and on an average day there are 6.5 million Americans bedridden with low back pain. In America it has been estimated that the incidence of low back pain is between 60%-80%, and the prevalence rate varies between 12% and 35% between the ages of 25 and 69.

The pathogenesis of low back pain is poorly understood, but can stem from a multitude of different etiologies. A few of the causes are as follows: congenital, tumor, metabolic, inflammatory, vascular, infectious, psychosomatic, degenerative, mechanical, injury, as well as from enteric origins. Low back pain is reported more frequently in individuals that are obese and those who are sedentary when compared to persons of normal weight who exercise regularly. Furthermore, a persons occupation may predispose an individual to develop low back pain if their job requires heavy lifting, twisting, stooping, forward bending, and/or prolonged standing. Likewise, obesity in conjunction with poor abdominal strength may increase the propensity of low back pain.
by moving the center of gravity anteriorly, increasing lumbar lordosis and poor posture.
With further research into the pathogenesis of low back pain, conclusions may find that this problem is multifactorial in nature.

The concept that the sacroiliac joint may be a source of chronic low back pain has been a continual area of great controversy. Some clinicians regard the sacroiliac joint as a significant producer of low back pain, while others believe the joint is too stable to cause significant problems. This is further compounded by the location and orientation of the joint and the assessment of symmetrical/asymmetrical position and/or motion. Some researchers doubt the capability of clinicians to detect movement, whether normal or abnormal, at this joint.

In order to effectively treat a potential sacroiliac joint dysfunction the clinician must perform a series of appropriate evaluative tests which leads to an accurate diagnosis. There has been extensive investigation, with several poor outcomes, into the reliability and validity of individual or combination of tests targeting the sacroiliac joint. This alone justifies the reasoning behind compiling a core set of reliable and valid tests to administer during evaluation of low back pain.

Patients and clinicians have exhausted all effective treatment possibilities in attempts of alleviating low back pain caused by sacroiliac joint dysfunction. Most conservative nonpharmacologic, noninvasive treatments incorporate many different modalities and/or techniques in the plan of care. A few of the treatments of choice are as follows: limited bed rest, traction, bracing, manipulation, heat, ice, ultrasound, therapeutic exercise, and patient education. Whether the treatment is administered alone or in
conjunction with another, patients and subsequently clinicians have received mixed results.¹

The purpose of this independent study is to review existing literature with a primary focus on the anatomy, biomechanics, evaluation, and efficacious manual therapy treatment of sacroiliac joint dysfunction. This study will attempt to provide reliable and valid evaluation techniques as well as outline appropriate manual therapy techniques for correction of sacroiliac and iliosacral joint dysfunction.
CHAPTER II

LUMBAR SPINE ANATOMY

In order to truly understand all possible mechanisms of sacroiliac dysfunction one must have a thorough understanding of the composition and function of the joints adjacent the sacroiliac joint.

**Lumbar Vertebrae**

The lumbar vertebral column is made up of five individual vertebrae, which are named (L1-L5) according to their relative position in the intact vertebral column. These vertebrae, classified as irregular bones, are composed of a number of individually named parts (Figure 1). The largest and most anterior portion of each vertebra is the body. The vertebral body is an ovoid box shape with flat superior and inferior surfaces. It’s central core is composed of soft cancellous bone surrounded by dense cortical bone. The superior and inferior surfaces of the body are called end-plates of which the central portion is covered by cartilage.

Attached to the posterior surface of the vertebral body is the neural arch which, encases and protects the neural elements (spinal cord, cauda equina, spinal matter, and associated vascular supply) in the vertebral foramen/canal. The neural arch consists of paired pedicles, lamina, articular processes (superior and inferior), transverse processes, and one spinous process. The pedicles project posteriorly from the superior aspect of
the vertebral body. Along with the pedicles from the inferior vertebra, these structures make up the superior and inferior boundaries of the intervertebral foramen.

Originating and projecting posteromedially from each pedicle is a short bony sheet called the lamina.\(^7\) The laminae come together in the midline of the neural arch and fuse with each other. Extending posteriorly from the junction of the fused laminae is the characteristically broad spinous process. The paired transverse processes project laterally from the pedicle-lamina junction. The paired superior and inferior articular processes also originate from the junction of the pedicle and lamina. In general, the superior articular processes face medially and posteriorly while the inferior articular processes face laterally and anteriorly.\(^7\) Each process has an articular surface known as an articular facet.

**Intervertebral Disc**

Interposed between each vertebral body of the lumbar spine is a layer of strong, yet deformable, fibrocartilage named the intervertebral disc. The disc is made up of a gelatinous ovoid nucleus pulposus surrounded by concentric rings of the annulus fibrosus. Covering the superior and inferior aspects of the intervertebral disc is the vertebral end-plates. These structures separate the disc from the adjacent vertebral bodies. Collectively the five discs of the lumbar spine make up approximately 33% of the total height of the lumbar spinal column.\(^8\)

The paracentrally situated nucleus pulposus consists of collagen fibrils suspended in a mucoprotein gel. This fluid like structure has a high water content at birth (88%) but with age the percentage of water decreases (77% at age 70).\(^8\) The fluidity of the nucleus pulposus allows it to be deformed under pressure from any direction. As a
result of uni- or multidirectional pressure increases the nucleus will deform and dissipate the pressure in all directions. By decreasing the overall water content of the nucleus pulposus this reduces the ability of it to function as a gel and ultimately withstand stress.

The surrounding annulus fibrosus is composed of highly ordered collagen fibrils. These fibrils arranged in approximately 10-12 concentric sheets are called lamellae. The lamellae are finer and more tightly packed posteriorly and thicker anteriorly and laterally. This results in a thinner posterior portion of the annulus. Fiber orientation within the lamella run obliquely from one vertebra to another. The orientation of the collagen fibrils alternate with each successive lamella forming a criss-cross pattern to the annulus. Similar to the nucleus pulposus, the annulus fibrosus deteriorates with age. As one ages, the potential for the development of fissures in the annulus increases as the elasticity of the annulus decreases.29

Zygapophyseal Joint

As mentioned earlier the superior articular process of one vertebra articulates with the inferior articular process of the vertebra directly above. This articulation is known as a zygapophyseal joint (a.k.a. facet joint). The orientation of the facet joints between L1 and L4 lie predominately in the parasagittal plane while the L5 inferior facets, lie more in the coronal plane. These joints are true synovial joints with synovial fluid and function to stabilize the motion between two vertebrae. They help keep torsion and translation in check while allowing sagittal flexion and extension.30

Surrounding the posterior, superior, and inferior aspects of the lumbar facet joints is a thick fibrous capsule. The superior and inferior aspects of the capsule are relatively
loose to permit movement of the articular processes. The capsule of the anterior aspect of
the facet joint is made up by the ligament flavum.\textsuperscript{31}

The superior and inferior articular processes are covered by cartilage and as a unit
conforms to the same flat, concave, or convex curvature as the articular process with
which it articulates. The cartilage functions to promote stability and distribute weight
bearing stress over greater surface areas.\textsuperscript{30,32}

\textbf{Myology and Ligaments}

The static and dynamic stabilizers and movers of the aforementioned bony and
soft tissue structures is the intricate network of muscles and ligaments. The lumbar spine
has attached to it a superficial group of muscles, the trapezius and latissimus dorsi, which
connect the upper limb to the trunk. The serratus posterior inferior lies immediately deep
to the superficial group and is active during respiration.

The most superficial of the deep muscles in the lumbar spine is the erector spinae
muscle group.\textsuperscript{27} The muscle origin is a thick tendon attached to the posterior aspect of
the sacrum, iliac crest, and lumbar spinous processes. The muscle fibers split into three
columns at the level of the lumbar spine. The column most lateral is the iliocostalis
which inserts into the angle of the ribs. The intermediate muscle column is the
longissimus with its insertion into the transverse processes of the lumbar and thoracic
vertebrae. The medial most column of muscle is the spinalis, which inserts into the
spinous processes of the vertebral column. The bilateral action of this group of muscles
is to extend the vertebral column and unilaterally act to laterally flex and rotate the
lumbar spine to the same side.
Deep to the erector spinae muscle group is the transversospinal muscle group which includes the multifidus and rotators. The multifidus is the largest and most medial of the lumbar back muscles. It is a series of repeating muscle fascicles, which originate from the lamina and insert into the spinous processes two to four levels higher. The multifidus functions to extend the spine and rotate it toward the opposite side. The rotators have similar attachments and actions as the multifidus but only span one to two vertebral levels. Additional deep muscles include the interspinalis (attach adjacent spinous processes) and intertransversarii (attach adjacent transverse processes). Respectively, they extend and laterally flex to the same side.

Muscles of the posterior abdominal wall also attach and influence the lumbar spine. The psoas major originates from the intervertebral discs between L₁-L₅ as well as from the transverse processes of the upper four lumbar vertebrae. Along with the iliacus, the psoas major inserts into the lesser trochanter of the femur. This muscle acts to flex the lumbar spine and laterally flex it to the same side. Moreover, the quadratus lumborum originates from the iliac crest and iliolumbar ligament and inserts into the twelfth rib and transverse processes of the upper four lumbar vertebrae. This muscle functions to counteract the ascending force of the diaphragm on the twelfth rib as well as to laterally flex the vertebral column to the same side.

Along with the bony configuration of the vertebrae, the ligamentous connections provide additional support. The anterior aspect of the vertebral bodies is covered by the strong, broad anterior longitudinal ligament. This ligament connects the vertebral bodies with each other and fibers are attached to the intervertebral discs. This ligament functions to resist vertical separation of the anterior ends of the vertebral bodies, which
occurs during extension movements. The posterior longitudinal ligament, which forms the anterior boundary of the spinal canal, connects the vertebral bodies and intervertebral discs. This ligament narrows as it passes over the bodies and expands laterally over the intervertebral discs. Starting at the L₁ vertebra this ligament begins to narrow as it descends the spine, becoming half of its original width at L₅. The posterior longitudinal ligament functions to resist vertical separation of the posterior ends of the vertebral bodies, which occurs during flexion movements.

The ligamentum flavum is a short, relatively elastic band of connective tissue attached to adjacent laminae. It extends from the inferior edge of one lamina to the superior edge of an adjacent lamina. Like the posterior longitudinal ligament the ligamentum flavum makes up the posterior boundary of the spinal canal. Combined with the elastic properties and arrangement of fibrils the ligamentum flavum resists buckling during various positions and movements which assists with protection of the neural elements.

Neural arches of adjacent vertebrae are connected by interspinous, supraspinous, and intertransverse ligaments. The interspinous ligaments connect adjacent spinous processes and function to resist separation of the spinous processes. This helps limit the amount of flexion between vertebrae. The supraspinous ligament bridges the spinous processes, to which it is attached, and functions the same as the interspinous ligament. Ligaments that attach adjacent transverse processes are named intertransverse ligaments. They function to resist separation between the transverse processes during lateral flexion to the contralateral side. Iliolumbar ligaments also attach to the transverse processes of the lower two lumbar vertebrae as well as the ipsilateral iliac crest. During lateral
flexion, the contralateral iliolumbar ligament tightens, which limits motion of that sacroiliac joint. It also restricts flexion and extension of the lumbar spine to a lesser degree.
CHAPTER III

SACROPELVIC ANATOMY

Lumbosacral Articulation

The inferior facets and body of the fifth lumbar vertebra articulate with the superior facets and body of the first sacral segment. This is the point at which the mobile segments of the vertebral column link the relatively immobile segments of the sacrum. The inverted triangular wedged shaped sacrum, which makes up the posterior wall of the pelvic cavity, is made up of five fused sacral vertebrae and is situated between the paired innominant bones.

The paired ilia, ischii, and pubi make up the two innominant bones and in conjunction with the sacrum make up the bony pelvis. The major function of the bony pelvis is to transmit the weight of the head, trunk, and upper limbs to the lower extremities and to dissipate ground reaction forces from below (Figure 2).¹⁸

Pelvic Anatomy

The pelvis can be bisected into two arches when divided vertically at the midpoint of the acetabulae (Figure 2). The posterior arch, whose main function is to transmit weight from the vertebral column to the lower extremities, consists of the upper three sacral vertebrae and a portion of the paired ilia spanning from the sacroiliac joints to the midpoint of the acetabular fossa.³⁴ The anterior arch is comprised of the two pubic bones
along with their superior rami and symphysis. This portion connects the lateral aspects of the posterior arch and functions to prevent separation of the paired ilia. Moreover, the anterior arch acts as a compression strut during transmission of ground reaction forces up through the femur and across the pubic rami (Figure 2).  

**Sacrum**

As previously mentioned, the triangular shaped sacrum is composed of five fused vertebrae (Figure 3). This inverted triangle, situated between the two innominant bones, forms the posterosuperior portion of the pelvic cavity. The base of the triangular sacrum lies superiorly and articulates with the fifth lumbar vertebra forming the lumbosacral angle. Furthermore, the apex of the sacrum is narrow and blunted and articulates with the coccyx.

The ventral surface is concave vertically and horizontally. Opening into the pelvic fossa are four paired pelvic sacral foramina. Those foramina transmit the ventral rami of the first four sacral spinal nerves. The dorsal surface of the sacrum is convex and possesses a raised interrupted median sacral crest formed from the fusion of the sacral spinous processes. Forming the area between the median sacral crest and dorsal sacral foramina is the fused sacral laminae. The lateral aspect of the dorsal and ventral sacrum is formed by the fusion of the sacral transverse processes and costal elements. Additionally, the dorsal rami of the sacral spinal nerves pass through the dorsal sacral foramina. Like the vertebral column, the sacrum has a vertebral canal called the sacral canal. This canal transmits and protects the ventral and dorsal rami of the sacral plexus.
Innominate Bone

The paired hip bones or innominant bones are large and irregular. Situated on the lateral surface of the innominant is the deep, cup-shaped acetabulum. These paired bones articulate in front at the pubic symphysis. Each innominant consists of the ilium, ischium, and pubis. Separated by cartilage early in life these individual parts eventually fuse into one bone as adults in the area of the acetabulum. The ilium makes up the superior portion of the acetabulum as well as the large wing of bone above it. The ischium makes up the lower portion of the acetabulum and the associated bone posteroinferior to it. Furthermore, the pubis forms the anterior portion of the acetabulum and separates the ilium and ischium as well as comprises the pubic symphysis where the two innominates articulate.

Sacroiliac Joint

The true joint or articulation between the sacrum and the ilium has been classified as synovial, amphiarthroidal, or diamphiarthroidal. Bernhard S. Albinus (1677-1770) and William Hunter (1718-1783) were the first to demonstrate that the sacroiliac articulations contained synovial membranes. No matter what type of joint classification the sacroiliac articulation is, the articular surfaces are flat in infants, and remain so until puberty, and irregular in adults. Males usually possess greater articular surface irregularities which, assists with restricting movement. This contributes to the joint’s strength in transmitting weight from the vertebral column to the lower extremities, as well as dissipating ground reaction forces from below. The sacral articular surface is lined by hyaline cartilage whereas the ilial articular surface is lined by fibrocartilage. Additionally, the broad upper portion of the sacral articular surface resembles an ear.
shaped appearance and is termed the auricular surface. These articular surfaces have also been described as having an L-shaped appearance.\textsuperscript{40} Generally, the short cranial portion is more vertical and the long caudal portion is more horizontal (Figure 4).\textsuperscript{27, 41, 42} The cranial arm of the “L” extends upward to the level of the first sacral vertebra while the caudal arm extends downward to the middle of the third sacral vertebra. Subsequently, by aligning the articular surfaces of $S_1$, $S_2$, and part of $S_3$ with their compliment surface found on the ilia, the sacroiliac joint is formed.

Ligaments

As a result of form following function, the sacroiliac joint is reinforced with an intricate network of strong ligaments, which contribute to the overall stability of the joint. The sacroiliac ligaments can be divided into three groups, ventral, interosseous, and dorsal. A fourth group of ligaments that contribute to the stability of the sacroiliac joint, but do not directly attach to each bone near the articular surfaces, are the vertebropelvic ligaments.

The two components of the ventral sacroiliac ligament, which are considered thickenings of the joint capsule, are the anterosuperior band and the anteroinferior band (Figure 5).\textsuperscript{27, 34} One possible function of this ligament is to resist anterior movement of the sacral promontory.\textsuperscript{21} The massive interosseous sacroiliac ligament, also know as the short axial ligament, is the main constraint to excess sacroiliac motion. This ligament, which consists of a superficial and deep portion, fills the irregular spaces superior and posterior to the joint (Figure 5).

The dorsal sacroiliac ligament consists of several bands classified as short cranial fibers and long caudal fibers. The lower fibers run obliquely from $S_3$ and $S_4$ to the
posterior superior iliac spine (PSIS). Laterally these fibers mesh with fibers of the sacrotuberous ligament and medially with the thoracolumbar fascia (Figure 4). The dorsal sacroiliac ligament functions to resist downward slipping of the sacrum.\textsuperscript{34}

There are three primary ligaments and their subsequent divisions classified as vertebropelvic ligaments. The most superior subdivision represents the iliolumbar ligaments, which attach the transverse processes of the lower two lumbar vertebrae with the ipsilateral iliac crest. During lateral flexion, the contralateral iliolumbar ligament tightens to limit motion at that sacroiliac joint. Bilaterally, each will limit the amount of flexion and extension in the lower lumbar spine to a lesser degree.

The sacrotuberous ligament (Figure 4) is attached proximally to the PSIS, lower sacrum, and upper coccyx and attaches distally to the ischial tuberosity. The superior portion of this ligament interdigitates with the long fibers of the dorsal sacroiliac ligament. Additionally, the obliquely running fibers twist upon themselves as the ligament travels inferiorly to its distal attachment. Fibers from the gluteus maximus and tendinous portion of the long head of the biceps femoris blend in with this ligament.\textsuperscript{27,34}

The sacrospinous ligament lies directly anterior to the sacrotuberous ligament and is attached to the lower sacrum and coccyx and runs inferiorly, laterally, and anteriorly to its attachment on the ischial spine (Figure 4).\textsuperscript{27,34} Both the sacrotuberous and sacrospinous ligaments resist flexion of the sacral promontory by the trunk. DonTigney\textsuperscript{43} states that these ligaments also function to keep the ipsilateral innominant from rotating posteriorly on the sacrum.
Myology

Whether muscles are directly attached to the constituent bones of the sacroiliac joint or attached elsewhere on the pelvic girdle, they have the ability to directly or indirectly influence motion at the sacroiliac joint. The muscle groups can be organized into five categories; 1.) trunk, 2.) abductors, 3.) posterior, 4.) anterior and medial, and 5.) hip flexors.

An example of a group of trunk muscles indirectly providing lumbopelvic stability is the combined action of the abdominals, erector spinae, and quadratus lumborum as they transfer and absorb body and gravitational forces. The multifidus and deep fibers of the erector spinae indirectly influence the sacroiliac joint via their attachments to the posterior sacroiliac and iliolumbar ligaments.

Although strong, and attached to a large surface area on the ilium, the muscles which abduct the hip joint (gluteus medius and minimus and tensor fascia lata) indirectly influence the motion/position at the sacroiliac joint. Innominant motion itself can also be affected directly by the hip abductors as they act to stabilize the pelvis in the frontal plane.

The muscles at the posterior aspect of the pelvis can be divided into a superficial and deep layer. The large muscles in the superficial layer are the hamstrings (biceps femoris, semitendinosis, and semimembranosis) and gluteus maximus. Because of their attachments to the sacrotuberous ligament, sacrum, and posterior ilium and ischium, they indirectly affect sacroiliac motion as well as provide sagittal stability to the pelvis.

Among the many muscles that influence innominant motion, and subsequently iliosacral motion, the rectus femoris and sartorius play a key role. Ipsilateral action of
these two muscles may cause an aberrant rotation of the innominant. General motion about the pelvic girdle is influenced by bilateral action of the adductors (pectineus, adductor longus, brevis, magnus, and gracilis). Furthermore, unilateral action of the adductors can influence pelvic motion at the pubic symphysis.

The strong hip flexors (psoas major and iliacus) can also directly influence lumbopelvic and sacroiliac stability/mobility via their attachments to the lower lumbar vertebrae, anterior sacroiliac ligament, sacrum, and iliac fossa.

The deep muscles of the posterior pelvis that influence sacroiliac motion are the short external rotators of the hip (piriformis, superior and inferior gemellus, obturator internis, and quadratus femoris). During their function they pull on their attachments which are the sacrum, ischial spine, or ischial tuberosity. Even though the piriformis is the only muscle with a direct attachment to the sacrum, it is obvious that sacroiliac motion is greatly affected by the many trunk and lower extremity muscles that attach to the pelvis.
Joint Axes

Movement at the sacroiliac joint and the axes that such movement revolves around, compared with the lack of sacroiliac joint movement has been a controversial issue in the past and present, and will remain so in the future. There are a number of studies,22, 24, 44, 45, 46, 47, 48 both in vivo and cadaveric, that detail sacroiliac joint movement and the axes which that particular movement revolves around. There is a great deal of controversy as to the occurrence and amount of movement at the sacroiliac joint, but most studies reviewed for this manuscript demonstrated that movement revolved around one or a combination of the six sacroiliac joint axes. Therefore, further detail on their results is warranted.

Mitchell and associates50 clearly define and differentiated iliosacral and sacroiliac joint motions. Iliosacral motion occurs when the transmission of forces originates from the lower extremities. Conversely, sacroiliac motion occurs when transmission of force is directed from the spine to the sacrum. Clinically, it is not imperative to make the distinction between these two motions because functionally they occur simultaneously.46 According to Cibulka and co-workers,51 iliosacral movement is the most commonly seen.

Mitchell50 described the six axes of sacroiliac joint motion as follows: (Figure 6)
1) **Superior Transverse Axis:** Known as the respiratory axis located at the level of S2. Sacral nutation (flexion) and counternutation (extension) occur at this axis.

2) **Middle Transverse Axis:** Located at the level of S2 and is the primary axis of "normal" iliosacral nutation and counternutation.

3) **Inferior Transverse Axis:** Located at the inferior most aspect of the sacroiliac articulation. Primarily considered the axis of "normal" iliosacral movement which occurs during ambulation.

4) **Transverse Axis:** Located at the level of the pubic symphysis. The ilia rotate around this axis during ambulation.

5) **Right Oblique Axis***: Named for the right side origin at the sacral base (i.e. runs from right superior to left inferior). Located on a line that connects the superior aspect of the right sacroiliac articular surface and the left inferior aspect of the left inferior sacroiliac articular surface.

6) **Left Oblique Axis***: Named for the left side origin at the sacral base (i.e. runs from left superior to right inferior). Located on a line that connects the superior aspect of the left sacroiliac articular surface and the right inferior aspect of the right inferior sacroiliac articular surface.

*Sacroiliac movement around the oblique axes produces posterior and inferior movement of the sacral apex on the same side and anterior and inferior movement of the sacral base on the opposite side.
Weismantel\textsuperscript{52} states that movement around all the transverse axes takes place together not separately of one another. This concept is clinically relevant in the treatment of sacroiliac joint dysfunction.

**Kinematics**

There are a number of theories in the literature regarding the nature and quantity of movement that takes place at the sacroiliac joints. This review will attempt to compare and contrast key movement theories addressed in the literature.

**Symmetrical Movement**

Sashin\textsuperscript{22} studied cadaveric specimens and discovered upward and downward gliding movement of the sacrum on the pelvic ilia. Contrary to those results, Weisl\textsuperscript{44} reports no superoinferior movement but did suggest the occurrence of anteroposterior movement as well as nutation and counternutation. He further described nutation accompanying trunk flexion (in a supine position) and counternutation accompanying trunk extension (in a standing position). Wilder and associates\textsuperscript{45} examined only 11 cadaveric iliac articular surfaces and reported that rotation around any sacroiliac joint axis could not occur without translation and/or separation of the articular surfaces. He states this could noticeably occur in the presence of ligamentous laxity.

Using Kirschner wires implanted into the ilia, Colachis and co-workers\textsuperscript{46} documented approximation of the PSIS's during sacral nutation associated with standing trunk flexion. The conclusions of Weisl\textsuperscript{44} and Colachis\textsuperscript{46} agree that nutation is accompanied by iliac crest approximation. Conversely, they reported the ischial tuberosities separate during sacral nutation.
Mitchell and associates\textsuperscript{50} believe that nutation accompanying trunk flexion and counternutation accompanying trunk extension is a gross over simplification of movement. They theorize that full trunk flexion (in standing or sitting) is associated with a "paradoxical" sacral nutation. Further research, which is not supported in the literature, by Greenman\textsuperscript{53} suggests that the paradoxical movements were the only sacral movements to occur during trunk flexion and extension.

**Asymmetrical Movement**

Pitkin and Pheasant\textsuperscript{49} simulated leg length discrepancy in young males by having them stand on a one and one-half inch block with their right foot. This produced posterior rotation of the right ilium and anterior rotation of the left ilium. This rotation occurred around the transverse axis at the pubic symphysis. Mitchell and co-workers\textsuperscript{50} conclude that the oblique axes are created by contraction of the contralateral piriformis muscle. Additionally, they concluded that during the swing phase of gait, the innominate moves from an anteriorly rotated position to a posteriorly rotated position. Furthermore, Janse\textsuperscript{47} proposed that during the swing phase of gait the innominant rotated anteriorly, and during the stance phase of gait, the innominant rotated posteriorly: These motions occurred around a combination of the three (Superior, Middle, and Inferior) transverse axes.

Sacroiliac joint axes and movement is further complicated by Renolds\textsuperscript{48} who stated that hip flexion is associated with sacral rotation around a sagittal axis. Likewise, he reported that hip abduction is accompanied by sacral rotation around a vertical axis and the combination of hip flexion and abduction is associated sacral rotation around a transverse axis. These results were based on the examination of only one cadaver.
The most widely accepted sacroiliac joint motions in the literature are nutation of the sacrum and anterior and posterior rotation of the ilia. As for the specific number and location of the joint axes, around which the movement takes place, there still remains a wide variety of opinions.

Although it has been hypothesized that sacroiliac joint motion probably occurs outside of the true cardinal planes. Thus, rotation, rolling, and gliding must occur simultaneously at the joint during functional activities. Furthermore, a universal model of sacroiliac joint function has not been presented, verified, or accepted by the research or clinical communities. Currently, the existing models appear reasonable, but clinicians and researchers alike should continue to question and analyze them.
CHAPTER V

EVALUATION

Objective examination of possible sacroiliac joint dysfunction has been scrutinized in the literature by clinicians and researchers for many years. In particular, Walker\textsuperscript{18} doubts the capability of clinicians to detect 1-3 degrees or 1-3 millimeters of movement at the sacroiliac joint whether normal or abnormal. As a result, physical therapists must implement reliable and valid sacroiliac joint examination procedures into their initial evaluation.

Prior to examination of the pelvis and associated pelvic joints, the examiner must first determine the absence of abnormalities in the lumbar spine and hip joints. These nearby joints are capable of referring pain to one or both sacroiliac joints. Once other peripheral areas are ruled out as potential causes of low back pain then the examiner can focus on the symmetry or asymmetry of the paired bony landmarks and eventual movement at the sacroiliac joint(s).

Each individual clinician should establish a sequential method of patient evaluation. The evaluation may include, but is not limited to, data collection in the areas of: patient history, observation, examination of movement, special tests, reflexes and cutaneous distribution, joint play movements, palpation, and diagnostic imaging.\textsuperscript{54} Commonly, sacroiliac joint pain is localized to the ipsilateral sacroiliac joint or may be
referred to the posterior thigh, iliac fossa, and/or gluteal region. Sacroiliac joint pain is commonly associated with turning in bed, moving from sitting to standing, and/or stepping up with the involved lower extremity. Sacroiliac joint dysfunction may be caused by falls, twisting, lifting objects from the floor, or excessive strain placed on tissues during various daily, occupational, or recreational activities.

Reliability and Validity

The reliability and validity of objective clinical evaluation techniques has been challenged in the literature with acceptable results in some studies and unacceptable results in others. Sacroiliac joint testing relies a great deal on the skillful palpation of bony landmarks by the examiner. Walker reviewed a study performed by Simmonds which focused on the inter- and intra-tester reliability of palpation of four bony landmarks. It was concluded that intra-tester error was seven to fourteen millimeters and inter-tester error was 12 to 24.5 millimeters. Moreover, this low inter-tester reliability of PSIS palpation contributes to the low reliability of the sacroiliac joint tests which use the PSIS landmark. It is crucial for the examiner to correctly identify, with consistency, appropriate bony landmarks in order to accurately and concisely detect sacroiliac joint dysfunction.

Assessment of leg length has been an integral component of pelvic and sacroiliac joint evaluation. Potter and Rothstein concluded there was no clinically reliable method of measuring leg length. Unfortunately, they failed to consider all possible leg length assessment techniques, and did not provide evidence to support their claims. Contrary to those claims, Woerman and Binder-MacLeod demonstrated that an indirect method of measuring leg length, which involved leveling the subjects pelvis by placing blocks under
the shorter leg, was more accurate than direct methods involving measurement between bony landmarks. However, of the measurement techniques studied, the researchers concluded that measurement between the anterior superior iliac spine (ASIS) and lateral malleolus was most precise. 56

Intra-tester and inter-tester reliability of the standing hip and knee flexion test, which assess sacroiliac joint mobility, was carried out by Herzog and associates. 57 They demonstrated that inter-tester reliability was not affected by the clinicians level of expertise or the degree of sacroiliac joint dysfunction. However, intra-tester reliability was statistically significant in regards to clinicians with minimal experience, whereas, experienced clinicians did not exhibit significant differences.

Potter and Rothstein, 55 examined inter-tester reliability of 13 frequently used sacroiliac joint tests. The authors concluded that a percentage agreement between the clinicians of 70 percent was required for the test to be deemed reliable. Of the 13 sacroiliac joint tests, supine iliac distraction and side-lying iliac approximation tested most reliable. The following tests, which used palpation, were deemed unreliable by Potter and Rothstein: 55 iliac crest levels in standing, iliac crest levels in sitting, PSIS levels in standing, PSIS levels in sitting, ASIS levels in standing, ASIS levels in sitting, standing hip flexion sacroiliac joint mobility test, standing flexion test, sitting flexion test, supine/long sitting test, and prone/knee flexion test. Moreover, Smith and co-workers 58 showed very high intra-tester and inter-tester reliability of PSIS and ASIS height assessment by using a meter rod with vertical and horizontal sliders.

Iliosacral dysfunction was diagnosed by Bemis and Daniel 59 on the combination of unequal PSIS heights in standing, positive standing flexion test, and negative sitting
flexion test. The investigators assessed the validity of the supine/long-sitting test by comparing a positive result with that of their aforementioned self-defined iliosacral dysfunction. The researchers concluded a statistically significant association between the self-defined diagnosis of iliosacral dysfunction and a positive supine/long-sitting test.

Another team of investigators under the direction of Maager\textsuperscript{19} examined the sensitivity and specificity of various tests to diagnosed sacroiliac joint dysfunction. They concluded that at a rate of 94% sacroiliac joint tenderness was the most sensitive test and in conjunction with the standing flexion test the two were most specific.

**Ligamentous Testing**

Although not every evaluative test specific for the sacroiliac joint is statistically reliable and valid, clinicians must continue to perform techniques which stress sacroiliac joint structures and assess mobility in order to properly evaluate low back pain. There are a number of tests, which stress the anterior and posterior sacroiliac joint ligaments as well as assess the amount of sacroiliac joint mobility. This review will highlight a few clinical techniques used in sacroiliac joint assessment. They are performed as follows:\textsuperscript{54}

1.) **Anterior Sacroiliac ligaments**

*Gapping Test* (Figure 7): The patient lies supine while the examiner applies a down and out force on the ASISs with the thenar eminencies. Unilateral gluteal or posterior leg pain indicates a positive test.

*Sacral Apex Pressure Test* (Figure 8): The patient lies prone on a firm surface while the examiner applies an anteriorly directed pressure on the apex of the sacrum. A positive test is indicated by pain over the involved sacroiliac joint.
2.) **Posterior Sacroiliac ligaments**

*Approximation Test* (Figure 9): The patient is side lying on the uninvolved side and the examiner applies a downward force with the palm of the hand on the upper portion of the iliac crest. A positive test is indicated by reproduction of pain in the involved sacroiliac joint and is indicative of a lesion of the posterior sacroiliac ligament.

*Squish Test* (Figure 10): The patient lies supine while the examiner applies a downward and medial force at a 45-degree angle on the ASISs with the thenar eminencies. A lesion of the posterior sacroiliac ligament will produce pain in the involved sacroiliac joint.

**Hypomobility Testing**

1.) **Seated Flexion Test** (Piedallu’s Sign, Figure 11): The patient is seated on a hard flat surface to eliminate the hamstrings from affecting pelvic flexion symmetry and increase the stability of the ilia. The examiner palpates the PSISs during seated trunk flexion. In the seated position if one sacroiliac joint is hypomobile the involved PSIS may be situated lower than the uninvolved PSIS. During trunk flexion if the lower PSIS (in sitting) becomes higher this indicates a positive test for sacroiliac joint hypomobility on that same side.

2.) **Standing Flexion Test** (Gillet’s Test, Figure 12): The patient stands and the examiner palpates each PSIS while the patient pulls the knee up toward the chest. The test is repeated on the other side. Minimal or superior movement of the PSIS on the flexed knee side indicates a positive test for hypomobility. Normal PSIS movement during the test is in an inferior direction.
Clinical Signs of Sacroiliac Dysfunction (Table 1)\textsuperscript{53}

* Described with right involvement only.

**Forward Sacral Torsion** (Right on Right)\textsuperscript{53, 61}

1.) Seated flexion test positive on the left.
2.) Sacral base situated anteriorly on the left.
3.) Inferior lateral angle (ILA) situated posteriorly on the right.
4.) Motion of ILA is increased on the right during forward bending.
5.) Left convexity of lumbar scoliosis.
6.) Shorter right medial malleolus in prone position.

**Backward Sacral Torsion** (Left on Right)\textsuperscript{53, 61}

1.) Seated flexion test positive on the left.
2.) Sacral base situated posteriorly on the left.
3.) ILA situated posteriorly on the left.
4.) Motion of ILA is increased on the left during backward bending.
5.) Right convexity of lumbar scoliosis.
6.) Shorter left medial malleolus in prone position.

**Nutation**\textsuperscript{53, 61}

1.) Seated flexion test positive bilaterally.
2.) Sacral base situated anteriorly.
3.) ILA situated posteriorly.
4.) Increased lumbar lordosis.
5.) Equal leg length in prone position.

**Counternutation**\textsuperscript{53, 61}

1.) Seated flexion test positive bilaterally.
2.) Sacral base situated posteriorly.
3.) ILA situated anteriorly.
4.) Decreased lumbar lordosis.
5.) Equal leg length in prone position.
Clinical Signs of Iliosacral Dysfunction (Table 2)\textsuperscript{53}

* Described with right involvement only.

**Upslip with Anterior Rotation**\textsuperscript{53, 61}

*Standing*
1. Right iliac crest situated superior.
2. Right PSIS situated superior.
3. Right ASIS situated inferior.
4. Left convexity of lumbar scoliosis.

*Sitting*
1. Right iliac crest situated superior.
2. Right PSIS situated superior.
3. Left convexity of lumbar scoliosis.

*Supine*
1. Right leg shorter
2. Right pubic symphysis situated anterior and inferior.

*Prone*
1. Right ischial tuberosity situated superior.
2. Right sacrotuberous ligament slackened.

**Upslip with Posterior Rotation**\textsuperscript{53, 61}

*Standing*
1. Right iliac crest situated superior.
2. Right PSIS situated inferior.
3. Right ASIS situated superior.
4. Left convexity of lumbar scoliosis.

*Sitting*
1. Right iliac crest situated superior.
2. Right PSIS situated inferior.
3. Left convexity of lumbar scoliosis.
Supine
1.) Leg length equal or shorter on the right
2.) Right pubic symphysis situated posterior and superior.
3.) Inguinal ligament tender with palpation.

Prone
1.) Ischial tuberosities level or superior on the right.
2.) Right sacrotuberous ligament tension normal.

Outflare\textsuperscript{53, 61}

Standing
1.) Standing flexion test positive on the right.
2.) Right PSIS situated medial.

Supine
1.) Right ASIS situated lateral.
2.) Right leg shorter.
3.) Inguinal ligament tender with palpation.

Prone
1.) Right PSIS situated medial.
2.) Narrow right sacral sulcus.

Inflare\textsuperscript{53, 61}

Standing
1.) Standing flexion test positive on the right.
2.) Left PSIS situated lateral.

Supine
1.) Right ASIS situated medial.
2.) Right leg shorter.

Prone
1.) Right PSIS situated lateral.
2.) Wide right sacral sulcus.
Anterior Rotated Innominate\textsuperscript{40, 53, 61}

Standing
1.) Standing flexion test positive on the right.
2.) Right PSIS situated superior.
3.) Right ASIS situated inferior.
4.) Pelvis (as a unit) rotated left.
5.) Right iliac crest situated superior.

Supine
1.) Right leg shorter.
2.) Pelvis (as a unit) rotated left.
3.) Right ASIS situated inferior.
4.) Level iliac crests.

Prone
1.) Right sacral sulcus shallow.
2.) Right PSIS situated superior.

Posterior Innominant Rotation\textsuperscript{40, 53, 61}

Standing
1.) Standing flexion test positive on the right.
2.) Right PSIS situated inferior.
3.) Right ASIS situated superior.
4.) Pronated left foot.
5.) Right iliac crest situated inferior.

Supine
1.) Right leg shorter.
2.) Right ASIS situated superior.
3.) Level iliac crests

Prone
1.) Right sacral sulcus deep.
2.) Right PSIS situated inferior.
As previously mentioned it is imperative that the evaluating therapist accurately and precisely with repeatability locate key identifiable bony landmarks on the pelvis for proper diagnosis of sacroiliac joint dysfunction. Without this refined skill, diagnosis of sacroiliac joint dysfunction and eventual correction is greatly hindered. This specific skill is only a minute component of a thorough low back evaluation but probably the most important. Most tests rely on assessing movement, restriction, and/or location of bony landmarks to obtain information leading to a particular diagnosis. Therefore, accurate assessment is strictly dependent on this skill.

The author recommends that clinicians use a core group of assessment techniques that should be performed during a lumbopelvic evaluation. The techniques, which are sacroiliac specific, should test ligamentous integrity, mobility, bony position, and leg length. The author suggests using the gapping (anterior sacroiliac ligament), and squish (posterior sacroiliac ligament) tests to assess ligamentous integrity. These tests are performed in a supine position which helps fix the sacrum by its contact on the plinth. Sacroiliac joint mobility tests should include the seated and standing flexion tests. These tests will identify sacroiliac joint hypomobility with and without the hamstrings influencing pelvic flexion. The author recommends that each clinician consistently perform one method of leg length assessment, preferably one which uses some type of objective tool, such as a tape measure or blocks of differing heights. As previously mentioned measuring between the ASIS and the lateral malleolus was deemed most the most precise method of leg length assessment.\(^5\)

The reader is encouraged to consult *Orthopedic Physical Assessment*\(^5\) for a comprehensive description of applicable evaluation procedures and specialized sacroiliac
joint tests. Keep in mind that most low back and sacropelvic evaluation techniques contained in this and other references are neither, reliable nor valid. One should use the “objective” data obtained from such tests with caution because a false assessment is possible.
CHAPTER VI

MANUAL THERAPY TREATMENT

In general, the overall goal of any orthopedic treatment plan for lumbopelvic dysfunction is to restore normal pain-free movement, muscle strength, ligamentous stability, and postural balance. The therapist is responsible for designing an effective and complete treatment program. This program should incorporate, but is not limited to, the following: patient education (regarding the disorder and treatment goals), selection of appropriate treatment procedures and techniques, methods of application, frequency of application, coordination of other healthcare professionals, and/or home program/follow-up care (if indicated). This section of the review will focus on treatment of various sacroiliac and iliosacral joint dysfunctions with manual therapy techniques.

The therapeutic use and selection of orthopedic manual therapy techniques depend on a number of factors, primarily the patient's age, the intensity of pain (which determines grade of movement used), and cognitive attitude of the patient. The proposed purpose of manual therapy techniques is to restore the physiological relationships of the joint by "manipulation." In most cases, the application techniques do not use manipulation as commonly understood, but impart a gentle mobilization using extrinsic and intrinsic generated forces. For example, an extrinsic generated force is applied by an operator gliding and thrusting an isolated body segment. Additionally, an
intrinsic generated force is produced through respiration and specific active muscle contraction.⁵³

The therapeutic use of orthopedic manual therapy techniques which include specific passive accessory movements help relieve pain, decrease muscle guarding, lengthen tissue (especially joint capsule and ligaments), and reduce derangement of intra-articular structures.⁶² Additionally, the patient may experience neurophysiological benefits from the mechanical effects of passive joint motion. For example, placing tension on the joint capsule and surrounding ligaments activates joint mechanoreceptors and assists with reducing pain.⁶³ During manual therapy treatment the therapist attempts to restore accessory motion and subsequently physiological motion normally present at a joint.⁶⁴ Normal physiological joint motion is movement of a joint in a direction that the patient can actively control. Additionally, accessory joint motion, which is targeted by joint mobilization, cannot be voluntarily produced by the patient but must be present for normal joint motion to occur.⁶⁴

**Joint Mobilizations**

The physiological and accompanying accessory joint motion may be either hypomobile (reduced available motion), normal, or hypermobile (increased available motion). The anatomical limit of normal joint motion is the termination of motion by the shape of the articular surfaces, ligaments and muscles, and the contact or tension of extra-articular structures.⁶⁴ The pathological limit of motion is usually found in a hypomobile joint. This joint is able, with decreased capacity, to attain its anatomical limit but because of pain or tissue restriction it is pathologically limited.⁶⁴
Joint mobilization is a form of passive treatment performed by the therapist. The physiological or accessory joint motion can be performed within or beyond the pathological limit, but cannot be performed beyond the anatomical limit. One treatment technique used to increase physiological motion may be a sustained stretch that approaches the pathological limit. Another treatment technique involves the therapist producing the accessory joint motion in the direction of limitation. The distance the joint is moved into its total range is graded into five sequential steps of increasing movement (I-V). The therapist rhythmically oscillates accessory joint motion up to and beyond the pathological limit (Figure 13).

**Muscle Energy Techniques**

Muscle energy techniques (METs) are also commonly used to re-establish normal position/movement at the sacroiliac joint by restoring appropriate tissue length in surrounding soft tissue. The MET described by Greenman is “a manual medicine treatment procedure that involves the voluntary contraction of patient muscle in a precisely controlled direction, at varying levels of intensity, and against a distinctly executed counter force applied by the operator.”

During application of specific METs the therapist strategically positions the patient until a specific barrier is reached. In this position the patient produces a submaximal isometric contraction held for five seconds against an equal and opposite counter force. After relaxation the new barrier is reached and the submaximal isometric contraction against the counter force is applied again. This procedure is repeated at least three times but may be performed more, if needed. Examples of specific METs and joint mobilizations to correct sacroiliac joint dysfunction will be discussed in detail later.
Precautions and Contraindications

Following a thorough evaluation the patient should be screened for precautions and identifiable contraindications prior to initiating treatment. Manual therapy is precautioned or contraindicated by the following:65

1.) The presence of autoimmune disease (i.e. ankylosing spondylitis or rheumatoid arthritis).
2.) The presence of active or past bacterial infection that has affected the joint surfaces or ligaments surrounding the joint.
3.) The presence of cancer.
4.) Contraindicated during the third trimester of pregnancy and precautioned during the second trimester.
5.) In the presence of neural compression, for example, spinal cord compression or compression of the S4 nerve root (Signs: saddle paraesthesia, impaired bowel and bladder function, and/or sexual impotence).
6.) In the presence of bony abnormalities.
7.) In the presence of severe neurosis.

Correction of Specific Pelvic Dysfunction

Once a definitive diagnosis of sacroiliac or iliosacral joint dysfunction has been concluded the next step is application of manual therapy techniques to correct this pathology. This section will focus on the manual therapy treatment of various sacroiliac and iliosacral dysfunctions. Only treatments for dysfunctions of the right sacroiliac and iliosacral joint will be discussed. The reader should be able to extrapolate the information and apply it to the contralateral side.

Sacroiliac Joint Dysfunction

Forward Sacral Torsion (Right on Right)53 (Figure 14)

Muscles Involved: Left multifidus and Right piriformis.
Patient Position:

1.) **Left multifidus**→Right sidelying with right lower extremity extended and left hip and knee flexed with left ankle in right popliteal space.

2.) **Right piriformis**→Right sidelying with both hips and knees flexed to 90 degrees. Thighs are on the table and legs are hanging off.

**MET:**

1.) **Left multifidus**→Apply counter force to anterior left shoulder and posterior left pelvis. Resist right trunk rotation and left pelvic rotation.

2.) **Right piriformis**→Apply counter force to both ankles. Resist right hip external rotation and left hip internal rotation.

**Backward Sacral Torsion (Left on Right)** (Figure 15)

Muscles Involved: Left piriformis and left gluteus maximus and medius.

Patient Position:

1.) **Left piriformis**→Left sidelying with both hips and knees flexed to 90 degrees. Thighs are on the table and legs are hanging off.

2.) **Left gluteus maximus and medius**→Right sidelying with left hip flexed approximately 30 degrees and entire left lower extremity hanging off table.

**MET:**

1.) **Left piriformis**→Apply counter force to both ankles. Resist left hip external rotation and right hip internal rotation.

2.) **Left gluteus maximus and medius**→Apply counter force at left ankle and resist abduction of the left lower extremity.

**Restricted Nutation** (Figure 16)

Patient position: Prone.

Palpate: The sacral base bilaterally with the thumb and index finger of one hand and stabilize them with the other hand.

Mobilization: Apply a grade II-IV oscillating force at the sacral base to produce an inferoposterior glide of the sacrum.
Restricted Counternutation\textsuperscript{61,66} (Figure 17)

Patient position: Prone.

Palpate: The sacral base bilaterally with the thumb and index finger of one hand.

With the heel of the other hand palpate the midline of the inferior aspect of the sacrum.

Mobilization: Apply a grade II-IV oscillating force at the sacral apex to produce a superoanterior glide of the sacrum.

Iliosacral Joint Dysfunction

Upslip with Anterior Rotation\textsuperscript{66} (Figure 18)

Patient position: Prone with involved hip extended, abducted, and slightly internally rotated.

Mobilization: Grasp ankle/knee with both hands and apply a high velocity, low amplitude traction force in the long axis of the involved lower extremity.

Alternate: The inferolateral aspect of the sacrum may be stabilized with the thenar eminence of a second therapist.

Upslip with Posterior Rotation\textsuperscript{66} (Figure 19)

Patient Position: Supine with the involved hip flexed, abducted and externally rotated.

Mobilization: Grasp ankle/knee with both hands and apply a high velocity, low amplitude traction force in the long axis of the involved lower extremity.

Inflare\textsuperscript{53} (Figure 20)

Muscle involved: Gluteus minimus.

Patient position: Supine with involved hip flexed 45 degrees and slightly internally rotated and abducted.

MET: Apply counter force at the involved knee and ankle to resist horizontal abduction.

Outflare\textsuperscript{53} (Figure 21)

Muscle involved: Iliacus.
Patient position: Supine with the hip flexed to 45 degrees and slightly internally rotated and adducted.
MET: Apply counter force at the involved knee and ankle to resist hip flexion and abduction.

**Anterior Innominant Rotation**\(^61,66\) (Figure 22)

Muscles involved: Hip extensors→gluteus maximus and hamstrings (involved side) and Hip flexors→rectus femoris, iliopsoas, and sartorius (uninvolved side).

Patient position: Supine with hips at caudal edge of table. Involved lower extremity is fully flexed and uninvolved lower extremity is fully extended.
MET: Apply an isometric counter force at the proximal tibia of the involved lower extremity and the anterodistal femur of the uninvolved lower extremity. Resist hip extension of the involved lower extremity and hip flexion of the uninvolved lower extremity.

Alternate\(^43\) (Figure 23)

Patient position: Hook-lying.

Mobilization: Place forearm in the popliteal space of the involved lower extremity and hand on the uninvolved knee. Apply a stabilizing force at the distal tibia and fibula with the other hand. Using the forearm as a second class lever (ex. wheelbarrow) apply longitudinal traction to the involved lower extremity through the long axis of the femur.

**Posterior Rotated Innominata**\(^61,66\) (Figure 24)

Muscles involved: Hip flexors→rectus femoris, iliopsoas, and sartorius.

Patient position: Supine close to the edge of the involved side with the affected lower extremity hanging off the table.
MET: Apply an isometric counter force at the anterodistal femur of the involved lower extremity with one hand and a stabilizing force at the contralateral ASIS with the other hand.
Alternate MET: (Figure 22) Position the patient the same as described for application of the MET for anterior innominant rotation. The difference is to resist hip flexion of the involved lower extremity and hip extension of the uninvolved lower extremity.

Even though treatment of pelvic dysfunction has been presented as discrete entities, dysfunctions tend to occur in combination with one another. Therefore, Fowler suggests that treatment/correction should follow a sequential pattern when appropriate. The suggested pattern of treatment/correction is as follows:

1.) Restrictive faults of lumbar spine.

2.) Dysfunction at the pubic symphysis (Must be corrected first because sacroiliac and/or iliosacral dysfunction will not resolve without symphysis correction)

3.) Sacral torsions.

4.) Innominant slips.

5.) Innominant Rotations.

6.) Innominant flares.

7.) Any dysfunctions of the lower extremities.

The therapist must also incorporate appropriate patient education in the areas of home exercise program, maintenance of proper static and dynamic posture, and proper lifting mechanics. Furthermore, manual therapy must be supplemented with pelvic and trunk stabilization and strengthening exercises to maintain normal lumbopelvic position and subsequent biomechanics during daily activities. Keep in mind that every person will respond differently to treatment, therefore, the therapist should be able to adapt to all situations that may arise.
CHAPTER VII

CONCLUSION

The sacroiliac joint has proven to be complex and controversial with varying scientific and anecdotal theories of function, pathogenesis, assessment, and treatment. Because of the irregular bony structure and intricate ligamentous support in conjunction with the multiple axes and associated kinematics the sacroiliac joint is considered difficult to evaluate and treat. A consensus can be reached by clinicians and researchers alike that "normal" structure of the sacroiliac joint is highly variable, depending on the individuals themselves, as well as their age, sex and circulating hormonal levels. This provides evidence for clinicians to remember the highly variable structure of the pelvis and associated joints during examination of a patient with idiopathic low back pain.

In order to develop an effective treatment plan the therapist must establish an accurate diagnostic representation of sacroiliac joint dysfunction. As previously demonstrated there are few reliable and valid evaluation procedures specific for sacroiliac joint dysfunction. Furthermore, therapists must always be cognoscente of the possibility of low back pain resulting from other sources.

Manual therapeutic treatment of sacroiliac joint dysfunction can vary a great deal from therapist to therapist. The two treatments most commonly used are muscle energy techniques (METs) and joint mobilizations. These particular methods of treatment can be
supplemented with specific active exercises. Complex sacroiliac joint dysfunction (i.e. upslop with anterior rotation) are usually treated with METs, whereas, less complex dysfunctions (i.e. nutation) are treated with joint mobilizations.

Physical therapists must refine their palpation skills along with their differential evaluation techniques in order to reliably diagnose a particular condition. Likewise, they must choose reliable and valid special tests from the numerous assessment procedures to define specific sacroiliac joint lesions. If accurate diagnosis and efficacious treatments are not implemented, patients with sacroiliac joint dysfunction have the propensity to develop compensatory problems and subsequent deterioration in overall function.

Research must continue in the laboratory and clinical settings which focuses on sacroiliac joint function. This should lead to clinical measurement tools to assess functional activities and differentiate between normal and abnormal sacroiliac joint movement or position. These measurements must be accurate, reliable, and independent of the technique used.

Finally, researchers and clinicians must use a language that is consistent throughout both societies. If larger populations of normal and abnormal subjects are studied, more insight into the diagnosis and treatment of low back pain caused by lumbopelvic dysfunction could be identified.
APPENDIX I

FIGURES AND TABLES
Figure 1. Typical lumbar vertebra: superior view (A) and inferior view (B).
Figure 2. Anterior and posterior pelvic arches with transmission of body weight force (BW) from above and ground reaction force (GRF) from below.
Figure 3. Typical sacrum: anterior view (A), posterior view (B), and superolateral view (C).
Figure 4. Typical posterior view (A) and anterior view (B) of sacroinnominant ligaments.
Figure 5. Cross-section through right and left sacroiliac joints representing bony configuration with intrinsic and extrinsic ligamentous attachments.
Figure 6. Sacroiliac axes system: transverse innominant axes (A), transverse sacral axes (B), and oblique axes (C), right oblique axis (a) and left oblique axis (b).
Figure 7. **Gapping Test:** Force is administered through the heel of the hands on the ASIS's in the direction of the arrows.

Figure 8. **Sacral Apex Pressure:** Force is administered through the heel of the hand on the apex of the sacrum in the direction of the arrow.
Figure 9. **Approximation Test:** Administer a force with the heel of the hand on the iliac crest in the direction of the arrow.

Figure 10. **Squish Test:** Administer a force on the ASIS's with the heel of the hand in the direction of the arrows.
Figure 11. **Seated Flexion Test**: PSIS (Dots) height and movement is assessed during transition from a seated position (A) to a forward flexed position (B).
Figure 12. **Standing Flexion Test:** PSIS (Dots) height and movement is assessed while the patient flexes the hip and knee.
Joint movement (physiological or accessory) during two types of mobilization though range of motion. Mobilization graded I-V.
Figure 14a. **Forward Sacral Torsion MET**: Administer isometric counterforce at shoulder and pelvis in the direction of the *RED* arrows to resist right trunk rotation and left pelvic rotation (*White* arrows).

Figure 14b. **Forward Sacral Torsion MET**: Administer isometric counterforce at the ankle in the direction of the *RED* arrow to resist right hip external rotation and left hip internal rotation (*WHITE* arrow).
Figure 15a. **Backward Sacral Torsion MET:** Administer isometric counterforce at the ankle in the direction of the *RED* arrow to resist left hip external rotation and right hip internal rotation (*WHITE* arrow).

Figure 15b. **Backwards Sacral Torsion MET:** Administer isometric counterforce at the ankle in the direction of the *RED* arrow to resist hip abduction (*WHITE* arrow).
Figure 16 **Restricted Nutation Mobilization:** Administer graded oscillation force in the direction of the arrow with the heel of the hand at the sacral base.

Figure 17. **Restricted Counternutation Mobilization:** Administer graded oscillation force in the direction of the arrow with the heel of the hand at the inferior aspect of the sacrum.
Figure 18. **Upslip with Anterior Rotated Innomonant Mobilization:** Administer a high velocity low amplitude traction force in the direction of the arrow.

Figure 19. **Upslip with Posterior Rotated Innomionant Mobilization:** Administer high velocity low amplitude traction force in the direction of the arrow.
Figure 20. **Inflare MET**: Administer isometric counterforce at the knee and ankle in the direction of the RED arrows to resist horizontal abduction of the hip (WHITE arrow).

Figure 21. **Outflare MET**: Administer isometric counterforce at the knee and ankle in the direction of the RED arrows to resist hip flexion and abduction (WHITE arrow).
Table 1. Sacroiliac Dysfunction

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>(+) Seated Flexion Test</th>
<th>Base of Sacrum</th>
<th>Inferior Lateral Angle Position</th>
<th>Inferior Lateral Angle Motion</th>
<th>Lumbar Lordosis</th>
<th>Lumbar Scoliosis</th>
<th>Medial Malleolus (Prone)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Torsion, Right on Right</td>
<td>Left</td>
<td>Anterior Left</td>
<td>Posterior Right</td>
<td>Right ↑ on Forward Bend</td>
<td>Increased</td>
<td>Convex Left</td>
<td>Short Right</td>
</tr>
<tr>
<td>Backward Torsion, Left on Right</td>
<td>Left</td>
<td>Posterior Left</td>
<td>Posterior Left</td>
<td>Left ↑ on Backward Bend</td>
<td>Reduced</td>
<td>Convex Right</td>
<td>Short Left</td>
</tr>
<tr>
<td>Nutation</td>
<td>Bilateral</td>
<td>Anterior</td>
<td>Posterior</td>
<td></td>
<td>Increased</td>
<td></td>
<td>Equal</td>
</tr>
<tr>
<td>Counternutation</td>
<td>Bilateral</td>
<td>Posterior</td>
<td>Anterior</td>
<td></td>
<td>Reduced</td>
<td></td>
<td>Equal</td>
</tr>
</tbody>
</table>

Common characteristics of selected sacroiliac joint dysfunctions\(^{53}\)
Table 2. Iliosacral Dysfunction

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>(+) Standing Flexion Test</th>
<th>ASIS</th>
<th>PSIS</th>
<th>Medial Malleolus (Supine)</th>
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<tbody>
<tr>
<td>Anterior Rotated Innominant</td>
<td>Right</td>
<td>Inferior</td>
<td>Posterior</td>
<td>Long</td>
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<tr>
<td>(Right)</td>
<td></td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
</tr>
<tr>
<td>Posterior Rotated Innominant</td>
<td>Right</td>
<td>Superior</td>
<td>Inferior</td>
<td>Short</td>
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<tr>
<td>(Right)</td>
<td></td>
<td>Right</td>
<td>Right</td>
<td>Right</td>
</tr>
<tr>
<td>Outflare (Right)</td>
<td>Right</td>
<td>Lateral</td>
<td>Medial</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Right</td>
<td>Right</td>
<td></td>
</tr>
<tr>
<td>Inflare (Right)</td>
<td>Right</td>
<td>Medial</td>
<td>Lateral</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Right</td>
<td>Right</td>
<td></td>
</tr>
</tbody>
</table>

Common characteristics of selected iliosacral dysfunctions.  

- Anterior Rotated Innominant (Right)
- Posterior Rotated Innominant (Right)
- Outflare (Right)
- Inflare (Right)


40.) Don Tigney RL. Function and pathomechanics of the sacroiliac joint: a review. *Phys Ther.* 1985;65:35-44.


