

Function and Pathomechanics of the Sacroiliac Joint

A Review

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The purpose of this article is to describe the biomechanics and function of the sacroiliac joint, the dysfunction and pathomechanics of the sacroiliac joint as a common cause of low back pain, a simple assessment procedure, associated pain mechanisms, treatment and prevention of the problem, and a discussion of related literature. The sacroiliac joints are essentially nonweight-bearing joints that function to absorb forces from various directions. The common onset of dysfunction is during trunk flexion when a person is standing without adequate support of the anterior pelvis. The anterior shift of the weight of the upper trunk causes the innominates to rotate anteriorly and downward and become fixed on the sacrum. Movement downward of the acetabula in relationship to the sacroiliac joint not only results in biomechanical changes but causes the legs to appear longer than they actually are. Physical therapists can correct the dysfunction by manually rotating the innominates posteriorly on the sacrum while they observe objective changes in apparent leg length. People can prevent this dysfunction through adequate anterior pelvic support when they lean forward. Some possible consequences of untreated sacroiliac dysfunction are also discussed.

Key Words: *Backache, Physical therapy, Sacroiliac joint.*

Pain in the low back is a problem that has plagued and puzzled mankind for thousands of years. Despite applying recent advances in research and technology, taking proper histories, and performing thorough physical examinations, a high percentage of patients with pain in the low back have no identifiable pathology. In 1966, Dillane et al demonstrated the specific cause was unknown in 79 to 89 percent of patients experiencing their first attacks of low back pain.¹ In 1971, Leavitt et al reported 84 percent of compensable cases of disabling low back pain were without definite diagnosis.² In 1982, Nachemson estimated that only in approximately 15 percent of those cases that become chronic (lasting longer than three months) does some proven pathoanatomical explanation exist.³ Obviously, the identification of some widespread pathology, probably biomechanical, is being ignored or is escaping through the vast network of commonly used tests, signs, and procedures. These tests, signs, and procedures are either not appropriate to the pathology involved or not being properly interpreted.

Dysfunction of the sacroiliac joint (SIJ) is commonly ignored. The SIJ is extremely strong, the range of motion

in the joint is minimal and is commonly dismissed as physiologically insignificant, and the function of the joint has not been properly described. Despite extensive analysis and computation in a recent study, Lavignolle et al concluded "the sacroiliac joints remain quite a mystery and knowledge of their precise mode of function is still incomplete."⁴ Kirkaldy-Willis and Hill, however, have suggested that the sacroiliac joint is a commonly overlooked cause of low back pain.⁵

Successful methods of treatment of the SIJ have been reported. Norman and May treated over 300 patients with injection of a local anesthetic into the SIJ relieving pain immediately in patients who had both sensory changes and an absent Achilles tendon reflex.⁶ Therapeutic results have been obtained by adding hydrocortisone to the anesthetic. Several patients who had one or two laminectomies for the removal of disks have been successfully treated by three or four injections.⁶

Definitive research also has identified the SIJs as a common cause of low back pain. Davis used ^{99m}Tc stannous pyrophosphate bone scanning with quantitative sacroiliac scintigraphy in 50 women with low back pain and found that 22 had sacroiliitis.⁷ Of those, 8 (36%) had unilateral sacroiliitis and 14 (64%) had bilateral sacroiliitis. Of the 22 patients with abnormal scans, 20 had normal radiographs.

Some practitioners have treated SIJ dysfunction for years with little or no understanding of the function of the joint. Some have ignored the joint, denying both function and dysfunction, and a few have made an honest, but frequently unappreciated, effort toward thorough assessment. Grieve concluded "that either the condition goes unrecognized, or because of authoritarian and intimidating pronouncements about its nonexistence, the likelihood of the condition is not included among the many factors for assessment, and a careful comprehensive examination of the joint is not conducted."⁸

The purpose of this article is to describe the biomechanics and function of the SIJ, the dysfunction and pathomechanics of the SIJ as a common cause of low back pain, a simple assessment procedure, associated pain mechanisms, and treatment and prevention of the problem and to discuss related literature.

ANATOMY AND MOTION OF THE SACROILIAC JOINT

The anatomy of the pelvic girdle is well-known and has been described in detail in *Gray's Anatomy*⁹ and many other medical texts. The sacrum supports the weight of the vertebral column and upper trunk and is, in turn, supported by the two innominate bones, which rest on the lower extremities

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when a person is standing. The sacrum is a double wedge, tapering from anterior to posterior and from cephalad to caudad, with convex auricular sides that fit tightly into matching concavities in the ilia. Cunningham observed that the sacrum is suspended from the iliac bones by the dense posterior sacroiliac ligaments and cannot be considered as the keystone of an arch.¹⁰ Grant stated that the sacrum tends to sink forward into the pelvis, which tightens the posterior ligaments and draws the ilia closer together.¹¹ The sacrum is protected from sinking too deeply between the innomines through this automatic locking device. Conversely, the innomines are also protected from moving too far posteriorly on the sacrum.

Weisl demonstrated that as weight is loaded onto the sacrum in changing from a recumbent to an erect posture, the sacrum slips vertically downward with some rotation and hangs more deeply between the innomines.¹² Colachis et al demonstrated the approximation of the ilia when a person moves from prone to a sitting position.¹³ Chamberlain observed that the strongest ligaments over the SIJ run in such a direction that the fibers are tightened when the innomines rotate posteriorly and loosened when the innomines rotate anteriorly.¹⁴ Erhard and Bowling have suggested that "for practical purposes the only motions permitted are gliding in a ventral and caudal direction and return to the resting position."¹⁵

Any movement of the sacrum on the innomines probably disturbs the intimacy of the matching surfaces and causes the convex surface of the sacrum to move slightly out of the concavity of the ilium, which slightly spreads this very tight joint. The normal elasticity in these ligaments then causes these bones to return to their resting position.

Weisl's work suggests there is a transverse axis of rotation through the posterior aspect of the SIJ when changing from a recumbent to an erect posture.¹² James Mennell¹⁶ and John Mennell¹⁷ describe a transverse axis of rotation through the SIJ with flexion and extension of the trunk on the pelvis in the sagittal plane. Bourdillon describes an oblique axis through the SIJ with oblique trunk flexion.¹⁸ Lavignolle et al found three different axes of rotation through the pubic symphysis with one hip fixed in flexion and the other in extension.⁴

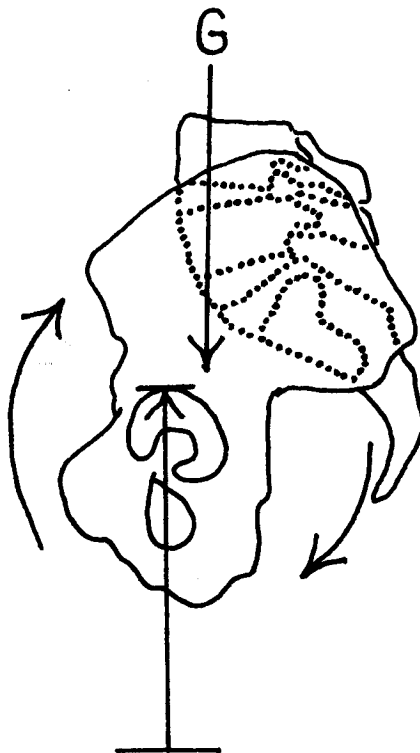


Fig. 1. Posterior rotation force in the normal standing posture. The line of gravity (G) is posterior to the acetabula.

In the normal standing posture, the line of gravity falls posterior to the center of the acetabula, and thus most of the weight of the trunk is transmitted through the posterior pelvis. This transfer causes a posterior rotation force (Fig. 1), and the pelvis rotates downward posteriorly around the acetabula creating an automatic pelvic tilt without any support of the anterior pelvis from the abdominal muscles.¹⁹

The sacrum, firmly entrapped between the innomines and suspended from the ilia, carries the weight of the spine. The SIJs are essentially non-weight-bearing joints. An increase in weight loading would increase the tension on the posterior ligaments and cause the sacrum to ride even more deeply between the innomines, until the limit of motion is reached.

FUNCTION

Gray's Anatomy stated that the function of the sacroiliac joints is to lessen concussion in rapid changes of distribution of body weight in each of two directions.⁹ In doing so, the joint undergoes some rotation through a transverse axis. Wilder et al also believed that the

joint may play a role in energy absorption.²⁰ Motion can occur but only by joint separation and ligamentous stretching. The shuffling movements found by Lavignolle et al add a certain flexibility to the pelvis during ambulation and cradle and minimize rotational forces on the spine.⁴

The SIJ appears to have another and probably more important role in ambulation. Ambulation can be considered as a controlled fall with a forward inclination of the trunk to initiate and continue forward movement (inertial moment) while the legs move forward alternately to maintain balance. A braking force (deceleration moment) is created on initial heel strike. Between the inertial moment of the upper trunk and the deceleration moment on the innomines is a margin of shear (Fig. 2). The SIJs function to absorb the shearing forces.

Other forces in the area should also be taken into consideration. The inertial moment of the trunk must always exceed the deceleration moment of the legs or forward motion will cease. The braking force created on initial contact is partially absorbed at the foot on heel strike, as the dorsiflexors act to decelerate and lower the anterior foot to the ground, and partially absorbed at the knee, as the quadriceps femoris muscle allows some knee flexion before terminal extension. Anterior and downward motion of the pelvis occurs, which is probably greater than that depicted in Figure 2, because of this knee flexion; anterior and upward rise of the pelvis is increased by some simultaneous plantar flexion.

Counterrotation of the upper trunk rotates the sacrum slightly posteriorly, which also serves to lessen the deceleration moment on the SIJ (Fig. 3). The intensity becomes apparent and can be easily demonstrated by having a person ambulate without using any counterrotation, that is, bringing the right shoulder forward with initial contact of the right leg and the left shoulder forward with initial contact of the left leg. All forces are markedly increased when a person is running or jumping.

PATHOMECHANICS IN TRUNK FLEXION

Activities commonly associated with onset of low back pain are lifting, bending, lowering, and twisting. The body

position commonly associated with most of these activities is trunk flexion. Such apparently innocuous tasks as working over a counter, making a bed, ironing, shaving, and washing dishes shift the weight of the trunk over the anterior pelvis. This anterior weight shift or standing in a lordotic posture causes an anterior rotation force on the pelvis (Fig. 4). If the anterior pelvis is not supported adequately by the abdominal muscles, the pelvis will rotate anteriorly and downward around the acetabula. Because the posterior ligaments of the sacrum are loosened when the innominates move anteriorly on the sacrum¹⁴ and the thin sheath of anterior sacroiliac ligaments offers only scant protection, the SIJ is vulnerable to dysfunction anteriorly. As the sacrum is wider anteriorly than posteriorly, any movement of the innominates anteriorly on the sacrum tends to spread the innominates and may cause them to wedge or bind. McConnell and Teall described the condition in which the ilium is forward, the ischium backward, and the innominatum thrown downward on the sacrum, which causes an apparent lengthening of the limb.²¹ Chamberlain identified this downward rotation and fixation of the innominate bone on the sacrum by using stereoscopic roentgenograms and special positioning techniques.¹⁴ He also found that "the patient's acute sacroiliac symptoms have almost invariably been on the side of the high pubis" when the patient is standing.¹⁴

Any movement of the innominates anteriorly on the sacrum stretches the anterior capsule of the SIJ and precipitates acute pain. Wyke noted that "the fibrous capsules of these joints are provided with a nociceptive receptor system in the form of a dense plexus of unmyelinated nerve fibers that weaves tridimensionally throughout the entire thickness of each joint capsule."²² The sacroiliac ligaments also contain nociceptive receptor nerve endings, which are threaded between bundles of ligamentous fibers.

The innominate bones moving downward in relationship to the vertebra probably stretches the spinal nerve roots. Sciatica frequently accompanies low back pain. Perl found that tissues subjected to unusual stresses can become inflamed and hyperalgesic, and this condition becomes a possible mechanism for sciatic neuralgia.²³

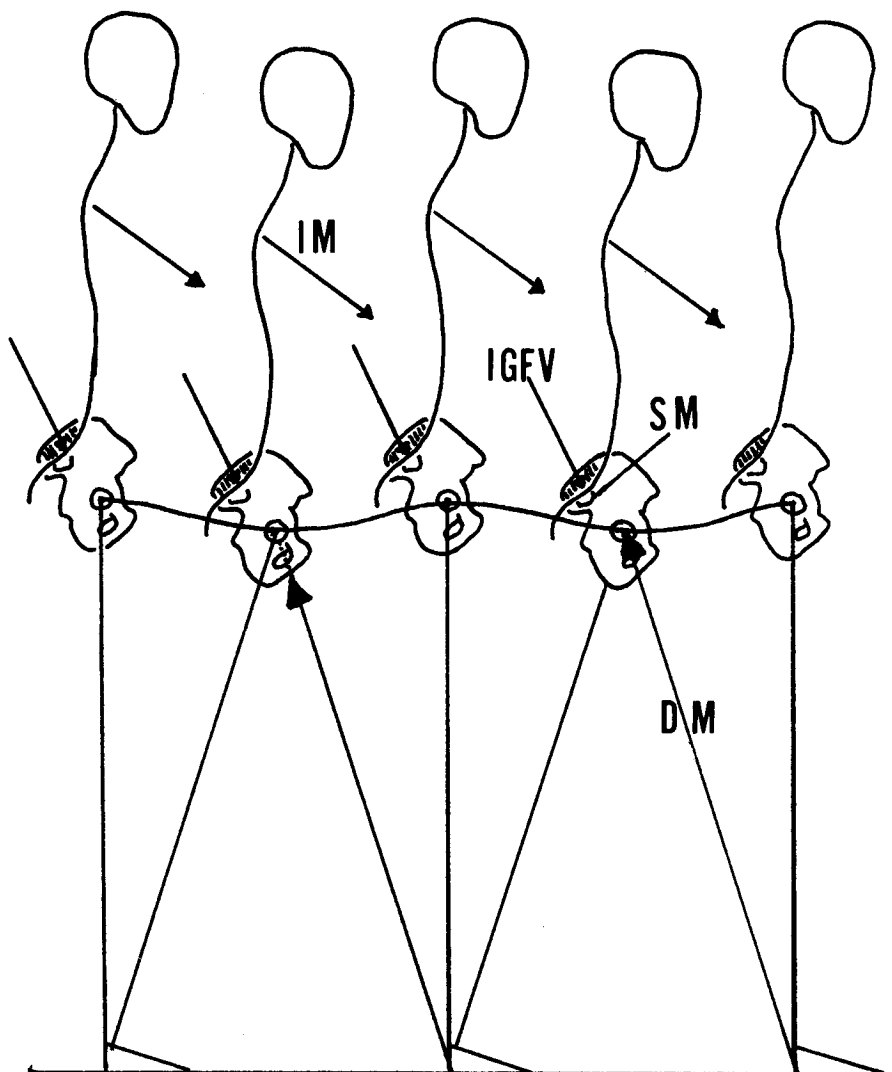


Fig. 2. The inertial moment (IM) combined with gravity produces the inertial/gravitational force vector (IGFV) that opposes the deceleration moment (DM) of initial contact. The sacroiliac joint functions to absorb these forces at the shear margin (SM).

About 30 to 40 percent of anterior dysfunctions of the SIJ are compromised by downward wedging of the sacrum. After the innominate rotates anteriorly on the sacrum and locks, the articular surfaces are altered in such a way as to allow the innominate to slip vertically upward on the sacrum (or for the sacrum to slip vertically downward on the ilium) and lock, effectively preventing correction by simple posterior rotation.¹⁹ Two likely mechanisms account for this dysfunction. The first mechanism involves leaning forward to lift an object in the absence of anterior pelvic support. The innominates rotate anteriorly and downward to fix on the sacrum. Finally, when the subject straightens, the addition of the weight of whatever object was lifted causes the

sacrum to settle vertically downward and more effectively locks the SIJ in the position of dysfunction. The second mechanism involves a subject who has an anterior dysfunction and who may step down hard from a step or fall on his buttocks. The sudden deceleration is combined with the inertial moment acting on the sacrum, and the sacrum is forced vertically downward on the ilium.

The most common lesion of the SIJ is reported to be posterior dysfunction.^{8, 16-18} Posterior dysfunction, however, probably does not exist because the SIJ functions most efficiently to absorb compressive forces when the innominate moves posteriorly on the sacrum where it is well-protected from injury in that direction by the dense

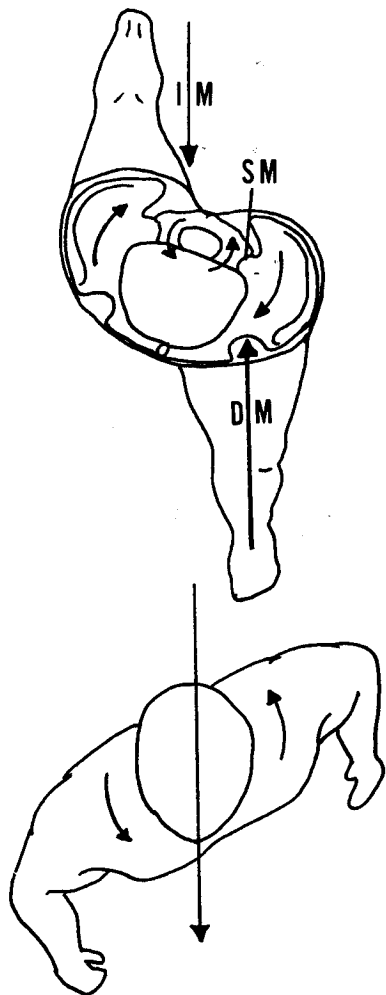


Fig. 3. The intensity of the deceleration moment (DM) increases on initial contact as the pelvis swings anteriorly. Forces on the spine are cushioned by the sacroiliac joint at the shear margin (SM) aided by the counter rotation of the upper trunk. All forces are affected by any increase in the inertial moment (IM).

posterior ligaments and the automatic locking mechanism described by Grant.¹¹ Not only has no mechanism been described that might cause the innominates to wedge and lock when moving posteriorly on the sacrum, but more importantly, the most common type of sacroiliac dysfunction probably occurs when the innominates are rotating as a unit—anteriorly and downward around the acetabula.

ASSESSMENT OF SACROILIAC JOINT DYSFUNCTION

The most important relationships that need to be assessed are comparisons of the levels of the anterior and posterior superior iliac spine; they are altered in

the posterior tilt position compared with the anterior tilt position (Fig. 5). If anterior dysfunction is unilateral when the subject is standing, the SIJ and the posterior superior iliac spine (PSIS) will be higher on the affected side than on the unaffected side or than when in the posterior tilt position. The anterior superior iliac spine (ASIS) will be lower in the position of anterior dysfunction.^{18,19,24} The sacral base will also be tilted higher on the affected side. If the subject is in the supine position, the sacral base tends to level itself, and the pelvis will be lower on the affected side. When in the supine position, the subject's lower extremity on the affected side will appear to be about 1 to 1.5 cm longer than the other extremity when the length of the extremities at the malleoli is compared. Because the ASIS on the affected side also moves downward, measurements from the ASIS to the medial malleoli remain about the same. If the patient is sitting, the PSIS will be higher on the affected side and because the acetabulum moves slightly posteriorly in relationship to the SIJ, the leg will appear to be shorter on the affected side. If anterior dysfunction is bilateral, both legs will appear to be the same length even though both sides are rotated anteriorly and downwards.

It also is important to note in the history if the onset of pain was innocuous or if it was associated with trauma. Additionally, noting results of conventional radiographs can be helpful to demonstrate bone lesions, but radiographic evidence does not always correspond to clinical evidence. The standard anterior-posterior view of the pelvis does not reveal the slight anterior rotation of the innominate on the sacrum although it does provide frequent evidence of pelvic obliquity and some apparent difference in the length of the lower extremities.

Palpation of the SIJ may be helpful and is frequently recommended.^{8,18} The SIJ, however, is difficult to palpate, especially in the obese, because changes at the joint are small and dyssymmetrical development is common. Furthermore, instead of assessing the relative height of the iliac crests, the therapist should assess the relative position of both PSISs.

The therapist must also do additional evaluative procedures because SIJ dysfunction may occur and exist with other problems such as spondylolisthesis, lumbar facet syndrome, degenerate disk

disorder, hip disease, or local sprains and strains. This evaluation should include, but is not limited to, movements of the spine and hip, site of pain and direction of radiation, areas of paresthesia, tests of muscle strength and reflexes, palpation of the abdomen, and observation of posture and gait.

Use of the straight-leg-raising (SLR) test is essential in the analysis of pain in the low back. Proper interpretation of the test is critical. In the conventional SLR test, pain is thought to arise from the following tissues: the dura mater, the nerve root, the adventitial sheaths of the epidural veins, and the synovia of the facet joints.²⁵

To perform the test, the therapist places the patient in the supine position, passively raises the patient's leg slowly with the knee extended, and notes when and where the pain occurs. Fahrni stated that the slack in the peripheral arborization of the sciatic nerve is taken up with from 30 to 40 degrees of hip flexion and then traction is exerted on the nerve roots at the intervertebral foramina and above until 60 to 70 degrees of hip flexion when no further sliding of the roots

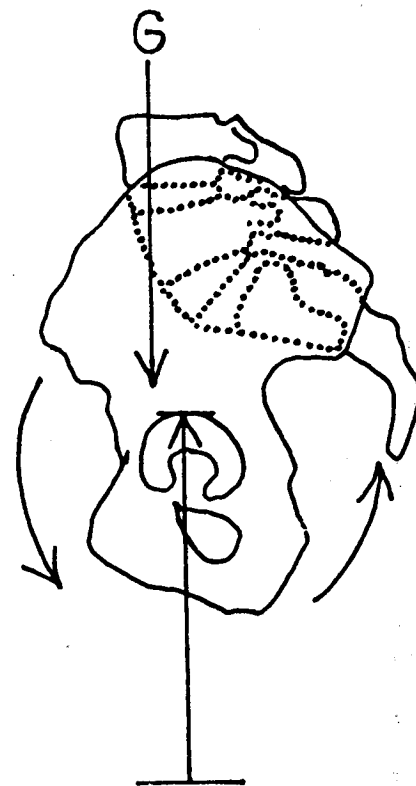


Fig. 4. Anterior rotation force in a lordotic posture with an anterior shift of the line of gravity (G) anterior to the acetabula.

occurs.²⁶ Pain from 70 to 90 degrees of hip flexion must be from some other cause than tension on the roots.²⁶ Pain during the early arc of the SLR is interpreted as abnormal tension on the root before the SLR test began, presumably because the nerve is stretched over a protruding disk,²⁷ or bony spinal structure. False positive and false negative results are common.²⁸ Pain in the back that is increased with passive SLR is thought to be due to dura mater irritation.²⁹

Pain may be ipsilateral or contralateral. Scham believed that the crossed SLR test involves the movement of the dura mater and the contralateral roots medially and distally and can indicate a large, more medially placed prolapse.³⁰ Unfortunately, false positive results are described for this test, too.³¹ A positive passive SLR test result suggests root irritation; it also is suggestive of, but not diagnostic of, disk herniation.²⁷ A disk lesion is not a prerequisite of pain on SLR and, even if present, need not necessarily have anything to do with causing the pain other than possibly making it worse.⁸

Other interpretations of the SLR test become apparent when the biomechanics of the SIJ are taken into consideration. As the leg is lifted during the SLR test, the pull of the hamstring muscles on the innominate bone causes a posterior torsion strain of the innominate on the sacrum on the same side.¹⁶ As the ipsilateral innominate bone moves posteriorly, it carries the sacrum posteriorly on the opposite innominate and causes an anterior rotational strain on the contralateral innominate. Anterior dysfunction should always be suspected on the contralateral side when contralateral pain is produced during passive SLR (whether a herniated disk is present or not) and when that pain is markedly reduced after a correction in flexion on that side. Mennell also found that rotating one innominate posteriorly increased anterior dysfunction on the opposite side.¹⁶ The pain of an anterior dysfunction may be eased during the passive SLR test as the ipsilateral innominate moves posteriorly on the sacrum.

Frequently, when the examiner begins to lower the leg, the patient will attempt to hold back slightly and actively lower the leg. The active contraction of the hip flexors, especially the iliacus muscle, will tend to pull the ilium

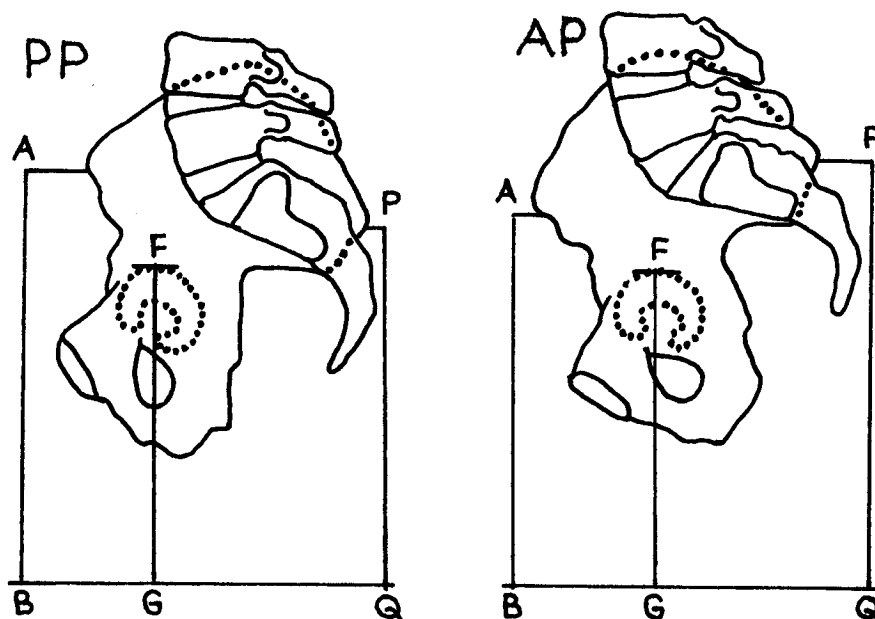


Fig. 5. In both the posterior position (PP) and the anterior position (AP), line FG remains constant from the acetabula to the floor or to the medial malleoli. Line AB becomes slightly shorter in AP and line PQ becomes markedly longer.

anteriorly on the sacrum and increase the pain of an anterior dysfunction. This pain is immediately eased by using a resisted hip extension to lower the leg.

An increase in ipsilateral pain in the low back on passive SLR has been described by some as indicating a posterior dysfunction of the SIJ because pain was increased as the pull of the hamstring muscles rotated the innominate posteriorly on the sacrum.^{16,17} I have found, however, this to be a consistent sign of an anterior dysfunction of the SIJ when it is compromised by a vertical sacral slip.

Confirmation and Correction of SIJ Dysfunction

Because the leg appears to lengthen when the innominate rotates anteriorly and downward on the sacrum, it can be expected to appear to shorten when the innominate is rotated posteriorly and upward on the sacrum to a corrected position. This apparent shortening is a positive, objective, frequently predictable sign of a corrected position, which relieves pain and restores function to the SIJ. The apparent change in leg length can be measured from the PSIS to the medial malleolus before and after mobilization.

The test to confirm anterior dysfunction is performed with the patient in a supine position on an examining table

and the examiner at the foot of the table. The therapist grasps an ankle in each hand with the medial aspect of each thumbnail resting lightly against the distal end of each medial malleolus. The malleoli are held together in the midline, in line with the nose and the navel, with a mild amount of manual traction on each, and the comparative length of each leg is noted. The therapist confirms and corrects the anterior dysfunction by rotating the innominate on the involved side, upward and posteriorly on the sacrum. This maneuver can be done by firmly flexing the knee along the side of the chest into the axilla (Figs. 6 and 7) or by placing one hand between the patient's legs and up under the ischial tuberosity and buttock, the other hand over the ipsilateral ASIS with the fingers pointing laterally and rotating the innominate bone strongly posteriorly and upward. The therapist then reexamines the patient's legs, as previously described, to see if they are now of equal length at the malleoli.

Chamberlain identified the unilateral anterior dysfunction but believed it highly unlikely that an equal and symmetrical displacement in the other SIJ might take place and did not consider bilateral dysfunction.¹⁴ Bilateral SIJ involvement, however, has been described^{19,24,32} and verified,⁷ and is thought probably to be more common.

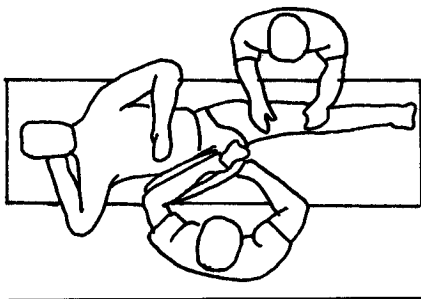


Fig. 6. Method of mobilization to correct an anterior dysfunction of the sacroiliac joint and reduce an apparent lengthening of the leg. (Courtesy of The DO²⁴ and the American Osteopathic Association)



Fig. 7. Alternate method to correct anterior dysfunction, viewed from above. (Courtesy of The DO²⁴ and the American Osteopathic Association)

If the patient experiences pain over both SIJs and the leg length appears to be equal at the malleoli, the therapist rotates one innominate posteriorly on the sacrum and then reexamines the leg length at the malleoli to see if that leg now appears to be shorter than the uncorrected side. The therapist then treats the uncorrected side in the same manner and the legs will again be of equal length. The less painful side is usually easier to correct first. Each innominate must be rotated posteriorly on the sacrum two or three times. For each rotation, the alternate hip bone must also be rotated and the leg lengths at the malleoli compared, until no more apparent shortening takes place. Frequently, two or three adjustments are needed to get a complete correction.

Confirmation and Correction of the Compromised Sacroiliac Joint Dysfunction

A vertical slipping of the innominate on the sacrum causes the leg that had appeared long on the affected side to

shorten again in an abnormal manner. The leg appears to be its normal length again. The method of correction tends to affirm the dysfunction. With the patient in a supine position, the therapist grasps the leg on the affected side and gives a sharp tug on that leg in the long axis and reassesses the leg length. That leg usually appears to become about 1 cm longer than it was, and the ipsilateral pain on passive SLR will be markedly decreased. The innominate must then be rotated posteriorly to correct the original anterior dysfunction and the leg will shorten to its normal position. These two, different maneuvers are necessary to correct this condition.

ASSOCIATED PAIN MECHANISMS

Patients with pain in the low back frequently complain of pain on sitting, pain on leaning forward, and pain on an increase of intraabdominal pressure. Although investigations by Nachemson and Morris³³ have found that intradiskal pressure is increased with these conditions, other mechanisms may cause pain in this area in the presence or absence of disk herniation.

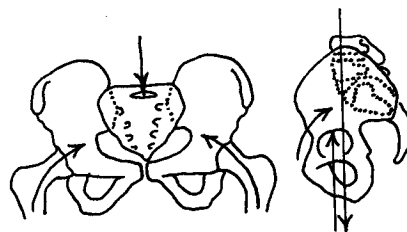


Fig. 8. Forces on the pelvis in the standing posture.

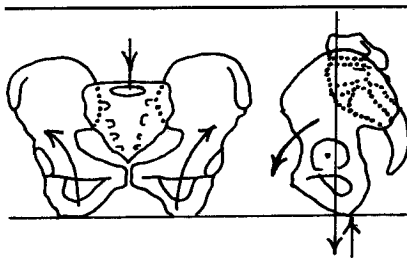


Fig. 9. Forces on the pelvis in the sitting posture.

Pain on Sitting

Although pain on sitting may be increased by an increase in intradiskal pressure if a herniated disk is present, Grieve noted that pain on sitting may also arise from the SIJs.⁸ If wedging at the SIJs has already slightly spread the innominate bones, any pressure that might increase the spreading and stretch of the anterior joint capsule could increase the pain. Grant stated that "in the standing posture, the acetabula and the sidewalls of the pelvis tend to be forced together, but the pubic bones, acting as struts, prevent this from happening. In the sitting posture, the ischial tuberosities tend to be forced apart."¹¹ Figures 8 and 9 illustrate these actions. During anterior dysfunction, the ischial tuberosities are posterior to their normal position, and weight bearing on them in sitting increases the anterior rotation strain on the capsule and on the spinal nerve roots.

Pain on an Increase of Intraabdominal Pressure

Pain in the SIJs may also be increased with an increase of intraabdominal pressure as the spreading of the joints stretch the painful tissues. If the pelvis is stabilized by manual compression of the ilia, the patient can usually cough or sneeze in relative comfort. This maneuver is not likely to affect intradiskal pressure one way or another.¹⁸

Back Pain and Instability During Pregnancy

Anterior dysfunction is a common, uncomfortable complication of pregnancy. As weight increases on the anterior pelvis and pelvic support weakens, an anterior rotation strain occurs at the SIJs, which results in anterior dysfunction. Another factor is the hormonal influences of relaxin during the final stage of pregnancy, which softens and relaxes the sacroiliac ligaments and the symphysis pubis for passage of the mature fetus. The softening, however, makes these areas less stable and more prone to injury.^{34, 35}

Pelvic Instability During the Menstrual Cycle

The presence of relaxin in the body about a week or 10 days before the onset of menstruation effects a hormonal lig-

amentous laxity similar to that of pregnancy but to a lesser degree and renders the pelvic ligaments less stable and, thus, more prone to minor injury. The relaxin is reabsorbed during menstruation and if the innominate is kept in its normal position on the sacrum at this time, the pelvic ligaments seem to regain their normal stability. I have observed that if the dysfunction is not corrected, the instability may continue into the next menstrual cycle.

TREATMENT

Each treatment of SIJ dysfunction must begin with assessment and manual correction of the dysfunction. For the relief of residual pain, mobilization is followed with heat, electrical stimulation, and massage. Massage is not only soothing but can be an excellent method of deep palpation for the therapist to become more familiar with and to better assess the affected tissues in the area. Ice massage or cold packs may be helpful if the pain is acute. Pelvic traction may be helpful in the presence of a neurological deficit and may also help to correct a compromised SIJ dysfunction by pulling the innominates caudally on the sacrum.

Corrective Exercise Program

Resting in bed may be helpful to the patient during the acute phase, but the therapist should also start a corrective exercise program. The sooner the dysfunction is corrected, the shorter the patient can convalesce. A pillow placed between the knees is helpful when the patient is side lying. When the patient is lying in a supine position, a pillow placed under the lower edge of the buttocks seems more helpful than a roll placed under the low back to maintain lumbar lordosis. Maintenance of lumbar lordosis is probably not necessary at rest. Prone lying is contraindicated.

The patient must be instructed thoroughly on the nature of his condition, its proper correction, and prevention. Correction is usually accomplished by rotating the innominate upward and posteriorly on the sacrum, which takes the tension off the nerve roots and the anterior joint capsule, restores function to the SIJ, shortens the lower extremity, and relieves the pain. The patient can perform this rotation by flexing the hip and bringing the knee into the ipsilateral

axilla from a supine, sitting, or standing position (Fig. 10). Swart recommended the patient lie supine, grasp the hands around one knee and pull with the hands while pushing with the knee (Fig. 11).³² This procedure is essentially a muscle energy technique. This corrective exercise must be done 2 or 3 times on each side, alternating each time with the other knee, and should be repeated up to 15 or 20 times a day for three or four days, and then 4 or 5 times a day for about another week. The patient should correct the joint before going to bed each night to take the stress off the tight structures and allow several hours for them to recover. Correct nightly exercise minimizes getting up in the morning with a stiff, painful low back.

To maintain the correction and to prevent recurrence of an anterior dysfunction, the anterior pelvis must be supported. This support is especially important when a person leans forward. If a person must lean forward for any period of time to perform such tasks as working over a counter, ironing, or washing dishes, placing a foot on a low stool will minimize anterior rotation of the pelvis. If the abdominal muscles are weak, they must be strengthened usually with bent knee sit-ups. Isometric abdominal exercises performed throughout the day are very helpful.

All leg-raising exercises should be contraindicated.³⁶ Whether doing sit-ups with the legs straight or doing leg raises, the pull of the hip flexors, especially the iliacus muscle, from the iliac fossa causes an anterior rotation strain of the innominates on the sacrum. In the absence of adequate support of the anterior pelvis from the abdominal muscles, an anterior dysfunction of the SIJs may be precipitated or exacerbated.

The therapist must explain the program thoroughly to the patient the first day of treatment. If the pain is still acute the second day, the patient may not be doing his exercises properly and should demonstrate to the therapist what he believes is the correct exercise. Because the patient often modifies the program, the therapist may have to reinstruct him in the correct method.

Supports

Doran and Newell found that the response to a corrective corset was slow, but the long-term effects were as good as those of other treatments.³⁷ The sup-

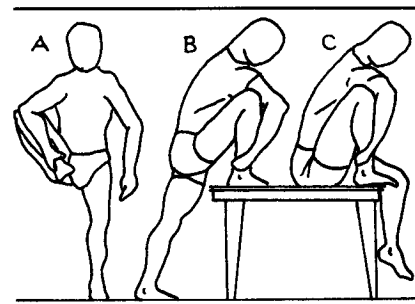


Fig. 10. Methods of self-correction. A. In standing or supine position, pull the knee into the ipsilateral axilla; alternate several times. B. With one foot on a table or bench, lean toward the knee and stretch it into the axilla; alternate. C. When sitting, pull one knee into the axilla and sit in this position for a few minutes; alternate. Repeat these exercises many times during the day and always make a correction on going to bed to relieve the strain on the involved ligaments through the night. (Courtesy of the Journal of Orthopaedic and Sports Physical Therapy¹⁸)

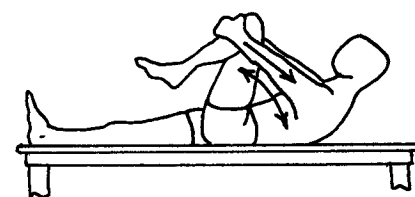


Fig. 11. A dynamic method of correcting an anterior dysfunction, pulling with the hands while pushing with the knee. (Adapted from Swart³²)

port should be put on after a correction has been made to help prevent recurrence. If the support is put on without correcting the dysfunction, it may increase pain by increasing pressures on the pelvic joints in that position.

Heel Lifts

Greenman recommended that lift therapy be used only to make the sacral base plane more level and not to equalize leg length or to influence lumbar scoliosis.³⁸ Heel lifts are commonly used to equalize the height of uneven pelvic crests. I have found that in over 95 percent of cases with apparent leg-length difference, the height of the crests can be equalized and the apparent leg-length difference resolved almost instantly with a simple, painless mobilization.

Transcutaneous Electrical Nerve Stimulation

Transcutaneous electrical nerve stimulation (TENS) can be very helpful during either the acute or chronic phase of low back pain if the TENS is used in conjunction with a corrective exercise program. Because the maintenance of function of the SIJ is necessary, dysfunction should be corrected with regular exercise and not be masked by the use of TENS alone.

RELATED LITERATURE

In the early 1900s, dysfunction of the SIJ was a common diagnosis, and a very high percentage of patients with this problem had an associated pain in the sciatic nerve. To determine if a relationship existed between the sciatic nerve and the SIJ, Danforth and Wilson did an extensive study and concluded that the SIJ did not act directly to cause sciatic nerve pain because "there is no canal nor semblance of a canal which holds the nerves against the joint."³⁹ In 1934, Mixter and Barr described the herniated disk,⁴⁰ which caused the emphasis in research to change to demonstrating how the various signs and symptoms associated with pain in the low back could be due to the herniated disk. Researchers, however, found no free motion in the SIJ, the joint seemed well protected by dense ligaments, and the function of the joint was not well understood; they generally concluded that it was a "misconception" that "the sacroiliac joint was susceptible to strain and subluxation from trivial injury."⁴¹

Because an anatomical relationship between the SIJ and the sciatic nerve could not be demonstrated to precipitate sciatic neuritis, the disk was assumed to be at fault. The possibility of a biomechanical relationship between the SIJ and sciatic neuritis was not considered.

Nachemson's studies demonstrated an increase in intradiskal pressure on leaning forward, sitting, coughing, or straining and have, by inference, implicated disk herniation as the cause of all cases of low back pain that are exacerbated by these conditions.⁴² An alternate etiology precipitating similar symptoms has seemed unlikely, but Barbor described these symptoms as related to pathology of the SIJ.⁴³

Because the intervertebral disk has often been assumed to be the site of most low back disorders, it has been

examined anatomically, microscopically, biomechanically, and chemically. Schultz has concluded that "idiopathic low back disorders are often ascribed to degenerative disk disease, but this has never been proved. In fact, it is known that disks very frequently degenerate without producing any symptoms of low back disorders."⁴⁴ Wyke found that "neither the nucleus pulposus nor the annulus fibrosus of mature intervertebral disks contains any type of receptor nerve ending."²²

Ulrich treated low back pain with variations of static postural positioning to relieve disk pathology.⁴⁵ McKenzie also reported some good success using various postures (especially hyperextension) to treat the lumbar disk.⁴⁶ Russek found that the anterior lumbosacral angle was 5 degrees less for a subject standing in hyperextension with the horizontal plane than the lumbosacral angle for a subject standing in the neutral position.⁴⁷ This finding indicated some pelvic flexion as the line of gravity moved posteriorly. This decreased lumbosacral angle was accompanied by forward shearing and compression of the anterior portion of the disk between L5 and the sacrum. The posterior shift of the line of gravity behind the center of the acetabula creates a powerful strain in posterior rotation that would help to correct an anterior dysfunction of the SIJs (Fig. 12).

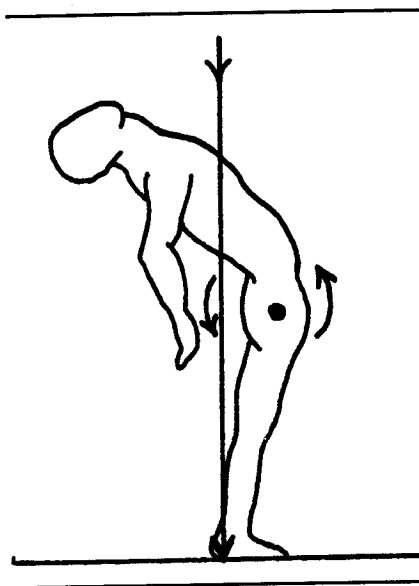


Fig. 12. A hyperextension posture causes the pelvis to rotate posteriorly and helps to correct an anterior dysfunction of the sacroiliac joint.

Dysfunction of the spinal joints also can be a significant cause of pain in the low back and may be affected individually or in association with SIJ dysfunction. Several theories have been proposed as to the nature of spinal dysfunction and its treatment. Techniques in mobilization have been described in the treatment of the lumbar spine to restore normal joint play,^{16,17} to correct minor intervertebral derangements,⁴⁸ or to replace a displaced annulus.⁴⁹ Techniques include gentle oscillations, graded movements, contract/relax movements, high-speed thrusts, manipulations stabilizing with one hand and thrusting with the other, and thrusts in opposite directions with both hands. Pain from the SIJs is frequently mistaken as coming from the lumbosacral joints. It is interesting to note that the treatment described by James and John Menell^{16,17} did not offer any procedures for manipulation of the lumbar spine in rotation. John Menell explained, "Upright rotation will only be limited by loss of function in the sacroiliac joint on the side to which the patient is turned or by pathology at the lumbosacral junction. Pathology elsewhere in the lumbar spine should not limit upright rotation, because there is virtually no intervertebral rotation in the lumbar spine."¹⁷ Cyriax conceded that minimal rotation occurs in the lumbar spine but found that one of the best methods of replacing a displaced annulus pulposus is rotation.⁴⁹ Pain relieved by rotation is probably from an undetected SIJ dysfunction rather than from spinal pathology.

Even though such a respected source as *Gray's Anatomy*⁹ suggests that the most common position of dysfunction is probably a backward movement of the innominate on the sacrum, usually unilateral, the automatic locking mechanism described by Grant¹¹ probably precludes locking in the posterior position. I have found the only variety of dysfunction to be an anterior fixation of the innominate on the sacrum, which may be occasionally compromised while in the anterior position by a somewhat vertical slipping of the sacrum on the innominate.^{19,24} Chamberlain identified unilateral dysfunction but assumed that a symmetrical displacement in the two sacroiliacs would hardly be the rule and did not investigate this displacement.¹⁴ Bilateral dysfunction is more common.

Pelvic obliquity is frequently assumed to be caused by a difference in leg length, and the leg-length inequality, in turn, is assumed to be a causative factor in the etiology of low back pain. Actually, the reverse is more common. The difference in apparent leg length is caused by the pelvic obliquity, which is created with dysfunction of the SIJ. This difference is easily altered with appropriate corrective mobilization.^{19, 24, 32, 50}

Leg-length difference has also been associated with degenerative knee-joint changes⁵¹ and idiopathic osteoarthritis of the hip.⁵² At least, part of the etiology may lie in the impairment of the energy absorber function of the SIJ. If the SIJ is fixed, the inertial moment of the trunk can be expected to be transferred through the innominate to the femoral head. This impact loading may cause microfractures of the trabeculae and stiffening of the subchondral bone, which may precipitate degenerative arthritis of the joint. If the SIJ is fixed during ambulation, the shear between the inertial moment of the trunk and the deceleration moment of the pelvis is

not absorbed but is transferred to the next adjacent area of soft tissue, which is the disk between the L5 and S1 vertebrae. This additional shearing force appears to lead to disk degeneration, an unstable segment, or spondylolisthesis. Surgical fusion of L5-S1 performed without restoration of function to the SIJs would only serve to transfer the shearing force to the L4-5 disk.

The necessity for research is apparent. What is the maximum range of motion of the SIJ and how much weight loading is necessary to reach it? Accelerometer studies are necessary to determine the nature of the inertial moment of the sacrum during different gaits and movements. How much are the spinal nerve roots stretched with an anterior dysfunction? What is the exact nature of the compromised anterior dysfunction? Can any other types of dysfunction be identified? How can we differentiate the pain on sitting caused from an increase in intradiskal pressure in the herniated disk from the pain on sitting caused from a dysfunction of the SIJ? What methods can be used to stabilize the

unstable SIJ? How can these methods of evaluation and treatment be improved?

CONCLUSION

Dysfunction of the sacroiliac joint is a common biomechanical lesion, which is frequently brought on insidiously; is related to inequality of leg length, pelvic torsion, and pelvic obliquity; is described as increased pain on sitting, leaning forward, coughing, or sneezing; and is associated with pain on passive SLR and pain during pregnancy. Many of these signs and relationships are attributed to the herniated intervertebral disk, and dysfunction of the SIJ is frequently ignored in favor of the disk. Correction and prevention of SIJ dysfunction is quite simple and effective; however, if the function of the joint is not restored and maintained, other degenerative problems may be precipitated.

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