Asia-Pacific Chiropractic Journal

CLINICALINQUIRY

Supine and prone SOT pelvic block placement: A comparative analysis of position by MRI

Chad Warshel, Sana Khan, Tammy Cassa, Charles L Blum

Abstract

Objective: Pelvic blocks or wedges have been utilised in the sacro occipital technique (SOT) method of chiropractic since the 1960s with a rational for both supine and prone block placements.

Methods: Four same-subject MRIs were taken supine and prone, two with pelvic blocks and two without pelvic blocks (control).

Results: Comparing control and intervention sequences, there does not appear to be any measurable anatomical changes in the sacroiliac joints between the control studies and the blocked studies.

Conclusion: Research has noted that with pelvic block use functional changes such as reduced pain, improved range of motion, and muscle strength has been found; yet this may be due to neuromuscular and not mechanical effects. This study had limitations and future studies should utilise greater field strength magnets for better resolution, visualise the whole bony pelvis instead of isolating the sacroiliac joint, and incorporate more extensive 3-dimensional analytic technology. The positive clinical functional changes associated with SOT pelvic block placement may be due to neuromuscular factors and not solely mechanical. Future research utilising the information learned from this study may yield a clearer picture of what is taking place with pelvic block placement(s).

Indexing terms: Chiropractic; SOT; SOT blocks; pelvic; wedges.

Introduction

Pelvic blocks or wedges were initially developed and utilised in the sacro occipital techniques (SOT) method of chiropractic by Major Bertrand DeJarnette, DC, DO in the early 1960s. (1, 2) DeJarnette (also known as De Jarnette) simultaneously developed a categorisation process (three categories) for analysing and treating patients with these pelvic blocks. (3)

The purpose of this study was to evaluate the tenets of SOT regarding to pelvic block position for its category one (prone) and category two (supine). Using MRI allowed us to ask '*do the blocks actually change the pelvis biomechanically compared to a control*' and '*is there a definitive change upon the pelvis with block positions compared to place supine or prone*'?

To evaluate this study's purpose we need to understand the reason for supine versus prone pelvic blocking procedures and how DeJarnette developed a method of generalising patient presentations into three categories. The three-category system stemmed from DeJarnette's engineering and anatomical background.

His study of anatomy helped him investigate the two aspects of the sacroiliac

> *… This study did not support the assertion that the sacroiliac joint is significantly affected by block position and that the sacroiliac joint is affected differently by placement of blocks on a prone or supine patient. Why might this be the case?…'*

joint, which has an anterior synovial portion and a posterior hyaline cartilage portion. While the sacroiliac joint is 'one joint', the anterior aspect should have motion and this is where sacral nutation and counter-nutation takes place. On the other hand the posterior sacroiliac joint is focused on weight-bearing stability and support, which is why at the posterior joint surface there is interlocking of the ridges, and grooves (form closure) as well as compressive forces by structures like muscles, ligaments and fascia (force closure). (4)

DeJarnette's engineering principles evaluated the weight-bearing characteristics of the sacroiliac joint and determined that when the joint could not adequately support body weight then load bearing stress will be moved superior-ward to the L5/S1 and L4/5 discs, most commonly.

Category One

Category I deals with the primary respiratory motion between the sacrum and occiput. This is described typically as pelvic torsion with altered sacral nutation. When pelvic torsion is sufficient to disrupt the anterior aspect of the sacroiliac joint, the normal sacral nutation can be affected. The spinal and cranial meningeal and CSF systems function to a degree like a closed kinematic chain. Therefore the sacral meningeal attachments and reduced sacral nutation can have an affect cranialward to the spinal column and cranial regions, purportedly causing meningeal altered tensions, CSF stagnation, and altered vasomotor function. (5)

Category Two

Category II involves instability of the sacroiliac joint causing a dysfunctional relationship between the sacrum and its corresponding ilium. The sacroiliac weight-bearing whole body pattern of imbalance causes proprioceptive compromise due to loss of the body to maintain itself against gravity. This stresses the whole body and can involve the spinal column, extremities, TMJ, and cranial sutural system. When Category II system of stress load accommodation reaches a threshold and can no longer compensate for the increased gravitational load this may lead to Category III. (5)

Category Three

Category III represents the body's inability to maintain sufficient weight-bearing at the posterior sacroiliac joint and can commonly lead to lower lumbosacral discopathy. DeJarnette described this category relating to nerve root compression or stretch syndrome due to direct involvement of the cartilaginous (discs) joints of the spine. He also determined that related muscles such as the *piriformis* and *psoas* need to be considered in both assessment and treatment and that sciatic nerve irritation was a common feature of this category. (5)

Why this study?

Studying the effect of pelvic blocks upon the sacroiliac joint is of value because it appears that SOT is a standard form of Chiropractic treatment within the field of Chiropractic: (i) 2005 Job Analysis of Chiropractic, (6) (ii) Mercy Guidelines (7) (for historical purposes), and (iii) chiropractic literature description of its 'named' chiropractic techniques (10 - 14) We expand these below:

1. The 2005 Job Analysis of Chiropractic published by the *National Board of Chiropractic Examiners* and its relationship to SOT. The Job Analysis was published in 1993; 1994, 2000, and the NBCE released a companion volume that included a state-by-state statistical report on chiropractic practice. The '*Job Analysis 2005*' was considered the largest and most comprehensive as compared to all prior volumes. (6) The more recent 2010 (8) study did not survey Chiropractic technique use and therefore the most recent volume for evaluation purposes was the 2005 study.

   With regard to the section of the study entitled '*the most utilised chiropractic adjustive techniques/ procedures adjustive*' SOT fared as follows:

   % of DC's Utilizing SOT in 1991: 41.3%

   % of DC's Utilizing SOT in 1998: 49.0%"

   % of DC's Utilizing SOT in 2005: 49.6%" (6)

2. The '*Guidelines for Chiropractic Quality Assurance and Practice Parameters*' (7) also know as the *Mercy Guidelines*, was for most of the 1990s considered the accepted guidelines for Chiropractic healthcare. While the majority of the SOT related literature published in the peer review literature was published following the review of the authors, their review still came to specific determinations regarding SOT's major treatment modality, the pelvic blocks. Using Kaminsky's (9) method of analysis for Chiropractic methods and techniques the Mercy review committee determined the following regarding SOT 'Pelvic Blocks':

   > Pelvic Blocks: These paired wedges are used primarily for positioning the lumbosacral and sacroiliac joints to produce a sustained stretch. This procedure is in fairly common use, and there is reasonable rationale and expert opinion on its utility in certain situations. (7)
   >
   > Rating: Promising for the care of patients with neuromusculoskeletal problems. (7)
   >
   > Evidence: Class III, Evidence provided by expert legal opinion, descriptive studies or case reports. (7)
   >
   > Consensus Level: 1, Established. Accepted as appropriate by the practicing chiropractic community for the given indication in the specified patient population. (7)

3. In efforts to evaluate chiropractic named techniques, SOT is always one method that is listed, and commonly considered a major form of care in chiropractic. (10 - 14) While the majority of these studies have not had full access to the SOT published literature, SOTO-USA is attempting to remedy that situation by the publication of the SOT Compendiums of Peer Review literature. (15, 16) The most current text by Gleberzon and Cooperstein on 'Named' Chiropractic Techniques (14) treats SOT quite favourably, yet even this text was written without access to all published studies on SOT related treatment.

One study performed by a review of the *Applied Chiropractic Department*, at *Canadian Memorial Chiropractic College*, completed in 1998, involving faculty, clinicians and students '*revealed that 87% of students are in favour of more exposure to named techniques*'. (10) It was determined that 53% of the students had interest in learning Sacro Occipital Technique, (10) which is similar to the NBCE study. (6)

If SOT does have some support based on its use by the Chiropractic profession, credibility in the various Chiropractic treatment guidelines, and is considered a standard Chiropractic named technique in the literature, the question becomes '*is there evidence for one of its primary methods of treatment for the pelvis*'?

Cooperstein notes '*Although both prone and supine pelvic blocking are intended to reduce pelvic torsion*, (17) t*he mechanics are somewhat different. Prone blocking, by raising the innominate bones relative to the sacrum, distracts the sacroiliac joints, whereas supine blocking, by elevating the innominate bone relative to the sacrum, would be expected to approximate the sacroiliac joints*'. (18) Essentially he suggests that the blocks aside from reducing pelvic torsion will either '*mobilise (prone blocking) or stabilise the low back (supine blocking)*'. (18)

The knowledge gap

What has not been clearly determined is whether an actual biomechanical anatomical change in the pelvis while the blocks are in place in both supine and prone patients can be objectively demonstrated. A radiographic study of pelvic block placement with a control did show an anatomical change in the pelvis. (19) However critics of the study suggested that the 'anatomical' change could have been solely the pelvis' distance to the x-ray beam and that there may not have been any actual anatomical change to the pelvis due to the block position. Therefore an MRI follow up study was suggested with the goal of utilising a 3-dimensional (3D) analysis to eliminate the 'beam to subject' distance issue.

This study was also necessary to further develop an evidence base of information regarding pelvic block use given we understand that some Chiropractic colleges teach that there is no difference to the sacroiliac joint whether the patient is treated with pelvic blocks in the supine or prone position.

Therefore the goal of the study is to answer the following three questions:

i) Do pelvic blocks placed upon a supine patient change pelvic anatomical position as compared to a control without pelvic block placement?

ii) Do pelvic blocks placed upon a prone patient change pelvic anatomical position as compared to a control without pelvic block placement?

iii) Is there a difference between prone and supine pelvic block placement upon the sacroiliac joint width at the anterior or posterior surface or at the superior or inferior joint interface?

Methods

Institutional review board approval for this study was received in February 2011 from Cleveland Chiropractic College, Los Angeles. Prone and supine magnetic resonance images of the sacroiliac joints were obtained in the following sequences utilising a recumbent 0.6T open MRI unit:

- axial T1
- axial T2
- coronal T1 and
- coronal T2.

The entire extent of the sacroiliac joints was not included. The study utilised a 57-year-old male for 4 specific MRI studies. Standard DeJarnette style pelvic blocks were used however all metal (nails, staples, and thumbtacks) were removed and fabric glue was used to maintain the block's prior shape. The subject had 4 MRI studies as follows:

1. A control study of the patient's sacroiliac joints while supine, without blocks.
2. An intervention study performed supine with pelvic blocks under the crest of the right ilium and left greater trochanter.
3. A control study of the patient's sacroiliac joints while prone.
4. An intervention study performed prone with pelvic blocks under the left ASIS and right greater trochanter.

The sequences were evaluated to determine if there were comparable slices demonstrating consistent landmarks to evaluate for any change in anatomic relationships of the pelvic osseous structures. This evaluation was undertaken for both prone and supine patient position control versus intervention sequences. Additionally, the prone and supine blocking views were to be compared to one another to determine if they show a measurable difference between the gapping of the sacroiliac joint based upon supine versus prone block positions.

Results

In evaluating the axial sequences and comparing with the control sequences, it is possible to find a similar landmark slice through the sacrum. The images are not completely identical, due to an expected slight change in angulation of the sacrum and innominate bones when blocks are in place.

However in comparing control and intervention sequences, there is no appreciable difference in the measurements of the anterior or posterior sacroiliac joint spaces.

The most notable difference between the control and blocked sequences is that when the blocks are in place, the subcutaneous fat and superficial musculature is compressed. There does not appear to be any measurable anatomical changes in the sacroiliac joints between the control studies and the blocked studies.

Discussion

This study was a follow-up on a prior radiographic study with an additional comparative study investigating prone versus supine pelvic block (wedge) placement and the sacroiliac joint. Initially Lisi, Cooperstein, and Morschhauser did a study relating to pain provocation and block placement (20) and then later Klingensmith and Blum did one regarding the same block placements and radiographs. (19) The radiographic study was criticised because it was believed a 3-dimensional view per MRI would give a clearer idea of what was taking place.

The results of this study did not appear to support DeJarnette, (5) Knutson, (21) or Cooperstein's (18) premise that that there is a mechanical difference between supine and prone block placement. Yet the current research does suggest that both prone and supine pelvic block placement do show positive functional changes during treatment, which may be significant. (22) A prone block study noted a positional preference for the pelvic blocks with associated reduced pain. (20) Other studies utilising pelvic blocks in a supine position have been found an improvement of muscle strength (23, 24) as well as lumbar ranges of motion. (25)

This study did not support the assertion that the sacroiliac joint is significantly affected by block position and that the sacroiliac joint is affected differently by placement of blocks on a prone or supine patient. Why might this be the case?

1. The test subject is a 57-year-old male. It is possible that sacroiliac joints are more freely mobile in a young subject, and as we age, they become more fibrotic and hence less mobile. In particular for this case, there is mild degenerative change of the right SI joint, which could impede mobility. Possibly if this study was repeated with a late 2nd to early 3rd decade subject, more movement might be appreciable.
2. The MRI scans were different to some degree. For a more complete assessment of anatomical changes to the sacroiliac joint and pelvis the entire span of the sacroiliac joints should have been imaged on all series, whereas just a portion of the joints was included in this study. Ideally, the entire pelvis from above the iliac crest to below the ischial tuberosity should be scanned so multiple landmarks could be assessed. It is also possible that instead of the 0.6T magnet used in this study a higher field strength closed MRI could also yield greater resolution.
3. This study would be much better served by utilising an imaging modality which allows for 3-dimensional rendering of the entire pelvis, blocked and unblocked. That would allow for much greater evaluation of any anatomic shifting. The machine and software used in this study do not allow for such 3D rendering. 3D reconstruction is most commonly done via Computerised Tomography (CT). A study using CT on a live subject may have problems receiving IRB approval as multiple CT scans of the pelvis would result in higher radiation exposure. Another study design option for which it would be easier to attain IRB approval is a CT study utilising a fresh, unembalmed cadaver. An unembalmed cadaver is recommended as embalmed cadavers have drastically different tissue properties from a live subject. While the fresh unembalmed cadaver will also have different tissue properties than a living subject, it would be closer to in vivo results. The 3D reconstruction images would also allow for evaluation of innominate rotation relative to the sacrum, as well as anterior or posterior joint gapping.

Knutson (21) and Cooperstein (18) both noted the anatomical shape of the sacroiliac joint suggests that a prone block placement would tend to open the anterior aspect of the joint and a supine block placement would tend to close posterior aspect of the joint. However these theories have not been subjected to objective 3D analysis to determine whether pelvic blocks cause an actual mechanical change in the osseous and ligamentous sacroiliac joint tissue. If we are finding that there are functional changes such as reduced pain, improved range of motion and muscle strength, is it possible that this is not due to the mechanical changes but related to neuromuscular modifications in the sacroiliac joint?

Knutson suggests that the 'load applied to ligaments stimulates neural receptors in the ligament, nociceptors, (26) and mechanoreceptors, (27) which signal for muscular reactions and pain perception. The sacroiliac joint and surrounding tissues are highly innervated with nociceptors and mechanoreceptors. (28) Mechanoreceptor stimulation results in direct (α-motoneuron) or indirect (γ-motoneuron) stimulation and/or inhibition of muscles, (27, 29, 30) however, SIJ pain does not necessarily mean SIJ sprain. Injection is considered to be the gold standard because it presumably isolates the problem to the SIJ. (31, 32, 33) In the Schwarzer et al study, tears of the ventral capsule, SIJ sprain, were significantly ($\div 2 = 4.74$, $p<0.03$) associated with relief of pain after intra-articular injection of 2%. (21, 32, 33)

Aside from a treatment model, Cooperstein has developed a method of mechanical or possibly neuromuscular assessment utilising the pelvic blocks. (18) This has value since both palpation of static and dynamic motions of the sacroiliac joint has been questioned in the literature. (34) Cooperstein describes the process by placing the blocks '*asymmetrically under the patient, either supine or prone, to serve as fulcrums that allow gravitational forces to affect the position or movement of the sacroiliac and lumbar joints. Blocking may as well be considered an orthopedic test, since the purpose of virtually any such test is to put the joints under investigation in stressed or potentially de-stressed positions, noting the symptomatological changes and drawing the appropriate clinical conclusions. Padded wedges, apart from their value in treating patients, can thus be used to generate diagnostic information, as well, that amounts to mechanically assisted orthopedic testing. Following that it then becomes the doctor's choice as to whether to proceed by adjusting the patient using padded wedges, a high-velocity, low amplitude thrust in side posture or on a drop table, a percussive instrument, etc*'. (18)

Cooperstein continues '*Although both prone and supine pelvic blocking are intended to reduce pelvic torsion, the mechanics are somewhat different. Prone blocking, by raising the innominate bones relative to the sacrum, distracts the sacroiliac joints-whereas supine blocking, by elevating the innominate bone relative to the sacrum, would be expected to approximate the sacroiliac joints. Whatever the diagnostic findings that accrue to supine blocking manoeuvres, the doctor has to decide on clinical grounds whether (apart from reducing the pelvic torsion) the clinical goal is to mobilise (prone blocking) or stabilise the low back (supine blocking)*'. (18)

Regarding the three questions asked representing the goal of this study:

i) Do pelvic blocks placed upon a supine patient change pelvic anatomical position as compared to a control without pelvic block placement?

ii) Do pelvic blocks placed upon a prone patient change pelvic anatomical position as compared to a control without pelvic block placement?

iii) Is there a difference between prone and supine pelvic block placement upon the sacroiliac joint width at the anterior or posterior surface or at the superior or inferior joint interface?

The answers are not clear. It appears that utilising the method of MRI study on a 57-year-old male with only a restricted view of the sacroiliac joint that no significant anatomical changes, other than a change in innominate/sacral angulation, could be visualised. Clinically, pelvic blocks have been reported for years to be successful interventions on geriatric patients (35) therefore it is unlikely that the mitigating factor for failing to isolate a pre and post MRI anatomical change is age contingent. Therefore in summary the following three suggestions are offered for future studies:

A. Utilise a higher field strength magnet and/or some additional method(s) of MRI to obtain greater resolution.

B. Visualise the whole bony pelvis to investigate whether there are changes occurring to not just the sacroiliac joint but also to the pelvis itself.

C. Utilise 3-dimensional analysis methodology to fully investigate control and supine/prone block placement and compare difference between supine and prone block placement.

It is also possible that future study might not show any anatomic change in the sacroiliac joint with block placements regardless of the imaging modality utilised. If this is the case then an alternative rationale, (e.g., neuromuscular) to address the clinical findings found with the pelvic blocks will be needed.

Conclusion

Sacro occipital technique has a category method of generalising patient presentations and treatment utilising pelvic blocks to affect the lumbopelvic region. Supine and prone pelvic block placements are purportedly capable of creating a mechanical change to the anterior and posterior aspect of the sacroiliac joint.

Utilising a 0.6T open MRI unit, other than a change in innominate/sacral angulation, the MRI study was unable to discern anatomic changes in in the sacroiliac joint with controlled versus blocked pelvis studies performed in both prone and supine patient positions.

Future studies to investigate mechanical changes in response to block placement are indicated utilising greater field strength magnets for better resolution, visualise the whole bony pelvis instead of isolating the sacroiliac joint, and incorporating more extensive 3-dimensional analytic technology.

Chad Warshel
DC
Private practice of Chiropractic
Santa Monica, CA

Sana Khan
DC
Private practice of Chiropractic
Santa Monica, CA

Tammy Cassa
DC
Private practice of Chiropractic
Santa Monica, CA

Charles L Blum
DC
Director of Research
Sacro Occipital Technique Organization - USA
Private practice of Chiropractic
Santa Monica, CA
drcblum@aol.com

Cite: Warshel C, Khan S, Cassa T, Blum CL. Supine and prone SOT pelvic block placement: A comparative analysis of position by MRI. Asia-Pac Chiropr J. 2025;5.4 apcj.net/Papers-Issue-5-4/#BlumSOTBlocks

References

1. Rosen MG, Blum CL, Sacro Occipital Technique: Technique and Analysis. Todays Chiropractic. Jul/Aug 2003; 32(4): 22,24-6.
2. Heese N. Major Bertrand de Jarnette: Six Decades of Sacro Occipital Research, 1924-1984. Chiropractic History. Jun 1991;11(1): 13-5.
3. Getzoff H. Sacro Occipital Technique Categories: a System Method of Chiropractic. Chiropractic Technique. May 1999; 11(2): 62-5.
4. Pool-Goudzwaard AL, Vleeming A, Stoeckart R, Snijders CJ, Mens JM. Insufficient lumbopelvic stability: a clinical, anatomical and biomechanical approach to 'a-specific' low back pain. Man Ther. 1998 Feb;3(1):12-20.
5. Monk R. Sacro Occipital Technique Manual 2006. Sacro Occipital Technique Organization – USA: Sparta, NC. 2006.
6. Christensen M, Kollasch MW, 2005 Job Analysis of Chiropractic, National Board of Chiropractic Examiners, Greely: CO, 2005. Chapter 10: 135.
7. Christensen MG, Kollasch MW, Hyland JK. Practice Analysis of Chiropractic 2010: A project report, survey analysis, and summary of chiropractic practice in the United States. National Board of Chiropractic Examiners: Greeley Colorado. 2010. [http://www.nbce.org/publication/practice-analysis.html] Last accessed July 6, 2011.
8. Haldeman S, Chapman-Smith D, Peterson DM, Guidelines for Chiropractic Quality Assurance and Practice Parameters: Proceedings of the Mercy Center Consensus Conference, Aspen Publisher, Inc.: Gaithersburg, Maryland; 1993: 106-8.

9. Kaminski M, Validation of Chiropractic Methods, Journal of Manipulative and Physiological Therapeutics, 1987; 110(2): 61-4.
10. Gleberzon BJ, Chiropractic Name Techniques in Canada: A Continued Look at Demographic Trends and Their Impact on Issues of Jurisprudence. J Can Chiropr Assoc. 2002; 46(4): 241-56.
11. Gleberzon BJ, Incorporating Named Techniques into a Chiropractic College Curriculum: A Compilation of Investigative Reports. The Journal of Chiropractic Education. 2000;14(1): 33-4.
12. Bergmann TF, Various Forms of Chiropractic Technique. Chiropractic Technique May 1993; 5(2):53-5.
13. Peterson DH, Bergmann TE, Chiropractic Technique: Principles and Procedures, 2nd Edition, Mosby: St. Louis, MO, 2002:460-2, 497, 499.
14. Cooperstein R, Gleberzon BJ, Technique Systems in Chiropractic Churchill Livingstone: New York, NY April 2004:123-36, 209-20, 300-1.
15. Blum CL (editor). Compendium of Sacro Occipital Technique: Peer Reviewed Literature 1984-2000. Sacro Occipital Technique Organization – USA: Sparta, NC. 2001.
16. Blum CL (editor). Compendium of Sacro Occipital Technique: Peer Reviewed Literature 2000-2005. Sacro Occipital Technique Organization – USA: Sparta, NC. 2007.
17. Cooperstein,R, Lisi A, Pelvic Torsion: Anatomic Considerations, Construct Validity, and Chiropractic Examination Procedures Topics in Clinical Chiropractic Sep 2000; 7(3): 38-49.
18. Cooperstein R, Lisi AJ.Blocking Procedures: An expanded approach. Journal of the American Chiropractic Association. 2004 Jan; 41(1):44-6.
19. Klingensmith RD, Blum CL, The Relationship Between Pelvic Block Placement and Radiographic Pelvic Analysis. Journal of Chiropractic Medicine. Summer 2003; 2(3): 102-6.
20. Lisi AJ, Cooperstein R, Morschhauser E, An exploratory study of provocation testing with padded wedges: Can prone blocking demonstrate a directional preference? J Man Manip Ther. Feb 2004; 27(2): 103-8.
21. Knutson G, The Sacroiliac Sprain; Neuromuscular Reactions, Diagnosis and Treatment with Pelvic Blocking, Journal of the American Chiropractic Association. Aug 2004; 41(8): 32-9.
22. Hahne AJ, Keating JL, Wilson SC. Do within-session changes in pain intensity and range of motion predict between-session changes in patients with low back pain? Aust J Physiother . 2004;50(1):17-23.
23. Unger JF, Jr. The Effects of a Pelvic Blocking Procedure upon Muscle Strength: a Pilot Study. Chiropractic Technique. Nov 1998; 10(4): 50-5.
24. Giggey K, Tepe R. A pilot study to determine the effects of a supine sacroiliac orthopedic blocking procedure on cervical spine extensor isometric strength. J Chirop Med. Jun 2009;8(2):56-61.
25. Hochman JI, The Effect of Sacro Occipital Technique Category II Blocking on Spinal Ranges of Motion: A Case Series. J Man Manip Ther. Nov 2005;28(9): 719-23.
26. Slosberg M. Effects of altered afferent articular input on sensation, proprioception, muscle tone, and sympathetic responses. J Man Manip Ther. 1988;11(5): 410-418.
27. Sjolander P, Johansson H, Djupsjobacka M. Spinal and supraspinal effects of activity in ligament afferents. Electromyogr Kinesiol 2002 Jun;12(3):167 -76.
28. Willard FH. The anatomy of the lumbosacral connection. Spine: State of the Art Reviews. 1995;9:333-55.
29. Johansson H, Sjolander P. Chapt. 9. Neurophysiology of Joints. In: V. Wright, E. Radin (eds). Mechanics of Human Joints. Physiology, Pathophysiology, and Treatment. Marcel Dekker, Inc: NY. 1993: 243-90.
30. Solomonow M. Ligaments: a source of work related musculoskeletal disorders. J Electromyogr Kinesiol 2004;14:49-60.
31. Fortin JD, Aprill CN, Ponthieux B, Pier J. Sacroiliac joint: pain referral maps upon apply in a new injection/arthrography technique, II: clinical evaluation. Spine 1994;19:1483-89.
32. Schwarzer AC, Aprill CN, Bogduk N. The sacroiliac joint in low back pain. Spine 1995;20:31-37.
33. Broadhurst NA, Bond MJ. Pain provocation tests for the assessment of sacroiliac joint dysfunction. J Spinal Discord 1998;11(4):341-5.
34. Goode A, Hegedus EJ, Sizer P, Brismee JM, Linberg A, Cook CE. Three-dimensional movements of the sacroiliac joint: a systematic review of the literature and assessment of clinical utility. J Man Manip Ther. 2008;16(1):25-38.
35. Killinger LZ. Chiropractic and geriatrics: a review of the training, role, and scope of chiropractic in caring for aging patients. Clin Geriatr Med. 2004;20:223–35.