Indian Journal of Basic & Applied Medical Research; June 2012: Issue-3, Vol.-1, P. 221-225

# "ABDOMINAL MUSCLE ACTIVATION IN LOW BACK PAIN PATIENTS: A SURFACE EMG STUDY."

**Swati Limaye* Deepak Anap****

**ABSTRACT:**

**Introduction :** Activation of abdominal muscles is essential for ensuring good sacroiliac joint stability. Intramuscular electrodes have been used in past for recording activity of abdominal muscles, however this limits the clinical application of the procedure. Our study compared the strength of abdominal muscle activation in low back pain patients and normal individuals using surface electromyography.

**Method** : EMG activity of ten normal individuals and ten low back pain patients during unilateral active straight leg raise was recorded using surface electromyography.

**Results :** Study participants in the experimental group had significantly smaller activation of Transversus abdominis as compared to the control group.

**Conclusion:** The study supports training of isolated contraction of transversus abdominis for treatment of low back pain.

**Key words:** Transversus abdominis, Sacroiliac joint, Surface EMG, Bracing action.

**INTRODUCTION :** The high incidence of low back pain invites for an in depth understanding of the pathomechanics of the human body. The transfer of load from upper extremity and anatomy, normal biomechanics and trunk takes place through the vertebral column, sacroiliac joints, hip joint and passes through the lower extremity to the ground. Out of these the sacroiliac joints present a unique feature. They are vertically oriented joints, yet responsible for transfer of weight to the lower extremities. The stabilization of the SI joint can be increased in two ways. Firstly, by interlocking of the ridges and grooves on the joint surfaces (form closure); secondly, by compressive forces of structures like muscles, ligaments and fascia (force closure)[(1)]. Muscle weakness and insufficient tension of ligaments can lead to diminished compression, influencing load transfer negatively[(1)]. A previous study indicated that patients with LBP had a significantly smaller increase in Transversus Abdominis (TAB) thickness, with isometric leg tasks as compared with controls, on ultrasound measurement. There was no difference for Obliqus

**Associate professor,
*BPT student
College of Physiotherapy,
Pravara Institute of Medical Sciences,
Loni (Maharashtra)

**Corresponding Author:**
Mrs. Swati Limaye.
Contact no: 9869748010

Internus(OI) or Obliqus Externus(OE). Similar results were found using intramuscular EMG electrodes. People with LBP had less TAB EMG activity with lower limb tasks, and no difference was found between groups for EMG activity for OI or OE[3].

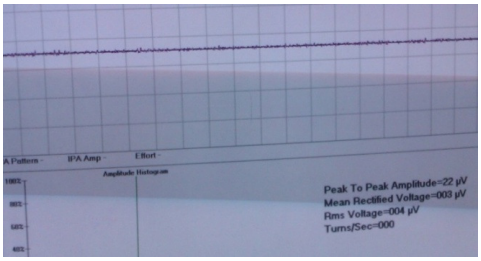
To facilitate screening of a large numbers of subjects, a method which can be easily applied to a clinical population was required. Previous research into TAB activity had involved the use of fine-wire EMG[4,5]. This technique required needle insertion into the abdominal wall along with ultrasound guidance and specialized skills to perform the insertion. Therefore this technique was not practical to use in the majority of clinical settings. Surface EMG (sEMG) has been more practical and cost effective method for evaluating muscle activity. A study validated the use of surface EMG for identifying the feed forward activity of TAB and established a reliable electrode site for the same. The aim of this study was to compare the strength of contraction of TAB muscle during its feed forward activation for lower limb movement.

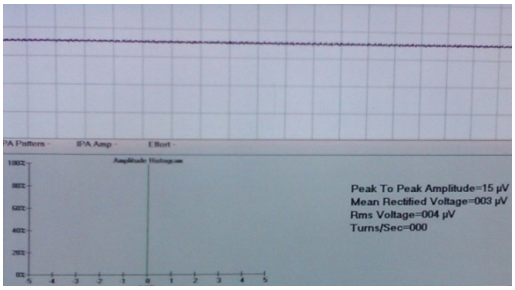
**METHOD:**

Twenty subjects were taken, ten healthy individuals and ten patients with low back pain (age 33.3 years, SD 4.572, weight 44.6 SD 3.777, height 48.5 SD 1.240, BMI 20.198

SD 1.334). All subjects had low adipose tissue around the abdominal area to improve signal integrity. Subjects were excluded if they had gross postural or skeletal abnormalities or neurological conditions. Consent was obtained from the subjects. The subjects were taken in supine lying position. The area of electrode placement was cleaned using a spirit swab. After allowing the skin to dry, pairs of circular Ag/AgCl surface electrodes with a contact diameter of 19 mm were placed with a center to center distance of 34 mm at a site 2cm medial and inferior to the left anterior superior iliac spine[4,5].

**DATA PROCESSING:** The EMG activity was recorded with the above mentioned electrode placement using RMS EMG EP Mark II machine. Baseline activity was defined as a signal of 15µV (SD 4.018). The subjects were asked to perform Active straight leg raise only up to 5 cm above the plinth with left leg[6] . Photograph 1 shows the baseline activity. Photograph 2 shows activity at unilateral active straight leg raise 5cm above the plinth. To minimize the effect of fatigue, a 30 second rest period was provided between each test procedure. Three readings were obtained for each subject.



**STATISTICAL ANALYSIS:**

The design used was an experimental study. The mean of the three test results was calculated and considered for analysis. The results were processed using GraphPad InStat3®. Unpaired T test was performed to compare values for normal individuals and low back pain patients.

**RESULTS:** The mean and standard deviation values for age, height weight and BMI of the subjects are shown in Table1. Table 1 gives a comparison between the EMG activation of transversus abdominis in normal individuals and low back pain patients.

Table 1 . Comparison of EMG activity (μV)

| EMG activity | Normal individuals | LBP Patients |
|---|---|---|
| **Mean** | ***38.497*** | ***30.397*** |
| **Minimum** | ***30.660*** | ***22.330*** |
| **Maximum** | ***57.330*** | ***41.330*** |

A significant difference was found in the activation of transversus abdominis between low back pain patients and normal individuals during unilateral leg raise (two tailed P=0.0168).

**DISCUSSION**: An anatomical study [7,8] showed the presence of cartilage-covered ridges and depressions which are complementary on the auricular surfaces of the sacrum and ilium. These ridges and depressions provide a high coefficient of friction giving stability to the vertically oriented sacroiliac joint, also termed form closure of the joint. Under loaded conditions, further stability is required which is provided by the muscles called force closure. Bilateral contraction of transversus abdominis acts as a corset improving sacroiliac joint stability, also referred as the 'bracing action'. Effectiveness of load transfer from spine to legs is improved when muscle forces actively compress the SIJ, preventing shear[2].

The current study demonstrated diminished strength of TAB contraction prior to lower limb movement in low back pain patients, a finding that correlates with another study[1]. Muscle weakness can lead to diminished compression, influencing load transfer negatively. Consequently continuous strain of pelvic ligaments can lead to pain.

The finding that SIJ stability increased even with slight muscle activity[2] supports the concept of feed-forward activation of TAB. A previous study revealed that TAB is the first muscle to get activated prior to any sacroiliac joint stability, also referred as the 'bracing action'. Effectiveness of load transfer from spine to legs is improved when muscle forces actively compress the SIJ, lower extremity or upper extremity movement[4].

Another study focused on isolated transversus abdominis activation and its contribution to lumbo-pelvic stability. The rationale was found to be effective for chronic low back pain (LBP) and could be included in management of many other pathologies of the lower and upper limb and also for prophylaxis in pain-free subjects. It also stated that altered timing of the transversus abdominis leads to poor core stability[10]. This emphasizes the importance of exercises directed towards specific transversus abdominis activation. These exercises are effective in the treatment of patients with chronic LBP attributable to a number of diagnoses[11].

Exercise techniques that promote independent contraction of the transversely oriented abdominal muscles (in co-contraction with multifidus)[12] have been found to have beneficial effects in relieving pain and disability in patients with chronic LBP [11] and lowering recurrence rates after an acute pain episode[12, 13].

The current study provides an electrophysiological evidence to the diminished strength of transversus abdominis muscle in low back pain patients. This consequently leads to diminished bracing action, resulting in insufficient stabilization of sacroiliac joint.

A training of isolated transversus abdominis contraction should therefore be incorporated in the management of low back pain.

**CONCLUSION:** The study revealed a significant difference between the activation of transversus abdominis in low back pain patients as compared to normal individuals, emphasizing upon the training of isolated transversus abdominis contraction as a treatment for low back pain.

**AKNOWLEDGEMENTS:** The authors are grateful to Dr. Subhash Khatri PhD; Dr. Kristina Kindblom, PhD, Dr. Chandra Iyer, MPT for providing guideline on research design and for statistical analysis.

**KEY NOTES**

- ✓ Stability of sacroiliac joint is essential for transfer of forces from spine to lower extremity.
- ✓ Transversus abdominis acts as a corset to provide compression at sacroiliac joint, thus improving its stability.
- ✓ Strength of activation of transversus abdominis is diminished in low back pain patients
- ✓ Isolated training of transversus abdominis should therefore be incorporated in management of low back pain.

**REFERENCES:**

1. A.L. Pool-Goudzwaard[a, b], A. Vleeming[a, b], R. Stoeckart[a], C.J. Snijders[c], J.M.A. Mens[d] Insufficient lumbopelvic stability: a clinical, anatomical and biomechanical approach to 'a-specific' low back pain Man Ther. 1998 Feb;3(1):12-20.

2. J. P. van Wingerden A. VleemingH. M. Buyruk K. Raissadat. Stabilization of the sacroiliac joint in vivo: verification of muscular contribution to force closure of the pelvis Eur Spine J. 2004 May;13(3):199-205. Epub 2004 Feb 24.

3. Ferreira, Paulo H. MSc; Ferreira, Manuela L. MSc; Hodges, Paul W. PhD. Changes in Recruitment of the Abdominal Muscles in People With Low Back Pain: Ultrasound Measurement of Muscle Activity Eur Spine J. 2004 May;13(3):199-205. Epub 2004 Feb 24

4. P. Marshall, B. Murphy The validity and reliability of surface EMG to assess the neuromuscular response of the abdominal muscles to rapid limb movement .Journal of Electromyography and Kinesiology 13 (2003) 477–489

5. McGill S, Juker D, Kropf P Appropriately placed surface EMG electrodes reflect deep muscle activity (psoas, quadratus lumborum, abdominal wall) in the lumbar spine. J Biomech. 1996 Nov;29(11):1503-7.

6. Dyedre S. Teyhen,PT,PhD, Jared N. Williamson, PT,PhD, Nathan H. Carlson PT, PhD, Jean Suttles PT, DPT Shaun J. O'Laughin, PT, PhD, Ultrasound Characteristics of deep abdominal muscles during the Active Straight leg test**.** Archives of Physical Medicine and Rehabilitation
Volume 90, Issue 5 , Pages 761-767, May 2009

7. Relation between form and function in the sacroiliac joint. Part I: Clinical anatomical aspects. Vleeming A, Stoeckart R, Volkers AC, Snijders CJ. Spine (Phila Pa 1976). 1990 Feb;15(2):130-2.

8. Relation between form and function in the sacroiliac joint. Part II: Biomechanical aspects Vleeming A, Volkers AC, Snijders CJ, Stoeckart R Spine (Phila Pa 1976). 1990 Feb;15(2):133-6.

9. Biomechanical Analysis of Reducing Sacroiliac Joint Shear Load by Optimization of Pelvic Muscle and Ligament ForcesJ. J. M. Pel, C. W. Spoor, A. L. Pool-Goudzwaard, G. A. Hoek van Dijke, and C. J. Snijders Received April 5, 2007; Accepted September 18, 2007.

10. Hodges PW, Richardson CA. Delayed postural contraction of transversus abdominis in low back pain associated with movement of the lower limb. Journal of Spinal Disorders [1998, 11(1):46-56]

11. O'Sullivan PB, Twomey LT, Allison GT. Evaluation of specific stabilizing exercise in the treatment of chronic low back pain with radiologic diagnosis of spondylolysis or spondylolisthesis. Spine 1997;22:2959–67.

12. Hides, Julie PhD; Wilson, Stephen PhD; Stanton, Warren PhD; McMahon, Shaun PhD; Keto, Heidi BPhty; McMahon, Katie PhD; Bryant, Martina B App Sc; Richardson, Carolyn PhD Long-term effects of specific stabilizing exercises for first episode low back pain. Spine 2001;26:E243–8.

13. Richardson C, Jull G, Hodges P, et al. Therapeutic exercise for spinal segmental Stabilization in low back pain. London: Churchill Livingstone, 1999.

**Date of manuscript submission: 30 October 2011**
**Date of initial approval: 29 December 2011**
**Date of Peer review approval: 20 March 2012**
**Date of final draft preparation: 28 May 2012**
**Date of Publication: 9 June 2012**
**Conflict of Interest: Nil, Source of Support: Nil.**