EMG Activity of Outer Unit Musculature in Patients with Non-Specific Low Back Pain

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Background and Purpose: *Chronic pain in lower back is a prominent cause of morbidity that affects wellbeing & productivity in comparable amounts across all communities. There are various evidences which have supported that it is the main local stabilizers which are more helpful in providing lumbar stability but little evidences on global stabilizers. So, the present study would try to explore that outer unit muscles are effected in cases of low back pain through Electromyographic (EMG) changes seen in these muscles and will be compared with normal subjects.*

Methodology*: 23 subjects were screened so that they fit to the selection criteria of non-specific low back pain and 23 matched controls were screened for having no low back pain. Prior to commencement of procedure, BMI of all participants were recorded. The EMG analysis was done in resting posture that is standing and activity position that is forward flexion. The surface electrodes were used for EMC measurements and were placed over the specific outer core muscles and activity was noted in form of amplitude. The EMG readings were taken for both sides and 3 readings in standing and bending were taken and mean of those 3 values were taken.*

Results: *The data was analysed using unpaired T-test. After statistical analyses, significant changes in EMG amplitude were observed in Abdominal Oblique (t=7.207), Latissimus Dorsi(t=5.076), Biceps Femoris (t=6.460) and Adductors (t=6.184) in static position while comparing group A and group B. Similarly significant changes in EMC amplitude were observed in Abdominal Oblique (t=6 383), Latissimus Dorsi(t=4.302), Biceps Femoris (t=8.470) and Adductors (t=6.549) in dynamic position while comparing group A and group B.*

Conclusion: *The results showed that there is a significant difference in EMG measurement of outer unit musculature in subjects with nonspecific low back pain and normal subjects. There is significant lower EMG amplitude of outer unit musculature during static and dynamic activities in control subjects when compared with Low Back Patients (LBP). In other terms there were significant higher muscle activities on SEMG pattern during static and dynamic positions in LBP when compared with control group.*

Keywords: Non-specific low back pain, Electromyographic activity, Outer unit musculature

1. INTRODUCTION

Low back pain is 2nd leading cause of manpower loss in many countries and it is a condition that decreases the productivity. It may be seen in 80% of general population during any period of life [1]. It is the major health issue due to its prevalence in general population and adverse effects on health. Low back pain in general term characterized by acute (<6weeks), Sub cute (6-12 weeks), chronic (>12 weeks) which are duration pendant and location specific (Berne 1998) [2]. Low Back in is leading cause of disability under the age of 45 years [3]. Studies show that 80% of adults experience LBP at some point in their lives. LBP arise from various etiological and various regional structures and abnormal and altered biomechanics. Several factors based on assumptions, clinical findings and scientific experiments have been associated with development of LBP [4]. SC Sharma et al estimated in a study done in 2003 that incidence of low back pain in work age group in adults in north India, 67% had psychosocial issues, 57% in blue colour jobs, 26% had to leave or change their profession and 38% did not enjoy their present job [5]. Non-specific low back pain has become a significant problem due to high health care utilization, rising costs of care lead to limitations of effectiveness of many current treatments [6]. It is a significant source of low back disability and chronic low back pain and absence from work and a substantial burden in industrialized societies.According to Bergmark A. the muscles responsible for maintaining spinal control are classified as global or local muscles [7]. The local muscles have direct attachment to the lumbar spine. Muscles most responsible for segmental stabilization have an attachment to the lumbar vertebrae and would include the transverses abdominis (TA) and the multifidus as well as the posterior fibers of the internal oblique (10) among others. The local system controls the spinal curvature. Also, the tonic characteristics of these muscles are reflective of their role in postural support. Outer unit as stabilizing system is a global muscle system designed for movement but many muscles such as obliques, abductors, QL., hamstrings, adductors serve as dual role tonic as well as phasic. If all of muscles in the squad are not functioning correctly, other muscles get overused, resulting in early tiredness, underperformance, and a higher risk of injury. Joint stiffness & segmental stability are matter of concern for inner unit muscles. They operate at low levels of maximum contraction for lengthy stretches of time. Transverse abdominis automatically co-contracts with multifidus to help create a stable spine for all the superficial movement producing, long lever muscles of outer unit to work off and use as a base. With one strategy, the brain recruits the deep stabilizing muscles of inner unit to provide low load protection for individual segments. This is our first defence against stress and strain and to maintain joint neutral position. With other strategy as load upon spine increases, brain intensifies the recruitment of large, torque producing muscles of the outer unit for dynamic control. If the load is heavy, the brains recruits the outer unit to maximal voluntary contraction which produces co-contraction rigidity to protect the spine. The deep stabilizing muscles of inner unit become impaired after back injury or pathology. So the brain adopts a simplified, motor programming strategy that emphasizesexcessive recruitment of large, strong, superficial muscular system to stabilize the spine [9]. The brain selects these outerunit muscles because they are easier to recruit to create torso rigidity for short term pain control. But outer unit muscles are not capable of providing segmental stabilisation. Richardson et al believe that spinal pain is accompanied by inhibition and atrophy of deep segmental "stabilizing" muscles and over activity of longer superficial "global" muscles [10-11]. Various evidences for stabilizing role of quadrates lumborum were provided by Anderson et al, who found that, unlike erector spinae, there was no electrical silence of muscle in full forward flexion. This muscle being a global muscle, capable of controlling the external loads placed on spine, showed over activity, tightness and trigger points are often reported by clinicians. Back muscle assessment is a critical part of the evaluation

process for identifying physical impairment in patient with LBP syndromes. Most of the techniques are subjective and rely upon the use of instruments that measure mechanical parameters that are cognitively perceived and therefore subject to voluntary regulation, physical tests of muscle strength and endurance may be influenced directly by patient motivation and willingness to risk discomfort as well as by socio-economic factors and secondary gain. SEMG may yield a somewhat more objective evaluation of muscle performance than solely mechanical indices [14].

Surface EMG provides information of myoelectric activities in muscles which is an objective method for lumbar neuromuscular functions assessment in both healthy and LBP patients[12]. Despite the fact that there are growing literatures reporting significant differences in EMG activity between persons with and without LBP, and that EMG measures can accurately differentiate these persons, clinical utility of EMG in LBP assessment has been doubted in previous reviews (Andrew J Haig et al. 1996) [15] and (Pullman et al. 2000) [16]. Rather than a diagnostic tool for detecting LBP, SEMG would be a prospective neuromuscular assessment upon pain behaviour assessment which allowed the illustration of effects of LBP towards muscular activities. The relationship between paraspinal electromypgraphy and low back pain is controversial. Studies of static paraspinal EMG activity have led to conflicting results. Thus the paraspinal EMG pattern during movement may be more beneficial. In certain movements there is reduction of paraspinal EMG activity in low back pain patients [17]. The purpose of the present study was that maximum researches have been done on individual muscles of inner unit which has the more roles in stability factors of lumbar spine. In recent years there has been a focus on local muscle system in studies concerned with etiological factors in chronic low back pain. But in order to explain the effect of low back pain on muscles, the more muscles groups should be investigated involving all the superficial and global muscles. So, our aim was to evaluate the EMG changes in muscles that provide lumbar stability and mobility.

2. METHODS AND MATERIALS

It was observational study for which ethical clearance was taken from the ethical committee, NIMS University. In this study observation was done to see the activity of outer unit musculature in non-specific low back pain subjects: 23 subjects with age group 24-56 years having clinical diagnosis of non-specific low back pain and 23 age matched normal subjects having no low back pain participated in the study. For data gathering, a convenient sampling approach was adopted.

Inclusion

- Age between 24-56 years.
- Both male and female participants included.
- Individuals with initial, moderate, and longterm pain of lowe back are considered
- Individuals interested to participate in the research.

Exclusion

- Subjects suffering from specific low back pain like PIVD, any instability, radicular symptoms, lumbar spondylosis, lumbar canal stenosis, spondylolysthesis
- Presence of neurological or neuromuscular symptoms.
- Subjects suffering from psychiatric disorders.
- Subjects with history of spinal trauma leading to fractures/ dislocations.
- Any history of other local or systemic major illness
- Subjects with history of spinal surgery or abdominal surgery
- Structural and fixed deformities

Instrumentation

- EMG machine was developed by Medicaid Company in New Delhi. The system uses round electrode of diameter 2cm array of 2 surface electrodes placed at distance of 2 cm from each other.

- Measuring tape for surface marking.

3. PROCEDURE

Prior to commencement of procedure, age (in years), weight (in kgs) and Height (in meters) of participants were recorded using weighing machine and measuring tape. Then BMI was calculated using BMI calculation formula. Each subject received verbal explanation and demonstration of the testing procedures. The EMG analysis was done in standing posture and forward flexion position. Before the electrode placement the sites were prepared by shaving, abrading and cleaning with isopropyl alcohol to reduce surface impedance. The electrode placement for all the 8 outer core muscle [18-19].

1. Abdominal Oblique muscle (AO) horizontally 2cm inferomedial to ASIS with in triangle outlined by inguinal ligament, the lateral border of the rectus sheath and line connecting ASIS.
2. Erecter Spinae (ES) centered 2cm lateral to spinous process at level of the iliac crest.
3. Quadratus Lumborum (QL):8cm from the spinous process at lumbar level L-4.
4. Latismus Dorsi (LD): Positioned obliquely 4cm below inferior angle of scapula. In more detailed structure 2cm from midline of L3 spinous process one electrode is placed and other 2cm above first.
5. Gluteus Maximus (GMax): Over the greatest muscle bulk proximal to a line between greater trochanter and ischial tuberosity
6. Gluteus Medius (GMed): Along the longitudinal axis centered 3cm below the midpoint of the illac crest
7. Biceps Femoris (BF): Midway on a line between the ischial tuberosity and lateral epicondyle of tibia.
8. Adductors (Add): Centered on proximal one-third thigh 8cm below the pubic tubercle.

Two recording electrodes will be placed at distance of 2 cm. Ground electrode of spinal muscles is placed on elbow and for hip muscles placed at knee joint. The first reading was taken in standing position. The surface electrodes were used for EMG measurements and were placed over the specific outer core muscles and activity was noted in form of amplitude. The EMG readings were taken for both sides. 3 readings were taken and their average was taken out. This gave the static data. For dynamic data subjects were in standing position and were asked to bend forward through trunk at comfortable speed and try to touch the toes with feet hip width apart. Then they were returned to neutral (erect position) and after 1-2 sec rest this was performed 3 times. During the test, surface EMG activity was recorded and peak to peak amplitude of EMG signals were assessed and average value of 3 readings gave dynamic data.

4. STATISTICAL ANALYSIS

Data analysis was carried out after collecting EMG static and dynamic data for both the groups. EMG Amplitude readings are analyzed by unpaired t-test. Statistics were performed by using SPSS 15 and level of significance was set at $p<0.05$.

5. RESULTS

Table 1: Comparison of the mean and t value for the variable EMG amplitude in static position between Group A and Group B.

Static Position	Mean Value		t value
EMG	Group A	Group B	
AO	222.9	162.9	**7.207****
ES	171.1	185.8	0.779
QL	211.8	177.6	1.863
LD	161.4	110.1	**5.076****
G Max	152	143.9	1.121
G Med	162.6	149.2	2.155
BF	163.6	205.2	**6.460****
Adductors	122.9	166.8	**6.184****
** Shows significant value at the level of 0.05			

Table 2: Comparison of the mean and t value for the variable EMG amplitude in dynamic position between Group A and Group B

Dynamic Position	Mean Value		t value
EMG	Group A	Group B	
AO	249.3	186.5	**6.383****
ES	137.1	152.8	0.937
QL	179.6	152	1.454
LD	180.2	141.7	**4.302****
G Max	122.1	121.1	0.135
G Med	132.9	131.5	0.242
BF	138.4	182.2	**8.470****
Adductors	140.4	184.4	**6.549****
** Shows significant value at the level of 0.05			

6. DISCUSSION

Athletic tasks that involve complete trunk range of motion are ubiquitous in regular living, occupational demands, and athletic events.As a result, understanding the biomechanics and clinical consequences of trunk range of motion is critical. In the present study SEMG activity was done in 2 different positions: Standing and bending forward from the waist. These two positions are supported by Arena et al [20] in which the author has taken six different positions and compared the SEMG activity in five LBP diagnostic group and pain free control subjects. The 2 positions that are standing and bending forward from the waist create most actual stress to the spine and therefore the greatest muscle tension in that diagnostic group.

In the present study, the SEMG reading during dynamic activity showed significant variation in Abd. Ob, Lattissmuss dorsi, biceps femoris and adductor muscles but not a significant reading in erector spinae, quadrates lumborum. gluteus maximus and medius. The result of the present study was supported by Schultz et al. [22].Despite the necessity to create posterior tissue tensions similar to erector spinae contractions, the scientists discovered that myoelectric signals of the erector spinae muscles were much smaller during lumbar flexion relative to calm upright posture. It was also found that SEMG patterns are different in LBP patients compared with control during flexion. They have suggested that the patients with LBP flex their back differently than those without pain, possibly flexing from the hips while keeping the spine extended, which results in increased Paraspinal SEMG activity.

Other experts, such as Kaigle et al [24], corroborated with our findings that there had been discrepancies between sick and asymptomatic participants across the flexion exercises. The researchers also said that as comparison to the unaffected category, participants with CLBP had considerably less capacity to flex & expand the trunk.

Garcia e.t al [25] found that coactivating entire trunk abdominal muscles improved spine stabilization and diminished displacement of lumbar after loading. All of the torso muscles seem to play a vital role in ensuring spinal stability & therefore must collaborate to establish this stability. Hollowing or drawing might reduce the activation of several muscles that are ordinarily engaged during dynamic movements, inhibiting natural abdominal cocontraction of all musculature.

In the present study it seen non-significant relation of ES in static and dynamic position between the groups. This is contradicting the study done by Daniel et al [26] in 2007. The reason behind this is that no specific group of LBP according to the chronicity of pain was taken. This can be supported by Punjabi et al [27] theory and study done by Muzeyyen Kamaz et al [1] that it is the multifidus muscle which is always affected first in all types of LBP and so early training in necessary. The reason for non-significant result in QL in both static and dynamic between both the groups was not supported by research done by Muzeyyan et al [1]. The results for gluteus medius activity in static and dynamic position between both the groups show that gluteus medius role is significant in static position but non-significant in dynamic position which is supported by biomechanical reason by Punjabi et al which says that gluteus medius is the muscle which helps in standing, walking but in activities like bending, sitting its activity is minimum.

7. CONCLUSION

There is a significant difference in EMG measurement of outer unit musculature in subjects with nonspecific low back pain than normal subjects. There is significant lower EMG amplitude of outer unit musculature during static and dynamic activities in control subjects when compared with LBP patients. In other terms, there were significant higher muscle activities on SEMG pattern during static and dynamic positions in LBP patients when compared with control group.

8. LIMITATIONS

- Small sample size
- Absence of randomization of sampling
- Patients with different etiologies of back pain were taken in the study
- Effect of gender on outer core musculature is not seen.
- The forward bending flexion angle was not controlled.

9. RECOMMENDATIONS

- This study can be done on older age group.
- Gender specific study can also be done.
- This study can be done in different stages of low back pain (Acute and sub-acute) and various types of back pain
- Determine normative data for obese individuals (BMI >40)
- Effect of muscle activity at different angles of bending could be seen.
- Effect of gait on these muscles can also be assessed and comparison can be made between normal and low back subjects

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