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ELECTROMYOGRAPHY ANALYSIS OF ERECTOR SPINAE AND EXTERNAL OBLIQUE MUSCLES DURING TWO STABILIZATION EXERCISES

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ABSTRACT

Stabilization exercises improve muscle performance and are effectively used to alleviate chronic low back pain. The aim of present study is to evaluate and differentiate the magnitude of electromyography activity of erector spinae and external oblique muscles during bridge and pelvic-tilt stabilization exercises. Thirteen healthy males have volunteered in this research. Muscle activity is recorded bilaterally of erector spinae and external oblique with Biopac MP150duringstabilization exercises. Normalized EMG values for erector spinae and external oblique muscles are evaluated as percentage of maximum voluntary contraction. Statistical analysis is performed using one-way ANOVA. The right erector spinae presents the highest activity during bridge exercise, whereas the left erector spinae shows highest activity during pelvic-tilt exercise. Mean activation of erector spinae is higher than that of external oblique during both stabilization exercises. NOVA reveals that bridge exercise produces significantly greater activity as compared to pelvic tilt exercise for for the both sides of erector spinae and the right side of external oblique.The mean activity of both SE viz. erector spinae and external oblique muscles are different in bridge and pelvic-tilt exercises. The findings of this research may be helpful to therapists when guiding a patient through a rehabilitation program for lower back pain, by first selecting pelvic-tilt exercise that produces low levels of electromyography activity in selected muscle and then bridge exercise that induces significantly higher electromyography activity.

Keywords: abdominal muscles, electromyography, exercise, muscle strength

INTRODUCTION

Core muscle stabilityis desired to balance, control and maintain appropriate core and hip posture during functional movements. Unstable core muscle may cause tissue strain injury leading to chronic low back pain (CLBP) (Reed, 2012).Core muscle stability training helps in enhancing the capability of active and passive stabilizers around lumbopelvic zone of human body. There are different research studies wherein this training has been used in the cure of CLBP (Aluko, 2012; Coulombe, 2017).The training strengthens core muscles to maintain spinal stability. The load transfer between the upper trunk and pelvis during functional movement is controlled by the abdominal muscles of the core.

Low back pain (LBP)is a worldwide problem in general population leading to limitation of human activities and work interruptions. LBP is prevalent in occupational setups and one of a major reason of dysfunction and absence (Lee, 2015; Costa-Black, 2010). There are various classification of LBP, often based on cause and duration. Non-specific low back pain is a widely recognized type of low back pain which is characterized as "low back pain not attributed to recognizable, known specific pathology". LBP is also classified in 3 subtypes: acute, sub-acute and chronic LBP. This specification depends on the time-period of the back pain. Acute LBP is a time-period of less than 6 weeks, and sub-acute LBP somewhere in the range of 6 and 12 weeks. CLBP can be described as pain continuing more than 12 weeks in the area between the lower rib cage and the gluteal fold (Arokoski, 2004; Cai, 2015; Page, 2016). Epidemiological studies have presented that a majority of acute LBP patients if not treated well finally suffer from CLBP (Pengel, 2003).

The strengthening of the erector spinae (ES) and external oblique (EO) muscles improve posture and stability of core muscles, decrease LBP incidence and enhance individual performance. Many investigators have submitted that purpose of strengthening the muscles of lumber spine region is often to improve LBP in patients (Kim, 2013; Lehman, 2005). As such, stabilizing muscles greatly help in the treatment and alleviation of LBP. Stabilization exercises (SE) minimize impairments in the trunk muscles and restore their ability to enhance the safety and shielding of lumber joint (Cholewicki, 2003).Various core SE, such as cobra posture, pelvic tilt, curl-up, wall squat, quadruped, and bridging exercises, have been demonstrated to improve core stability (Akuthota, 2004; Choi, 2021).

The present aims to investigate the level of electromyography (EMG) amplitude in ES and EO muscles during two stabilization exercises viz., bridge and pelvic-tilt exercises. Clinical purpose of the present work is to enhance the strength of core muscles and to prevent the occurrence of CLBP.

METHODS

This experimental study is conducted in the Industrial Kinesiology Lab, Dayalbagh Educational Institute (DEI), Agra, India. The study includes 13 healthy males aging between 19 to 30 years who are in sound health with no back or lower extremity pain. Subjects are eliminated if they are left handed or have any previous back surgery or BMI above 30 or any disability. A brief demonstration of EMG equipment and two SE are given. The rights of the subjects are protected and an informed consent is obtained prior to experiments from each subject.

The EMG data are collected using Biopac MP150 apparatus and Acknowledge software (version4.1, Biopac Systems, Inc., CA). EMG signals are recorded using self-sticky one time use round surface electrodes (Ag-AgCl) with contact area of 1 cm^2 and a centre to centre interval of 2 cm. The electrodes are applied bilaterally across muscle bellies of ES and EO as in the studies carried out by Choi et al (Choi, 2021).In addition, skin is cleaned with sprit and the resistance between skin and electrodes is reduced to under5 KΩ. All EMG processes are in accordance with the standard norms (International Society of Electrophysiology and Kinesiology, 1999). The EMG signals are amplified and fully rectified by band-pass filter with cut off frequency as 20 to 500 Hz and sampled at 1000Hz.The electrode locations are verified by manual muscle evaluation and doing maximum voluntary contraction to isolate every muscle activity and minimize cross talk (Vezina, 2000).For reducing the noise, every channel has a separate ground electrode and for stopping the artefact, the electrodes are well taped. To confirm a constant temperature and impedance, within 5 min of placement of electrodes no recording is conducted.

Each subject carried out six different trials. To minimize possible interference, middle four trials are considered for find out the mean of the peak effort of the selected muscles. Each repetition holds for twenty seconds, a rest break of one minute is given after each exercise ensuring that subjects are not over-stressed. Each participant executed both SE, viz., bridge and pelvic-tilt exercises as shown in figure 1 and figure 2. For EMG activity analysis, raw EMG data are used. The raw EMG data are fully rectified and interference free. For each muscle, the normalized rms-EMG value is expressed as percentage of maximum voluntary contraction (%MVC). MVC is defined as the maximum EMG value recorded for a specific muscle across the selected exercises. The mean % MVC is used to present a basis for rms-EMG signals amplitude and provide the information regarding muscles EMG activity. Complete statistical analyses are conducted using the one-way analysis of variance (ANOVA) and α=0.05 is take in to consideration as the significance level.

Figure 1. Bridge exercise

Figure 2. Pelvic-tilt exercise

RESULTS

In present study, the subject's average age, average height and average weight are22.61±3.17years, 169.38±4.46 cm and 70.07±11.90 kg, respectively and BMI is 24.43±3.43. The averaged normalized rms-EMG (%MVC) values and SD are shown in Figure 3. For a bridge exercise, the EMG amplitude in the left ES, right ES, left EO and right EO, is 29.89±19.04%, 32.59±22.13%, 24.50±25.43% and 26.42±24.90%, respectively. Whereas for a pelvic-tilt exercise, the EMG activity in the left ES, right ES, left EO and right EO, is 15.67±14.97%, 15.32±15.44%, 12.12±14.71%, and 8.49±14.35%, respectively. For bridge exercise, EMG signal amplitudes ranged from 24.50%±25.43% to 32.59%±22.13% MVC in ES and EO muscles. Therefore, bridge exercise would be treated an exercise of moderate intensity. For pelvic-tilt exercise, EMG signal amplitudes varied from 8.49%±14.35% to 15.67%±14.97% MVC in both EO and ES muscles, so pelvic-tilt would be considered a low intensity exercise. One-way ANOVA results reveal, a significant difference is observed between bridge and pelvic-tilt exercise for both muscles. Bridge exercise produces highest amplitude in right ES as related to other muscles, whereas pelvic tilt produces highest activity in left ES. Mean activation of ES is more than that of EO during both SE.

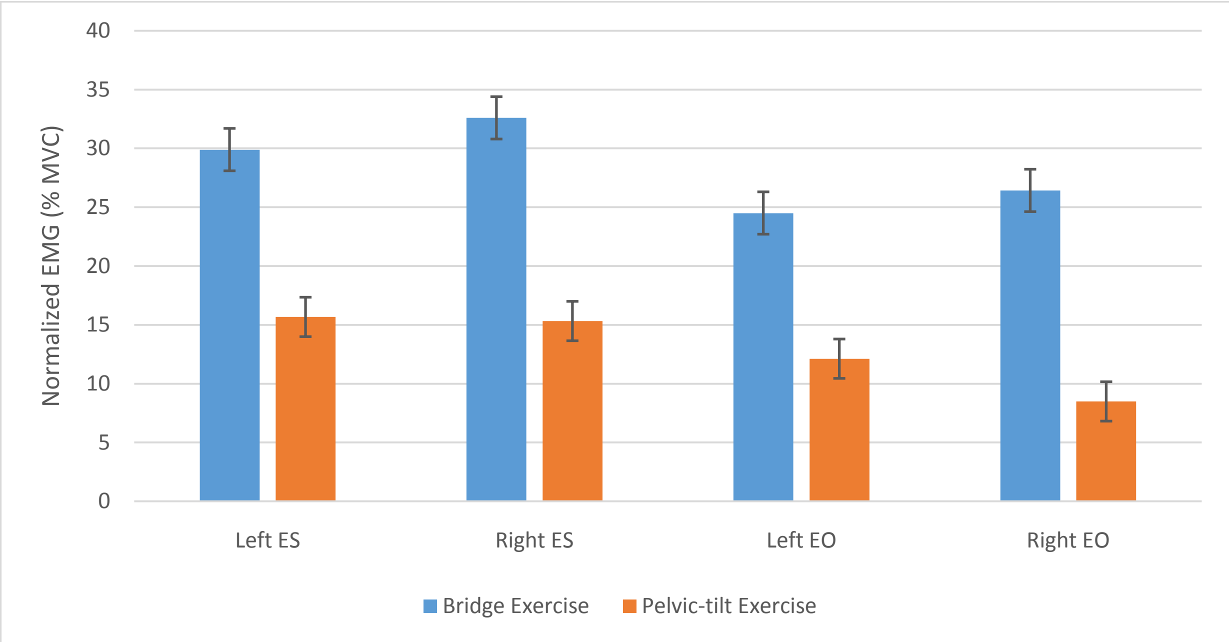

Figure 3. Normalization EMG (%MVC) values and SD for the left ES, right ES, left EO, right EO in bridge and pelvic-tilt exercises.

DISCUSSION AND CONCLUSION

The management of CLBP may involve of several intervention approaches, including surgery, acupuncture, physical therapy and more, as well as medication and yoga. In general, physical therapy exercises are beneficial for treating CLBP (Steele, 2014).A number of physical therapy exercises recommended for the treatment of CLBP include muscle strengthening, muscle resistance and lumber stability (Shamsi, 2017).The outcomes of the present investigation unveil that the mean %MVC of abdominal and lumber muscles are different in selected SE. Overall, EMG activity is higher in right ES and left ES as compared to EO bilaterally during both SE. In individuals along CLBP, a decline of local abdominal muscles function has been witnessed (Rasouli, 2011; Southwell, 2016). Investigators have presented that the SE cause least burden on the backbone segments. Therefore, SE can be suggested in the rehabilitation program of CLBP (Southwell, 2016; Djordjevic, 2015).Some studies have been demonstrated the contribution of the spinal muscle system in alleviating CLBP. Investigations have shown a strong correlation between CLBP and EMG amplitude of erector spinae muscles (Shamsi, 2017; Southwell, 2016; Djordjevic, 2015).

ES and EO are sufficiently activated during bridge and pelvic-tilt exercises, so these exercises could be deemed effective for strengthening these muscles. The findings of the current study may be useful to therapists when guiding a patient through a rehabilitation program for LBP, by first selecting pelvic tilt exercise that produces low EMG activity and then performing bridge exercise that yields greater muscle activity. Healthy individuals were selected as participants in the existing research because the objective is to compare activity of ES and EO muscles across two SE. Limitations of the existing study are non-inclusion of female subjects, and smaller sample size related to the population.

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CONFLICT OF INTEREST: None

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