ELECTROMYOGRAPHICAL ANALYSIS OF THE EFFECT OF YOGA POSTURE ON THE TRUNK MUSCLE ACTIVITIES AND ITS SIGNIFICANCE: A PILOT STUDY

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ABSTRACT:

Objective: *To determine the effects of Yoga posture on the Trunk Muscle Activities by examining the muscle activation patterns in erector spine and rectus abdominis muscles.*

Design Setting: *Repeated-measures of descriptive study done at Biomechanics laboratory, Biomedical Engineering Department, NIT Raipur.*

Participants: *In this work, participants with no previous experience of Yoga and low back pain (mean age ± SD, 18.0 ± 4.3 y; 10 Males) were recruited.*

Methods: *we recorded muscle activity from erector spine and rectus abdominis muscle for two different yoga poses. By maximum voluntary contraction procedure, mean muscle activity value for two different yoga poses were determined.*

Results: *There were significant effects of yoga pose on trunk muscle activities. We found significant ($p<0.0001$) change in trunk muscle activation during cobra pose as compared to boat pose.*

Conclusions: *From the result we found variations in trunk muscle activities during cobra pose and boat pose. There was significant difference in muscle strength during cobra pose as compared to boat pose; therefore the Cobra pose is effective for strengthening Erector spinae muscle and this pose can be incorporated in yoga training module for addressing low back pain (LBP).*

Keywords: *Biomechanical, yoga posture, trunk muscles, erector spinae muscle, rectus abdominis, EMG*

INTRODUCTION

The trunk muscle control is the main centre of the body for preventative and rehabilitative purpose for LBP. Trunk control (TC) is the ability of the trunk muscle to perform selective movement of the trunk in order to maintain the center of mass during adjustment of posture[1,2,3]. The weakness of trunk muscle and its control are commonly associated with LBP. Lee JH et al[4] showed the trunk muscle weakness as a risk factor for LBP. Renkawitz T et al[5] also observed that imbalanced patterns of erector spinae (ES) activity and reduced trunk extension strength among patients with LBP.

The tone of weak muscle are strengthen by practice of Yoga postures. Yoga has been used for enhancing the dynamic control of the trunk muscles and reduces the LBP through the increased hip and spinal flexibility[6,7,8]. Sherman et al[9] observed that the symptom of LBP are reduced in yoga practices. So the regular yoga practice helps in establishing functional balance between various organ systems, which can leads to better health.

Electromyography (EMG) is an electro diagnostic medicine technique for evaluating and recording the electrical activity produced by skeletal muscles[10]. The muscle activation is commonly delayed in the LBP. Kimberly et al[11] study illustrates positive biomechanical effects on LBP subject with the help of Yoga. Recently Petrofsky et al[12] demonstrated higher EMG activation of rectus abdominis during loading as a result of practicing Yoga that has implications relevant to objective measures of trunk muscle co-activity. According to the literatures available, it seems that very little work has been done to quantify muscles during yoga and most of the previous EMG studies do not assess the muscle activation pattern during yoga pose like cobra pose (CP) and boat pose (BP). Therefore the objective of our study is to find out the mean muscle activation of the trunk on CP and BP; to address specific deficit in strength and muscular endurance of trunk muscle; and to promote the physical fitness and rehabilitation. We hypothesized that the CP would produce more trunk muscle activation in the back area of the trunk while the BP would produce more muscle activation in the front area of the trunk.

MATERIAL AND METHODS

Participant's details

A total of 10 healthy male subjects (student) voluntarily participated in our study. Table 1 denotes the Descriptive Characteristics of participants. Participants with existing or unresolved injuries and neurological & musculoskeletal dysfunction were excluded from this work. All participants filled the written consent and detailed experimental procedures

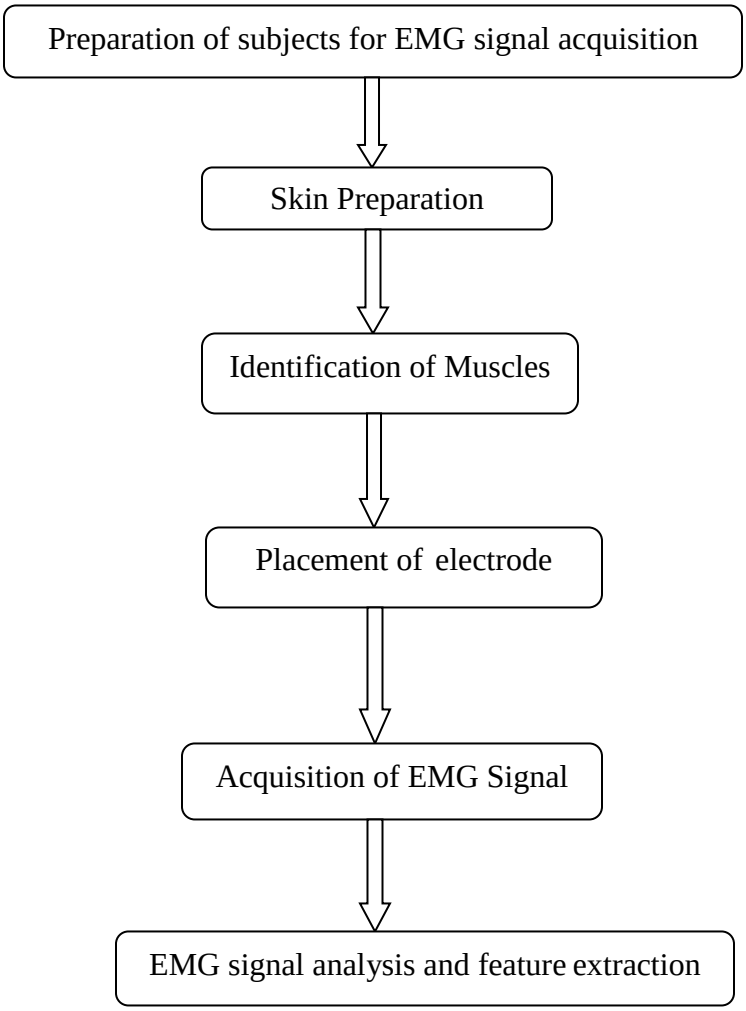
were clearly explained to each participant.

Table 1: Descriptive Characteristics of participants

Variable	mean ± SD value of Normal Subjects characteristics
Number of participants (n)	10
Age(Year)	19 ±3
Weight (kg)	50 ±10
Height (cm)	165.1 ± 8.89

Recording of the EMG signal

The study setting was in the Department of Biomedical Engineering, NIT Raipur. Subjects (student) were asked to complete the consent form after the arriving the laboratory. Then they allowed for warm up exercise. After that, electrodes were placed on Erector spinae (ES) and rectus abdominis (RA) muscle. EMG signal voltages of ES & RA muscles for yogic postures (cobra pose and boat pose) were recorded from the each young adult subject with the help of BIOPAC system as per flowchart.



Flow Chart of Methodology

EMG signal recordings were collected using 2 bipolar vinyl adhesive surface electrodes. At first electrodes were placed on the RA front muscle. Then electrodes were also placed on the ES muscle in the same way. An unshaded ground electrode was placed on the bony area. Each subject was asked to perform the yogic posture (CP and BP) and maintain each pose for period of 8 seconds for recording EMG signal.

Procedures: The subjects were instructed to perform the two forms of yoga pose as mentioned below:

Cobra pose:[13]

1. First lie flat on the stomach with legs straight, feet together and the soles of the feet uppermost.
2. Then place the palms of the hands flat on the floor with the fingers together. The arms were position close to sides of the body and point the elbows backward. Close the eyes and rest the forehead on the floor. Whole body especially the lower back was relaxed.
3. Raise the head slowly. Tilt the head backward gently, so that the back of the neck is compressed and chin points forward. Then neck was raised first and then shoulders. Using the back muscles first the elbows was straightened and furthers the trunk and back of arch was raised by the arm muscles.
4. The pubic bone remains in contact with the floor and the navel is raised a maximum of 3 cm in the final position. Hold for 8 seconds in the final position.
5. Slowly release the upper back by bending the arms, lower the navel, chest, shoulders and finally the forehead to the floor to return to the starting position and lower back muscles are relaxed.
6. Inhale during torso rising.
7. In the final position breathe normally or retain the breath.

Boat pose[13]**:**

1. Lie in the starting position. Keep the eyes open throughout. Breathe in deeply.
2. Raise the legs, arms, shoulders, head and trunk off the ground. The shoulders and feet should be no more than 1 5 cm off the floor. Balance the body on the buttocks and keep the spine straight.
3. The arms should be held at the same level and in line with the toes. The hands should be open with the palms down. Look towards the toes.
4. Remain in the final position and hold the breath. Count to 5 mentally (or for longer if possible).
5. Breathe out and return to the supine position. Relax the whole body.

EMG data processing

The acquired EMG signals were amplified and filtered using BIOPAC Systems amplifiers. Further filtered EMG Signals were analyzed. For each posture, three trails set of muscle activity were assessed. From the trail set of EMG data, we calculated the mean muscle activity.

STATISTICAL ANALYSIS

For Statistical analysis, SPSS 11.5 version Software was used. A paired student t- test was used to analyze the data of the study. Means and standard deviations were also calculated.

RESULTS

It has been found that EMG values for mean trunk muscle activity of CP is greater than BP. And significant differences among CP and BP are shown in the various graphs 1, 2, 3 and Tables. The mean value for BP is 0.807 and for CP is 1.90 as shown in Table 1. The result showed that Mean Muscle activation Value is greater in the CP than BP. Table 2 is representing significant correlation between CP and BP ($r = 0.77$; $p < 0.01$). Most important Table 3 is representing that there is highly significant ($p < 0.0001$) change in trunk muscle activity during CP as compared to BP. Therefore CP pose might be more effective than BP pose for LBP for strengthening the trunk muscle but to prove we need to do pilot study on patient suffering from LBP in future.

Table 1: Mean electromyographic values (mean ± SD) for the two pose tested (N =10)

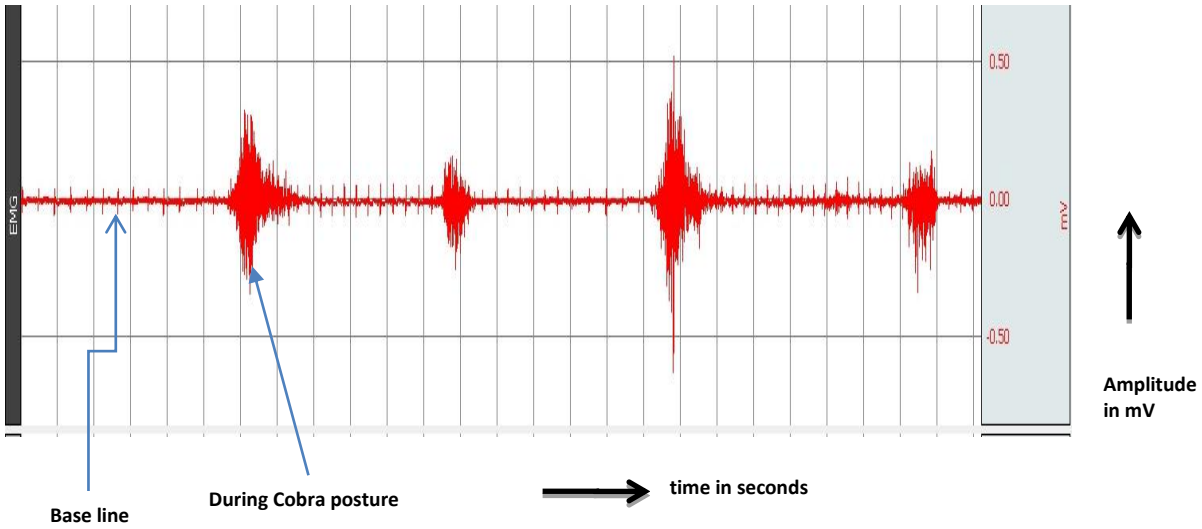
Yoga Pose	Number of subject	Mean ±SD	Std. Error Mean
Boat	10	0.807 ± 0.272	0.86
Cobra	10	1.90 ± 0.292	0.092

Table 2 Significant Correlations between Boat & cobra posture

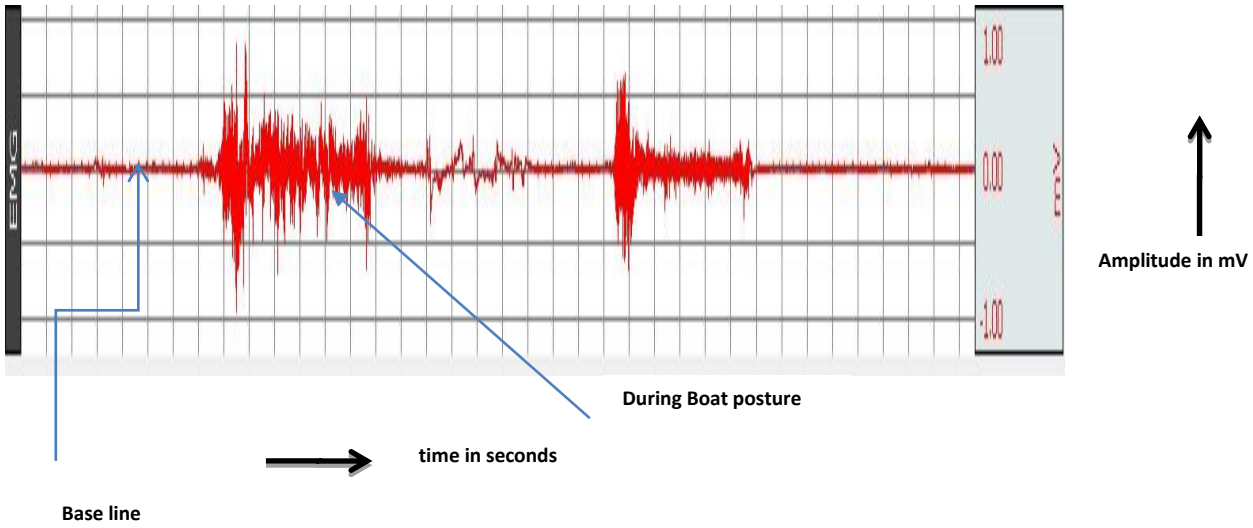
Yoga Pose	Number of subject	Correlation co-efficient (r-value)	Significance (p<0.05)
Boat & Cobra posture	10	0.72	0.018

Table 3: Comparison between Boat & cobra posture

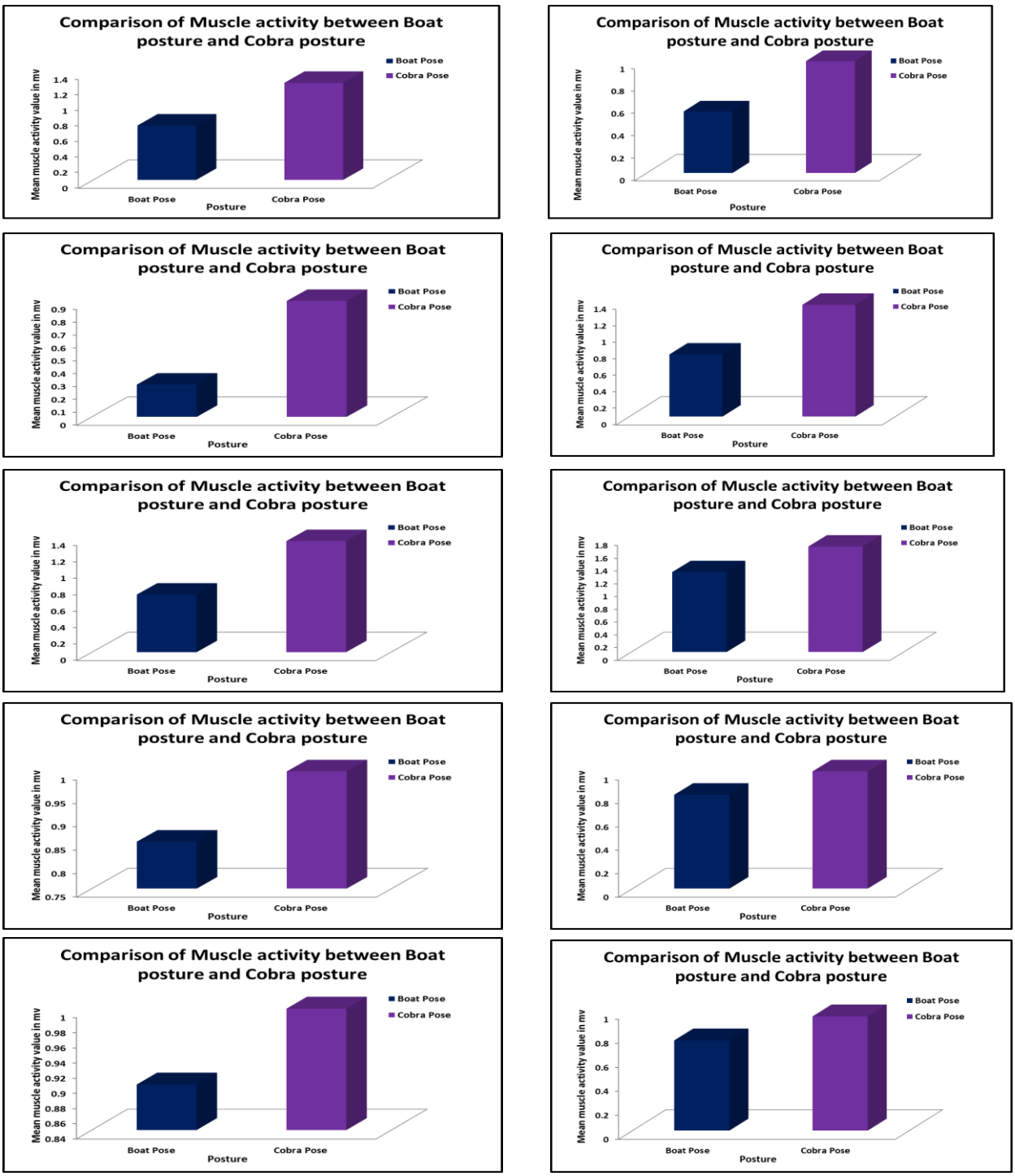
Yoga Pose	Mean±SD	Std Error Mean	Significance (p<0.05) (2-tailed t-test)
Boat & Cobra Posture	0.383±0.211	0.668	.0001



Graph 1: Snap shot of muscle activity during CP



Graph 2: Snap shot of muscle activity during BP



Graph 3: EMG activity during Boat pose Vs Cobra pose all data are the mean result of group

DISCUSSION

The trunk is the main centre of the body and it is known that many people with LBP have got weak low back muscle[14]. Thomas et al studied the effect of LBP on trunk muscles activation and showed that significantly delayed muscle activity for chronic LBP subject as compared with control subjects[15]. Fryer G et al also studied on paraspinal muscle and showed that the paraspinal muscle activity is decreased in LBP [16]. Elnaggar et al[17] studied the effect of spinal flexion and spinal extension exercise in two different groups, they found increasing ROM at the sagittal pain and decreasing LBP. A decrease of the muscle strength in LBP may decrease spine ROM through its effect on LBP or inactivity. Previously various studied not showed the effect of yogic exercises on trunk muscle

while the yoga has used for enhancing the dynamic control of the trunk and to reduce the LBP through the increased hip and spinal flexibility[6,7], so in that regard we analyzed the muscle activity levels of selected trunk muscle during the CP and BP. The result shows the mean RA and ES muscle activity of the CP 1.900, while of the BP 08070. Therefore our results indicate that CP would produce more muscle activation on the trunk as compared to the BP.

The CP is mainly works upon the vertebral column and the joints of the hip region, but other joints too involved [18]. The most important movement of the CP is the extension of the spine. There are three muscle groups (the neck muscles, the shoulder muscles and the back muscles) involved mainly in the CP[18] as per anatomy of Hath Yoga. The trunk muscles namely Erector spine muscle are involved as the prime movers[18]. Spine extension was created by these muscles. Moreover, mobilization of the lumbar spine is limited by the rectus abdominis and oblique muscle. Mekenzie also suggested passive lumbar extension exercise to accentuate momentarily the lordosis and thus correct the dysfunction syndrome[19] and dysfunction syndrome is characterized by adaptive shortening of soft tissue and a partial loss of movement of lumbar spine[20]. Jacueline et al also studied on the physiotherapy management for low back pain and found an extension of lumbar spine decreased pain more than flexion[21]. Akihiko Inufusa et al studied on anatomical changes of spinal canal and inter-vertebral foramen and found that the axial tomography scans proved that extension could significantly decrease the canal, mid sagittal diameter, and subartical sagittal diameters, which aids in moving the backward protruded disc anteriorly, that is probably the pre causer of nerve root decompressing[22]. Our study also support that the extension yogic exercise is better as compared to the flexion yogic exercise for trunk weakness, because of the mean muscle activity is more in extension yogic pose like CP as compared to flexion yogic pose like BP. CP improved the muscle recruitment of trunk muscle and enhanced the spinal stability during yoga by proper skeletal alignment which can be used for the management of the LBP.I

The study presents a new approach towards the evidence based yoga programmed for LBP and can be beneficial for targeting specific muscle during evidenced –based yoga therapy.

CONCLUSION

In conclusion, our study investigated the **"**Significances of Yoga pose on Trunk Muscle Activation". It is known that inactivity of trunk muscle activity decreases the trunk muscle strength and also results in decreased spinal flexibility. In this study, the result showed that the trunk muscle activation is greater in the CP as compare to the BP. For this reason, our study presents a new approach towards the evidence based yoga program and it can be used by clinician for the management of LBP for prevention and rehabilitation

Conflict of Interest

We confirm that there is no known conflict of interest and no significant financial grant for this study.

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