

Influence of Head Posture on Trunk Muscle Activation during Prone Bridging Exercise

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Abstract

A Prone Bridging Exercise (PBE) was known common treatment clinically controlling the posture during the bridging exercise was effectively influence on trunk muscle. The purpose of this study was to investigate the influence of head posture on trunk muscle activation during the PBE. Fifteen healthy men of the S University participated in this study. Subjects were randomly assigned three conditions of trial the PBE with head posture neutral, flexion, and extension. The muscle activation of the Rectus Abdominal muscle (RA), erector muscle of spine (ES), Transverse Abdominal muscle (TrA) and Lumbar multifidus muscle (MF) during the PBE on the three different head postures were measured using the surface electromyography (sEMG). In the PBE, the %Maximum Voluntary Contraction (%MVC) values of the RA muscle during the flexion posture was significantly higher than neutral posture ($p < .05$). The %MVC values of the RA muscle during the flexion posture were significantly higher than the extension posture ($p < .05$). The %MVC values of the MF muscle during the extension posture were significantly higher than the neutral posture ($p < .05$). The sEMG activities of other muscles were not significant difference among the three head postures. The results of current study mean that head posture was effective to activate the trunk muscle during the PBE. We suggested that the PBE with head posture is effective method to make the greater contraction of the global and local muscles.

Keywords: Component, Electromyography, Head Posture, Muscle, Prone Bridging Exercise, Trunk

1. Introduction

A bridging exercise is commonly used from of training the trunk muscle such as therapeutic exercises, pilates, yoga, boxing and other sports in life¹. The bridging exercise is comfortable and pain-free to most patients and related trunk stability by injury prevention and rehabilitation⁵. Immovable movements of the bridging exercise are help to start activity of daily living and to make strong body²⁷. According to the previous studies, bridging exercise is practical, reliable, and valid methods of reflecting trunk muscle strength and endurance capability²⁵. However, previous studies have focused on investigating the effect of different postures of the lower extremities on Electro Myographic (EMG)

activities of the trunk, hip, and thigh muscles during a bridging exercise^{11,17,24}. The previous study investigated that trunk muscle activation during the Prone Bridging Exercise (PBE) lifting lower extremity and quadruped arm¹⁵. Another study demonstrated that when the PBE was performed on an unstable surface, there was change activity in trunk muscle¹². Therefore, PBE was contributed stability of trunk muscle. All trunk muscles are contributed to adjust spine positions and movements in healthy population². Trunk muscles were divided into global and local muscles³. The global muscles such as Rectus Abdominal muscle (RA) and erector muscle of spine (ES) located superficial within the body. It impacted the alignment of the spine, produced larger torque and transfers the weight immediately.

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In the local muscles, Transverse Abdominal muscle (TrA) and lumbar multifidus muscle (MF) located deep within the body that have portions with attachments to the spine and conducted segmental stability of lumbar spine while movements¹². Head posture is able to affect the posture¹³. When changing the head posture, vertebra joint alignment automatically changed. Previous study reported that specific sitting position was associated head posture. In addition, it needs to increase cervico-thoracic muscle activations in order to support the weight of neck and maintain posture⁴. Furthermore, the Normal Bridging Exercise (NBE) with active neck flexion of various heights showed the activity of the RA was significantly increased. Therefore, the activity of the trunk muscle was associated with neck flexion heights. According to correlation of head posture with trunk muscle, there are many studies about bridging exercise compared global and local muscle. However, no studies to analyzed data to report any between global and local muscle of the trunk according to the head posture during the PBE. Therefore, the aim of this study was to compare activation of the trunk muscle according to head posture and to investigate which head posture is most effective to trunk muscle activation.

2. Method

2.1 Subjects

Fifteen healthy men of S university participated in this study. Exclusion criteria included a history of neurological disorder, spine surgery, lumbar spine disorder, musculoskeletal disorder, recent abdominal surgery and neck pain within the last two years. Their mean age was 21.41 ± 1.50 , heights ranged from 153 to 177 cm (mean 166.54 ± 7.55); weights ranged from 47 to 89 kg (mean 61.95 ± 11.75). All subjects were fully informed about the procedure and aims of current experiment. All participants were signed up on consent form for research prior to experiment.

2.2 Procedures

The subjects performed the PBE on three different head postures (neutral, flexion, extension) (Figure 1). Subjects wore a comfortable pant. In the PBE, the subjects lay with only the legs and feet in contact with the surface. The angle of the trunk and hip joint was 0° (neutral) and shoulder joint between trunk was 90° in a lumbar neutral position and it was measured by a goniometer. The hands

were positioned directly underneath the shoulders with the fingers facing forward. At the starting of each PBE, examiner gave verbal starting cue sign to subjects. The subject endured this neutral position during the PBE. The examiners were confirmed subject's position consistently. Three different head postures were performed for all PBE. All exercises were executed neutral-flexion-extension sequence in three times repeated. The PBE positions were held for ten seconds, with a resting of at least 15 seconds between each exercise.

2.3 Measurement of Muscle Activation

To measure the electrical activity of the RA, TrA, ES and lumbar MF muscles during the PBE on three different head posture, a surface Electro Myography (sEMG) system (OQUS100(Zero WIRE EMG, Italy) with disposable bipolar sEMG electrodes was used. Disposable bipolar Ag-AgCl disc surface electrodes with a diameter of 1.0cm were attached bilaterally over the muscle groups studied with a center-to-center spacing of 1.5cm. The sEMG electrodes were adhered parallel with the muscle fibers on the skin above the RA, TrA, ES, and lumbar MF on each subject's right side (Figure 2). The global muscle's electrode placement was performed according to that described in a previous study. The electrode placement on the global trunk muscle was as follows : RA(3cm lateral to the umbilicus) and the ES(above and below the L3 level and midway between the midline and lateral aspects of the body)^{8,14}. The electrode placement on the local trunk muscle was as follows : TrA(2cm medial to the anterior superior iliac spine) and the lumbar MF(lateral to the midline of the body and below the line connecting the posterior superior iliac spine)^{6,16}. All the EMG signals were amplified MVC STACK with an amplifier. The raw data were collected at a sampling frequency of 1,000 Hz and band-pass filtered between 6 and 500 Hz and full-wave rectified using analysis software. EMG linear envelopes were used for further analysis. The Linear envelopes were produced using signal smoothing by means of Root Mean Square (RMS) (window of 100 ms). The RMS was calculated for the three repetitions of the different exercises, and every subject was maintained stably the posture during each exercise. The RMS during the exercise was normalized as a percentage of the average RMS obtained over a five second period during the maximum voluntary contraction test (MVCtest, %MVC), using the MyoResearch software 1.06.



Figure 1. Prone bridging exercise with three different head posture.

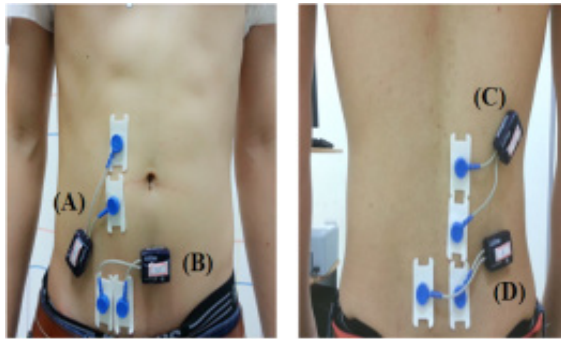


Figure 2. Electrodes of the RA, TrA, ES and MF muscle (A) Rectus abdominal muscle (B) Transverse abdominal muscle (C) Erector muscle of spine (D) Lumbar multifidus muscle.

2.4 Statistical Analysis

All statistical analysis was performed using the SPSS statistical analysis software v12.0. The mean and standard deviations of variables were calculated by descriptive statistics. One way repeated ANOVA was used to detect differences in the activation of trunk muscle between the three head posture during the PBE. A post hoc test was performed using Bonferroni correction. The significance of level was set at $p < .05$.

3. Result

The mean EMG amplitudes of the different trunk muscles during the PBE of the three head posture are presented in Figure 3. In the PBE, the %MVC values of the RA muscle during the flexion was significantly higher than that during the neutral ($p < .05$). The %MVC values of the RA muscle during the flexion was significantly higher than that during the extension ($p < .05$). The %MVC values of the lumbar MF muscle during the extension was significantly higher than that during the neutral ($p < .05$). The EMG activities of other muscles were not significant difference among the three head posture ($p < .05$).

4. Discussion

This study was to investigate the muscle activations of the RA, TrA, ES and lumbar MF during the PBE with three different head posture. There was too much similarly studies to investigate the trunk muscle activation during the bridging exercise of using a tool or changing a surface. However, there are little studies of correlation between the trunk muscles and the head posture. For this reason, we undertake the current study.

The RA muscle was showed greater activity in flexion. The bridging exercise was commonly used to activate the trunk muscle¹. When moving arms or legs during bridging exercise increased in RA muscle activation^{8,15}. In addition, Ishida¹³ reported that the trunk muscle activation of healthy men compared during the NBE with three different passive neck flexion (flat, 6cm, 12cm) and four different active neck flexion (flat, slightly above flat, 6cm, 12cm) by measuring EMG. The RA muscle was increased in NBE with increasing neck flexion height¹³. These result were able to support our study. So, the neck flexion position is good for strengthening RA muscle.

The TrA muscle activation was not statistically increased in our study. The TrA muscle is the innermost of the flat muscles of the abdomen, being placed immediately beneath the internal oblique abdominal muscle. The electrode placement for the gluteus medius muscle have cross-talk from the gluteus maximus⁷. Stokes et al. concluded that surface electrodes over the multifidus muscle pick up EMG signal from the longissimus thoracis muscle²⁸. For these reasons, TrA muscle also difficulty measured the exact muscle placement. Therefore, it may have allowed for some cross-talk from the internal oblique abdominal muscle because of its proximity. In our study, the ES muscle activation was not changed. The ES muscle is concerned with dynamic movement while not related to support segmental of spine^{22,23}.

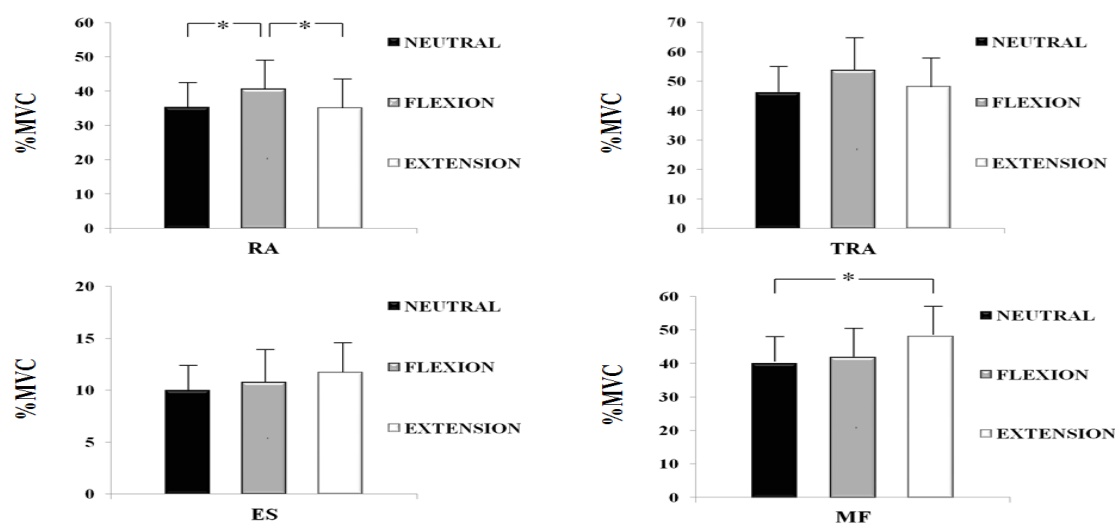


Figure 3. The above graph show the mean activity and significant value between head postures according post hoc test result. %MVC: Percentage of maximum voluntary contraction.

The ES muscle was consisted of cervical, thoracic and lumbar part²¹. Vogt reported lower extremity movements affect lumbar spine due to the anatomical proximity between the lower leg and lumbar spine²⁹. For this reason, the ES muscle activation was not increased in our study. Because trunk and hip joint was fixed during the PBE. The MF muscle activation was highly increased in our research. Passive neck flexion (12-cm block) with NBE was confirmed the decreasing lumbar lordosis¹³. This means the head posture was affected the change of lumbar vertebra alignment. Because, the vertebra was linkage to whole trunk. The MF muscle is important stabilizer to maintain lumbar neutral position⁹. In addition, the lumbar MF muscle controlled the posture stability of lumbar spine by supported weight and gravity effectively²¹. Therefore, the MF is highly activate to maintain bridging position and realign lumbar vertebra during the PBE with neck extension.

Our results showed that regularly sequence in each abdominal muscle and back muscle. Abdominal muscle activations were increased in neck flexion than neutral. Back muscles were increased in neck extension than neutral. For improving the RA muscle strengthening during the PBE, we suggested neck flexion. Also, for the lumbar MF muscle strengthening, neck extension was efficient head posture during the PBE. These means, the PBE with neck flexion and extension are more time-effective than the general PBE to strengthen the each muscles and provide other various treatments to patients by saving time.

However, there are limitation in our study. That was a sEMG. The sEMG was generally used for superficial muscle. It is not conclusion that sEMG not able to measure the deep muscles²⁸. However, the fine-wire electrodes were used to reduce cross-talk from measuring deep muscles¹⁹.

5. References

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