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Original Article

A STUDY TO DETERMINE THE ELECTROMYOGRAPHIC ACTIVITY OF VASTUS MEDIALIS OBLIQUE MUSCLE DURING SQUATS ON DIFFERENT SURFACES

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ABSTRACT

Aim: The aim of the study was to examine the effects of squat exercises performed on different surfaces on the activity of the Vastus Medialis Oblique (VMO) muscle.

Method: Forty healthy subjects performed squat exercises for five seconds each on three different support surfaces: concrete floor, foam, and rubber discs. As the subjects performed the squat exercises on each surface, data on the activity of the vastus medialis oblique was collected using electromyography.

Results: The activity of the vastus medialis oblique and was found to be statistically significantly higher ($p<0.05$) on rubber discs than when the squats were performed on concrete floor or foam.

Conclusion: The activation of vastus medialis obilique is more on unstable surfaces. Hence they are more suitable strengthening of VMO.

KEY WORDS: Vastus medialis oblique, Electromyography, Support surfaces.

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INTRODUCTION

The knee is one of the largest and most complex joints in the body. The patella functions as pulley for quadriceps muscles. Because of the incongruence of the patellofemoral joint, however, the patella is dependent on static and dynamic structure of its stability.

The primary function of the quadriceps muscle, at knee joint, is for providing large forces during pushing/pulling movements, as well as assisting in leg extension and shock absorption during running and jumping. The vastus medialis (VM) is considered to be a key muscle in knee extension and patellar stability and to be the only muscle which directly and actively counteracts lateral movement of the patella [1].

Patellofemoral pain syndrome (PFPS), patellar subluxation, and patellar dislocation are factors that increase knee joint instability and are major causes of anterior knee pain [2]. Patients with patellofemoral pain syndrome (PFPS) often develop excessive lateral tracking of the patella that could be caused by a weakness of the VMO because this muscle mainly provides medial stabilization for the patella [3,4]. The pull of vastus lateralis muscle is normally 35^0 lateral to long axis of femur, whereas the pull of the proximal portion of the vastus medialis muscles is approximately 40^0 [5]. A muscular imbalance between the VMO and the VL, and improper timing of activation between the two muscles are perceived to result in abnormal patellar tracking and to be the two most common causes of PFPS [2]. For this reason the retraining and strengthening of the VMO is regarded to be important in the management of anterior knee pain and patellar instability.

Several studies conducted to improve the VMO activation have proposed strengthening of the quadriceps using open kinematic chain exercises and closed kinematic chain exercises [6]. Patients with any type of internal knee derangement have been shown to develop atrophy of the VMO and lose the last few degrees of full extension before any other measurable loss of girth. One researcher reported that early atrophy of the VMO is an indicator of general quadriceps weakness and not just weakness in the particular muscle. In particular, squat exercises are known to help the selective strengthening of the VMO, and many studies have investigated the optimum methods for conducting squat exercises [6,7].

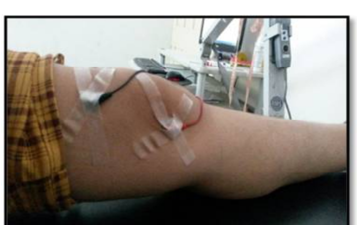
Training using unstable surfaces results in greater joint movement and leads to more proprioceptive feedback; therefore, it can promote muscle activation [8]. Present study thus examines the muscle activation of the VMO at different levels of instability.

MATERIALS AND METHODS

Present study conducted with 30 healthy adults having age between 18-25 years and excluded the subjects with Musculoskeletal, Neurological disorders, Traumatic injury to the knee joint, any Knee deformities and uncooperative Subjects.

Prior to measurement the site of electrode placement was abraded with sand paper cleaned with alcohol to minimize the skin impedence. Surface electrodes with a 10mm diameter were used to assess the EMG activity. Surface electrodes applied with electrode gel were positioned on the target muscle, i.e. VMO, and firmly secured with adhesive tape. (Fig. 1)

Fig. 1: Electrode placement for VMO.



The squat exercises to be performed on the different support surfaces were randomly assigned to the subjects. During the squat exercises, subjects' feet were placed apart at a distance of each subject's shoulder width. Knee joint angles were maintained at a flexion angle of 60° and were controlled using goniometers.

The entire testing procedure was done on the same day in a single session. The EMG signals were acquired and analyzed using the RMS EMG PK M-II software. EMG signals were collected for five seconds while the subjects maintained their knee joints at an angle of 60°. Three trials were taken and the average values were used. A five-minute rest was given between each measuring session.

RESULTS

The squat exercises to be performed on the different support surfaces were randomly assigned to the subjects. During the squat exercises, subjects' feet were placed apart at a distance of each subject's shoulder width. Knee joint angles were maintained at a flexion angle of 60° and were controlled using goniometers.

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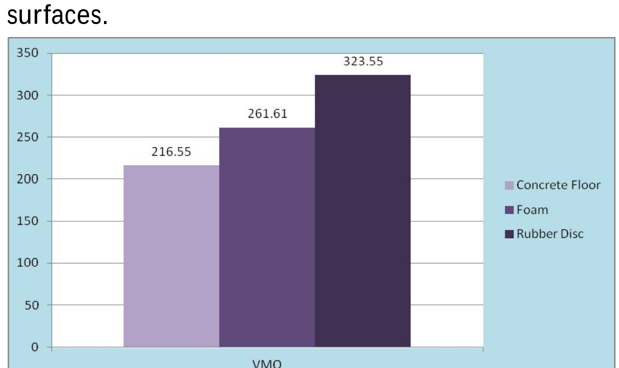
Table 1: Differences in muscle activity of VMO muscle on the different support surfaces expressed as Mean ± SD.

Muscle	Support surface		
	Concrete floor	Foam	Rubber disc
VMO	216.55 ± 91.36	261.61 ± 95.06	323.55 ± 102.95

Fig. 2: Mean % MVIC of VMO on different support surfaces.



DISCUSSION

Many factors are commonly cited as being primary contributors to the development of Patellofemoral Joint Pain. The most commonly cited factors are atrophy or dysplasia of the VMO or an imbalance in the strength ratios between the VMO and the VL. Muscle injuries are common in sports and physical activities. Patellofemoral joint deterioration, which is characterized by subjective reports of anterior knee pain and objective evidence of patellar degeneration, is a common condition and spans a spectrum of athletic and nonathletic individuals. For this reason, various protocols are proposed for rehabilitation professionals [9].

In the present study, squat exercises were performed on support surfaces with different levels of instability and the VMO activity was measured. The VMO activity was 216.55 $\pm$ 91.36 on the stable concrete floor, 261.61 $\pm$ 95.06 on the foam surface with low levels of instability, and 323.55 $\pm$ 102.95, the highest, on the rubber discs, which had the highest level of instability. These results mean that squat exercises performed on unstable surfaces with high levels of instability can enhance the activity of the VMO, and that squatting exercises performed on foam surfaces with low levels of instability or hard surfaces are not as effective for the selective activation of the VMO.

The reason for the higher activity of the VMO particularly enhanced on rubber discs can be the fact that unstable surfaces make maintaining ankle joint positions difficult, so that more effort is required to maintain posture [8]. These characteristics of exercises on unstable surfaces are considered to better stimulate the receptors in the joints, thus increasing the afferent inputs of the proprioceptive senses and eventually leading to increased reflexive motor responses [10].

Marín and Hazell [11] examined the effects of using an unstable surface during whole body vibration (WBV) exercise on leg and trunk muscle activity during a static semi squat and found performing the half squat in the no vibration unstable surface condition decreased VMO EMG rms activity by 14.5% versus the stable surface condition. The addition of 30Hz WBV to the unstable surface condition increased EMG rms 7.1% versus the no vibration stable surface condition and 25.3% versus the no vibration unstable surface condition.

Unstable surfaces are effective at enhancing VMO/VL ratios. In the present study, higher VMO/VL ratios were observed on the rubber air discs. These results are consistent with arguments indicating that training on unstable surfaces enhances muscle activity more than training on stable surfaces.

Limitations of the study includes: There was surface EMG used measure muscle activity and was assumed that recorded EMG signal indicated activity of each muscle but it can be caused by cross talk of adjacent muscle and dominancy was not consider.

CONCLUSION

Squat exercises on unstable surfaces allow optimal activation of the Vastu Medialis Oblique muscle. Thus to activate the VMO unstable surfaces that are highly unstable should be selected.

Conflicts of interest: None

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