RESEARCH ARTICLE

EFFECTS OF ELECTROMYOGRAPHIC BIOFEEDBACK ON THE PERFORMANCE OF VASTUS MEDIALIS OBLIQUE MUSCLE IN KNEE OSTEOARTHRITIS: A RANDOMIZED CONTROLLED TRIAL

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ABSTRACT

Background: Knee osteoarthritis is a common musculoskeletal disorder, enhancing performance of Vastus Medialis Oblique (VMO) can reduce the symptoms**. Objective:** The study objective was to determine the effects of Electromyographic Biofeedback (EMG BF) on the performance of VMO in patients with knee osteoarthritis (OA). **Methods:** A Randomized Controlled Trial (RCT) was conducted at Pakistan Railway General Hospital, Rawalpindi from July to December 2019. In this study, n=30 patients with a diagnosis of knee OA were recruited with the age ranging from 50 to 65 years. The participants were randomly allocated to two groups. Group A has received isometric exercises with Electromyographic Biofeedback (EMG BF) training and Group B has received only isometric exercises for 6 weeks. The Assessments were taken at the baseline and after 6th week of intervention. The outcome measure of vastus medialis oblique (VMO) performance was maximum voluntary isometric contraction (MVIC), measured by an EMG BF device, and one-repetition maximum (1RM)). The VMO muscle thickness was measured by musculoskeletal ultrasound. SPSS version 21 was used for data analysis. **Results:** The mean age of the group A was 58.94±3.1 years and of group B was 59.44±2.9 years. There was found significant between-group improvement ($p<0.001$) in VMO thickness and 1RM. But for MVIC between-group difference was not significant ($p>0.05$). Within-group analysis for all variables was statistically significant ($p 0<.001$) in both experimental and control groups. **Conclusion:** It is concluded that VMO training with an EMG BF device is more effective to enhance VMO thickness and strength in terms of 1RM in patients with knee osteoarthritis.

Keywords: Osteoarthritis, Electromyography Biofeedback, One repetition maximum.

INTRODUCTION

Knee extensor weakness is a typical characteristic of knee osteoarthritis (OA) and it is related to the development of symptomatic knee as well as a decrease in function over time in people with knee OA[1].In most countries of the world knee OA is a primary cause of pain and disability[2].The Quadriceps muscle weakness plays a major role in worsening knee pain, poses instability to the knee joint, and makes it susceptible to more degeneration. Literature supports that there occurs 76 % reduction in quadriceps strength in Knee OA[3]. Patients with knee osteoarthritis suffer mostly from a walking disability[4]. Specifically, weakness of Vastus medialis oblique (VMO), a component of the Quadriceps, is found to be linked with severe pain in patients with knee OA[5]. Literature indicates strength deficits ranging between 20 to 45%[6]. A variety of different modalities have been used to optimize the effects of quadriceps enhancing therapies. Electromyographic biofeedback (EMGBF) is a modality that aims specifically at reducing cortical mechanisms associated with strength generation. It is reliable tool (r=0.89) to train and assess muscles performance[11,12]. It is hypothesized to increase muscle strength and quadriceps muscle group neuromuscular control[7].

EMGBF facilitates the regeneration of the peak torque of quadriceps more effectively in conjunction with the strengthening exercise program in osteoarthritis[8]. It is already known that isometric exercises results in less intra articular pressure, inflammation and gradual bone degeneration, a study has evaluated the effectiveness of EMGBF with isometric quadriceps reinforcement in patients with knee OA and has proposed increased muscle strength of quadriceps compared to only isometric exercise program[9].

It is evident from all previous studies that EMGBF was used for the treatment of many musculoskeletal disorders for example knee patellar mal alignment has been corrected by VMO strengthening by EMGBF. But very a smaller number of studies has been conducted on effects of EMGBF on knee disorders. Up to best of researcher's knowledge and literature search, no evidence of EMGBF training of VMO in Knee OA has been reported nationally. As per high national prevalence rate of Knee OA and linked disability,

there is need to include more reliable therapeutic tools in routine protocol of knee OA management. So the rational of this was to quantify performance of VMO, the most affected muscle in knee OA, by EMGBF as compared to conventional Physical therapy protocol of knee Isometrics. The objective of this study was to determine the effects of EMGBF on performance and thickness of VMO muscle.

METHODOLOGY

The single blinded randomized controlled trial (RCT) was conducted from July to December 2019, at Pakistan Railway General Hospital, Rawalpindi. This trial was registered at www.ClinicalTrials.gov with registry number NCT04194853. the sample size(n=34) was calculated online using software Open-epi tool at confidence Interval of 95% and power of 80%[10].The Participants were selected through non- purposive sampling technique from patients of age between 50-65 years. The both genders, with diagnosis of Knee OA according to the American college of Rheumatology, and Kelgren-Lawrence scale grade 1 and 2 and Body Mass Index should be <35kg/m^2 were included. the exclusion criteria the patients who has received physical therapy sessions or intra articular injections in last three months, the patients who had taken corticosteroids, the patients with knee surgeries, the patients with a history of diseases like Rheumatoid arthritis and radiculopathy. After taking written informed consent from the enrolled subjects, they were randomized into Group A (n=15) and Group B (n=15) through sealed envelope method as for keeping the participant blinded to their respective allocation. (Figure 1).

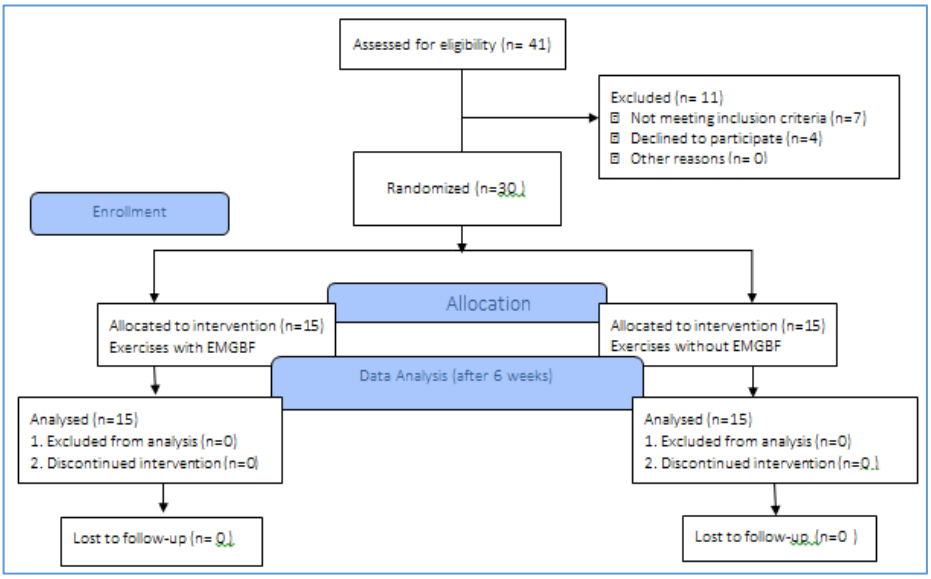

Figure 1: Consort diagram

Baseline assessment was taken which includes demographic data and history was taken. Further patient underwent to diagnostic Musculoskeletal ultrasound procedure by a Consultant Radiologist for measuring the VMO thickness[10]. Muscle performance which was the primary outcome variable was assessed by EMGBF device[11,12]. The Muscle strength was measured through 1 RM. One repetition maximum (1RM) test, the maximal weight that can be lifted once with correct lifting technique, is the gold standard for measuring muscle strength [13].

In the Group A participants has received EMGBF training with isometrics knee exercises. With the patients in supine position, active electrode was applied 4 cm above the patella, the reference electrode was placed 3 cm medially to the superomedial aspect of the patella and the ground electrode was attached to the same leg 2–3 cm inferior to the patella[5]. To perform isometric quadriceps, exercise a rolled towel with a width of 10 cm was put on the popliteal fossa of the patients' knee and asked to press the towel as hard as possible for 5 seconds. The muscle was then relaxed for the 10 seconds and the procedure was repeated for a total of 15 mins (60 cycles)[14]. The patients were advised to do three sets of exercises with 8-10 repetitions three times a day at home. Exercises

were straight leg raising, isometric hip adduction exercise, terminal knee extension exercise, isometric quadriceps exercise[15]. In the Group B, only isometric exercises were performed without the application of EMGBF. Rest of the treatment including home plan was same for the participants in this group. Post assessment was performed by the end of the 6th week. The data was presented as n(%), mean±Sd, median(IQR). The assumption of parametric test was not met, so nonparametric test were used for data analysis. For the comparison of both groups Mann Whitney U-test were applied, while for with-in group changes, Wilcoxon signed rank test was applied. The level of significance was set at p<0.05. The data was analyzed using SPSS ver. 21.

RESULTS

In this study n=30 patients were recruited with the mean age (group A = 58.94±3.1 years and group B = 59.44±2.9 years). In total male participants were n=4 and female participants were n=26. Individually in group A, there were n=13 females and n=2 males and in group B there were n=13 females and n=2 males. Within group analysis for all variables was statistically significant (p <0.001) in both groups. (Table 1) In between group analysis there was found significant improvement (p<0.001) of VMO thickness, 1RM in experimental group as compared to control. For the variable of MVIC, between group comparison has shown non-significant (p>0.05) differences. (Table 2)

Table 1: With-in group changes 1RM, MVIC and VMO muscle thickness

		Group A (EMGBF+CPT) n=15				Group B (CPT) n=15			
Variable	Assessment	Mean ± S.D	M.R	Med (IQR)	P-value	Mean ± S.D	M.R	Med (IQR)	P-value
1 RM (kg)	Pre	2.06± 0.96	8	2(1)	0.001	1.6± 1.03	8	8(1)	0.014*
	Post	4.66± 1.79	0	5(3)		3.06± 1.66	0	2(2)	
MVIC (uv)	Pre	267.5± 122.3	8	294(173)	0.001	356.1± 249.6	8	243(320)	0.001**
	Post	1651.1± 493.8	0	1999(745)		1553.2± 510.9	0	1764(235)	
VMO muscle thickness (mm)	Pre	14.4± 4.65	0	14.6 (7.7)	0.002	12.5± 3.15	8	11.2(3)	0.001**
	Post	17.7± 2.95	8	18.3(2.9)		14.6± 3.4	0	14(4)	

Significance Level: p<0.05, p<0.01**, p<0.001****

Table 2: Between group comparison (1RM, MVIC and VMO muscle thickness)

		Group A (EMGBF+CPT) n=15			Group B (CPT) n=15			
Variable	Assessment	Mean ± S.D	M.R	Med (IQR)	Mean ± S.D	M.R	Med (IQR)	P value
1 RM (kg)	Pre	2.06± 0.96	17.87	2(1)	1.6± 1.03	13.13	8(1)	0.121.
	Post	4.66± 1.79	19.17	5(3)	3.06± 1.66	11.83	2(2)	0.02*
MVIC (uv)	Pre	267.5± 122.3	14.8	294(173)	356.1± 249.6	16.2	243(320)	0.663
	Post	1651.1± 493.8	16.6	1999(745)	1553.2± 510.9	14.4	1764(928)	0.464
VMO muscle thickness (mm)	Pre	14.4± 4.65	16.93	14.6 (7.7)	12.5± 3.15	14.07	11.2(3)	0.372
	Post	17.7± 2.95	19.97	18.3(2.9)	14.6± 3.4	11.03	14(4)	0.005**

Significance Level: p<0.05, p<0.01**, p<0.001****

DISCUSSION

The present study indicated that an isometric exercise with biofeedback training is more efficient to improve muscle strength and thickness. In this study 1RM was used as an outcome measure for assessing muscle strength. So, the group of patients who were trained with EMGBF assisted isometrics has shown great improvement in terms of maximum force generation in one maximum contraction of quadriceps as compared to control group after 6weeks of intervention. These results are supported by the study of Anwer S et.al, they aimed to evaluate the effectiveness of Electromyographic biofeedback with isometric quadriceps reinforcement in patients with knee OA. They found that a 5-week isometric exercise program seemed to increase muscle strength of quadriceps compared to exercise program alone in patients with knee OA[9]. Similar findings regarding the muscle strength for this study were demonstrated by Yılmaz OO et.al. In their study one group has received strengthening exercise program with EMGBF, while the other had the same exercise program without EMGBF 3 times a week for 3 weeks. The patients were asked to perform the same exercise program regularly thrice a day. Isometric strength was measured through isokinetic dynamometer. As a conclusion these exercises improved muscle strength equally in both groups [16].

An important primary outcome intended to evaluate the changes in muscle performance was of Maximum voluntary isometric contraction (MVIC) measured by EMGBF device. Participants of the current study in both groups have shown significant improvements after 6 weeks of isometric training either assisted or not assisted by EMGBF. Despite of more clinically significant improvement of MVIC in EMGBF assisted group, there was found not statistically significant (p=0.464) difference between the two groups. Contrary to this finding, Choi YL et.al has reported significantly positive effects on MVIC of VMO amongst groups treated with EMG guided biofeedback and those treated with ultrasound guided biofeedback (USBF) in patients with knee OA. Whereas their control group which has received hot pack, TENS and ultrasound, showed no improvement in MVIC[10]. This finding is comparably different from the present study in which both groups have shown improved MVIC after 6 weeks of intervention. The possible reason is both groups has received same volume of quadriceps isometric training, one with and the other without EMGBF. Whereas in the above-mentioned study the control group has not been treated with exercise therapy that is why no significant improvement was not found. Further they have measured MVIC with strength dynamometer.

Current study evaluates the structural changes in the Vastus medialis Oblique muscle by musculoskeletal ultrasound. Participant of the present study in both groups have shown significant increase in VMO thickness after the 6 weeks of isometric exercises with EMGBF and without EMGBF but there were a greater number of patients with increased VMO thickness in experimental group. This study has also illustrated significant difference (p=0.001) within group analysis. Choi YL et.al has reported the effects of isometric exercises using the EMGFBF on pain in knee OA patients. The Patients in the EMGBF training were trained with the subsequent physical training exercise program targeting the VMO, whereas the patients in the control group were treated with conventional physical therapies. By comparing the VMO thickness between pre and post intervention, significant improvement was noted in the EMGBF group (p=0.005)[10]. These findings support the present study in which experimental group have shown more increased in VMO thickness after 6 weeks of intervention.

The current study has some limitations, Researcher was unable to complete the calculated sample size due to study time limitation, study setting was just a single setup and only those patients were participated who visited the hospital in that time, Repeated charging of device made delay in delivery of sessions to patients sometime.

CONCLUSION

It is concluded from the current study findings that isometric exercises using EMG biofeedback technique enhances VMO performance and thickness in patients with knee Osteoarthritis. The improvement linked with this specific form of muscle training is observed to be due to more interest in exercise participation using audio and visual feedback of device. Exercise training with EMG BF should be used as an adjunct in routine component of physical therapy for knee osteoarthritis, other devices for EMG BF can be utilized in future studies. Data should be collected from multiple clinical set ups to have diversity in patient population with different lifestyles.

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