

## Effect of exercises for VMO in patients with OA Knee by EMG analysis: Quasi experimental Study

1. K. Lakshmi Prabha (PhD) scholar, (RMMCH)  
Sree Balaji College of Physiotherapy
2. Prof Dhanpalsingh, HOD, RMMCH, Chidambaram.

### ABSTRACT

#### BACKGROUND:

**Osteoarthritis** is a chronic degenerative disorder primarily affecting the articular cartilage of synovial joints, with eventual bony remodelling and overgrowth at the marginal of the joints. Electromyography is used to evaluate the scope of neuromuscular disease or trauma, and kinesiological electromyography is a tool to study muscle function. The Vastus Medialis Oblique is the most important quadriceps muscle and the most responsible muscle for knee stability.

**Aim:** To check the EMG activity of Vastus Medialis muscle before and after multi model exercises for Vastus Medialis muscle in patients with OA knee.

**Method:** Total 40 subjects (15 male and 25 female) were taken in this study. EMG activity of VMO was recorded before and after exercises.

**Outcome Measure:** EMG activity-Amplitude

NPRS - Pain scale

**Statistical Analysis:** The differences between the Vastus Medialis Oblique muscle was assessed by using student t-test.

**Results:** The EMG activity of Vastus Medialis muscle was recorded

**Conclusion:** These finding suggest that there was significant difference in data before and after intervention.

**Key Words:** OA knee, VMO muscle, EMG.

### INTRODUCTION:

Worldwide Osteoarthritis is the eighth leading cause of disability (Mathers CD et al 2003) with the joint most frequently associated with disability being the knee (Felson DT et al 1987).

Epidemiologically, OA in India is not clear but it is estimated that osteoarthritis (OA) is the second most common rheumatological problem and is most frequent joint disease with prevalence of 22% to 39% in India (Chopra A et al 2001). Prevalence of OA in India is reported to be in the range of 17 to 60.6% (Sharma MK et al 2007).

Knee osteoarthritis prevalence increase with age. (Dinesh Bhatia et al 2013) the study reveals that the prevalence of OA between the age of 30 to 65 years.

Electromyography was outcome measure to record activity of vastus medialis muscle as pre and post intervention. EMG was used to detect and record electrical potentials from muscle fibres.

EMG is the recording of the electrical activity of muscle and as a whole, the study of motor unit activity. EMG was used to analyse the efficiency of the muscle.

The VMO, which is short for "Vastus Medialis Oblique." This is the most important quadriceps muscle and the most responsible muscle for knee stability.

Vastus Medialis Oblique muscle acts as a pillar to prevent the lateral displacement of the patella. This muscle closely related to tendon of the adductor magnus. There are so many exercises are said to be strengthen vasti muscle. After analysis review article and the results obtained from this study, certain exercises are useful to improve muscle power.

Osteoarthritis is one of the common disorder of weight bearing joint in developing and developed countries. We could not predict the reason for Osteoarthritis knee joints due to its multi factorial causes apart from senescence and aging .but whatever the reasons the disorder ended in impairment and decrease the quality of life and inactivity due to pain and inflammation leads to various disorders like obesity, cardiac disease, psychological complication and diabetes etc.

Specifically, the joint function was affected due to pain, inflammation and articular cartilage erosion. This in turn results in decreased joint stability as well as muscle efficiency around knee joint. The joint pathology leads to quadriceps insufficiency which is very much needed to stabilize knee joint during stance phase of gait. This OA changes will affect knee muscles especially VMO. A study by Nichole M. Livechietal mentioned that early disuse of the VMO is an indicator of general quadriceps weakness. Because there is evidence for importance of VMO, it is necessary to improve the strength of the VMO.

Clinically therapist use last 15-degree knee extension exercise and high sitting knee extension exercise for strengthening of VMO but there were of other exercise for VMO strengthening. There are few studies that show the EMG activity of the VMO muscle.

As some of the exercise from this study causes isometric contraction of VMO which may be pain free which can be substantially useful in VMO activation. So purpose of the study is to find out effect of exercise for Vastus medialis in OA knee patients.

### **AIM AND OBJECTIVES:**

**AIM:** To find out the EMG activity of vastus medialis oblique muscle before and after multi model exercises in patients with OA knee.

**OBJECTIVES:** To find out the EMG activity of vastus medialis oblique muscle before and after exercises.

### **HYPOTHESIS:**

**NULL HYPOTHESIS:** There is no significant difference of EMG activity of vastus medialis oblique muscle in patients with OA knee.

**ALTERNATIVE HYPOTHESIS:** There is significant difference of EMG activity of vastus medialis oblique muscle after specific multi model exercises in patients with OA knee.

### **METHODOLOGY:**

Study Design: Observational study

Sampling Technique: Convenient sampling

Study Setting: Physiotherapy clinic, Chennai

Sample Size: 30 subjects

Study Duration: 4 weeks(5<sup>th</sup> June-5<sup>th</sup>July)

Source of Data: Subjects was collected from OPD in and around physiotherapy centres. Study Population: OA knee Selection criteria.

**INCLUSION CRITERIA:**

- Age: 50-55 year
- Gender: Male and Female
- Patients diagnosed with primary osteoarthritis.
- Stages 2 and 3 osteoarthritis of knee on radiographs finding. (The Kellgren and Lawrence system)
- Patients with unilateral or bilateral OA knee.
- Criteria for OA knee ACR (American College of Rheumatology)

**EXCLUSION CRITERIA:**

- History of trauma around knee, hip, ankle, foot
- Any neurological condition
- Osteomyelitis
- Any other musculoskeletal disorders
- Non cooperative patient

**MATERIALS:**

Materials used in study,

- Neurotrac Myoplus4 EMG
- Surface electrodes
- Electrode gel
- Weight cuff (2.5 kg)
- Ball
- Consent form

**PROCEDURE;**

Subjects were selected as mentioned and explained about the procedure .After getting consent and willingness to participate in study exercises given. Before intervention EMG and NPRS was tested as pre-test score. After 4 weeks of intervention EMG and NPRS score was taken as post-test.

Exercises given:

1. Static quadriceps
2. Crook lying isometrics to adductors
3. Twisted leg raise
4. Keep ball or pillow between knee and bridging.
5. a)Keep wedge or towel roll under knee and have 15\*angle and extension of knee  
b)Same exercise with 1 to 2 kg weights depends upon subject
6. High sitting position: Ask patient to keep medicine ball or pillow in between knees and ask patient to squeeze pillow and hold for 10 counts and relax
7. Wall slide

8. Semi squat
9. Eccentric activity on Swiss ball against resistance

All exercises were given 20 repetition/daily one time/4 week

**EXERCISE GIVEN:**



Fig 1.Static Quadriceps



Fig.2a.keepingtowelwedgeandterminalextension



Fig 2b

Fig3crooklyingSLRwithinternalrotation



Fig4a&bhighsittingkneeextension





Fig.5 Crooklyingadductorssqueeze



Fig 6 Wall Squat

**METHOD OF DATA COLLECTION:**

40 participants (females and males), aged 50 to 55 years old were recruited and written consent was taken from subjects, who fulfilled the inclusion and exclusion criteria.

Activity of the vastus medialis muscle was checked before interventions. The EMG signals were acquired and analysed using the neurotrac Myoplus software EMG amplitude taken as a outcome measure.

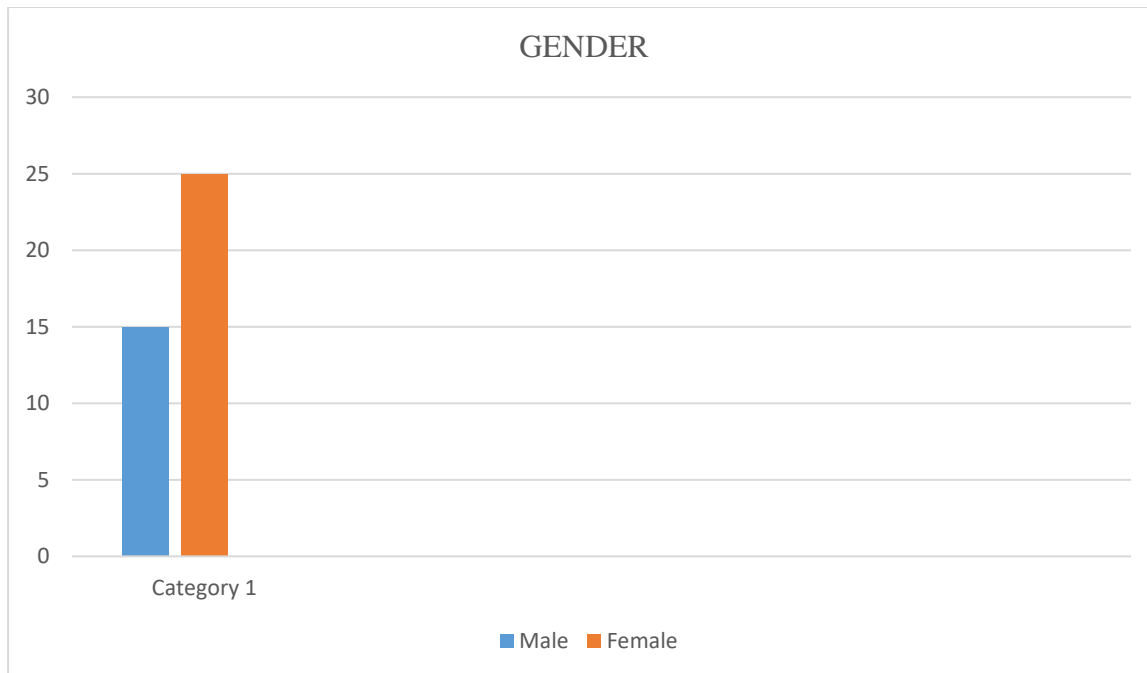
Knee pain is the one of the crucial cause which leads to so many disability due to OA knee.

## DATA:

SLNO	GENDER	AGE	SIDE	PRETEST EMG() $\mu$ V	POST TEST $\mu$ V EMG	PRE TEST NPRS	POST TEST NPRS
1	M	51	Rt	61.5	80.9	6	4
2	M	54	Rt	56.8	98.3	7	4
3	F	55	Lt	60.7	74.9	5	3
4	F	53	Lt	71.6	87.9	6	4
5	F	52	Rt	56.5	76.9	4	3
6	F	51	Rt	45.8	75.8	7	4
7	M	54	Both	54.9	87.9	5	2
8	F	52	Both	46.6	108.5	6	1
9	M	51	Both	67.5	80.8	6	4
10	F	53	Rt	65.8	90.9	7	2
11	M	54	Rt	63.8	93.4	5	3
12	F	55	Rt	74.9	120.8	6	2
13	M	54	Rt	65.7	98.9	7	3
14	F	54	Lt	53.8	99.9	5	2
15	M	52	Lt	49.9	95.6	7	3
16	F	51	Lt	50.8	110.3	5	2
17	F	54	Lt	55.5	93.6	5	3
18	F	55	Rt	56.7	110.8	8	2
19	F	52	Rt	56.7	98.9	6	3
20	F	52	Rt	45.6	96.7	7	4
21	M	53	Rt	59.7	97.9	8	2
22	M	54	Lt	60.1	98.8	7	4
23	F	54	Rt	57.8	95.6	5	3
24	F	55	Rt	68.7	97.7	8	3
25	F	55	Rt	54.6	98.3	7	2
26	M	52	Lt	53.6	98.9	5	3
27	F	51	Lt	45.5	95.8	6	2
28	F	53	Rt	69.6	99.3	7	3
29	F	54	Rt	67.3	114.8	5	2
30	F	53	Rt	65.4	99.8	6	3
31	F	50	Lt	70.8	124.5	7	3
32	M	51	Lt	88.2	132.5	8	2
33	M	51	Rt	99.7	145.2	5	2
34	M	54	Rt	98.7	135.9	7	1
35	M	52	Rt	98.5	138.6	8	2
36	M	54	Rt	95.6	125.8	6	1
37	F	52	Rt	98.4	124.8	5	1
38	F	55	Lt	97.8	126.8	5	2
39	F	54	Lt	99.8	125.5	6	1
40	F	53	Both	95.8	127.7	5	1

**DATAANALYSIS:**

No	Male	Female
40	15	25



Total: 40

Male: 15.37.5% Female 25.63.5%

In female average mean is 53.

In male subject the average mean is 52.

Among 40, right side OA 23, Lt side OA 13. That means unilateral OA changes totally 36 among 40. 90% of population were affected unilaterally. Only 10% were affected with bilateral involvement. Bilateral involvement 2 female and 2 male subjects. Even though OA Knee was common among Female, the distribution of bilateral involvement is equal (2,2)

**PAIREDt-TEST RESULTS:**

Results of the Paired-t test indicated that there is a significant large difference between before (M = 67.7,SD = 17.6) and after (M= 104.6,SD = 18.3),  $t(39) = 19.5$ ,  $p < .001$ .

It showed that EMG activity of Vastus Medialis muscle showed great difference in its electrical activity before and after exercise intervention. The pain and pathology due to OA results in inactivation of VMO muscle. During the stance phase, VMO with other knee joint muscle provides stability by assisting in locking the joint. It was failed to do so due to pain which was exerted by applying compression force during stance phase on knee joint.



SLNO	GENDER	AGE	SIDE	PRETEST EMG( $\mu$ V	POST TEST $\mu$ V EMG	PRE TEST NPRS	POST TEST NPRS
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4	F	51	Rt	45.8	75.8	7	4
5	F	52	Rt	45.6	96.7	7	4
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7	M	54	Lt	60.1	98.8	7	4

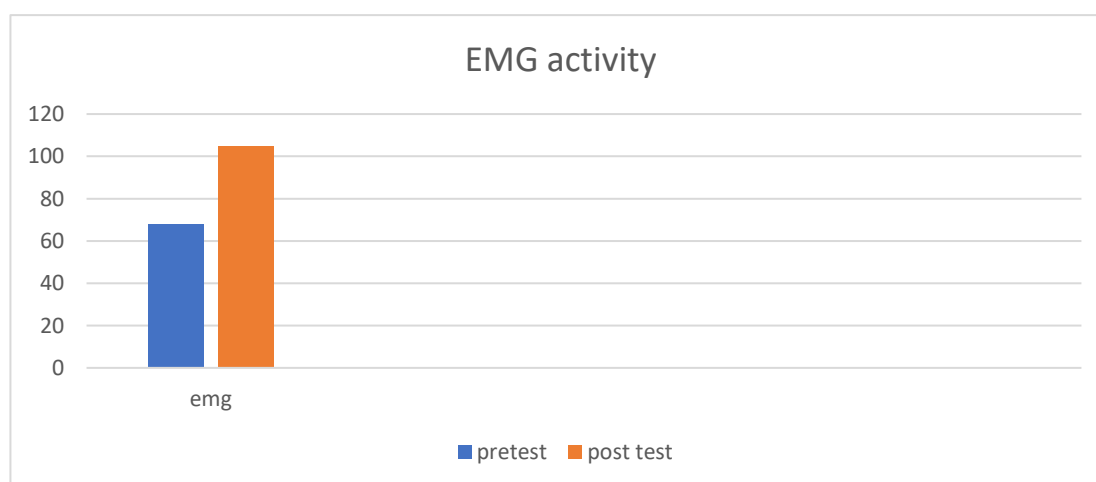
Among 40 subjects, almost all showed good muscle activity after exercises. But the subjects those who were not having pain reduction were unable to create muscle force. Even after 4 weeks.

Intervention of exercises, 4 male and 3 female subjects not shown more electrical activity of vastus medialis muscle. Maximum muscle activity (98.8 $\mu$ ) was seen in male subject and NPRS scale was only 4. Related to post-test NPRS score(4) pain was inhibiting muscle action which was stated by Daniel R Souza Michael T Gross in 1991.

At the same time in 51 year male subject showed maximum muscle activity (145.2 $\mu$ ) and the NPRS scale was 2. This subject had NPRS scale only 5 and pre-test EMG was 99.7 $\mu$ . This showed pain and muscle activity were inter related each other. Ali H. Alnahdi, PT, MS et al in their study in 2012 stated that there was strong bond between OA knee pain and muscle impairment. In this study also subjects shown improvement in muscle activity had NPRS scale 1(6) and 2(13).

#### DATA ANALYSIS:

#### EMG ACTIVITY OF VMO



	Pre-test	Post-test
EMG	67.7	104.6

Paired sample T-test using (df: 39) distribution (two-tailed){validation}

### 1. H0 hypothesis

Since the  $p\text{-value} < \alpha$ , H0 is rejected.

The before population's average is considered to be not equal to the after population's average. In other words, the difference between the averages of before and after is big enough to be statistically significant

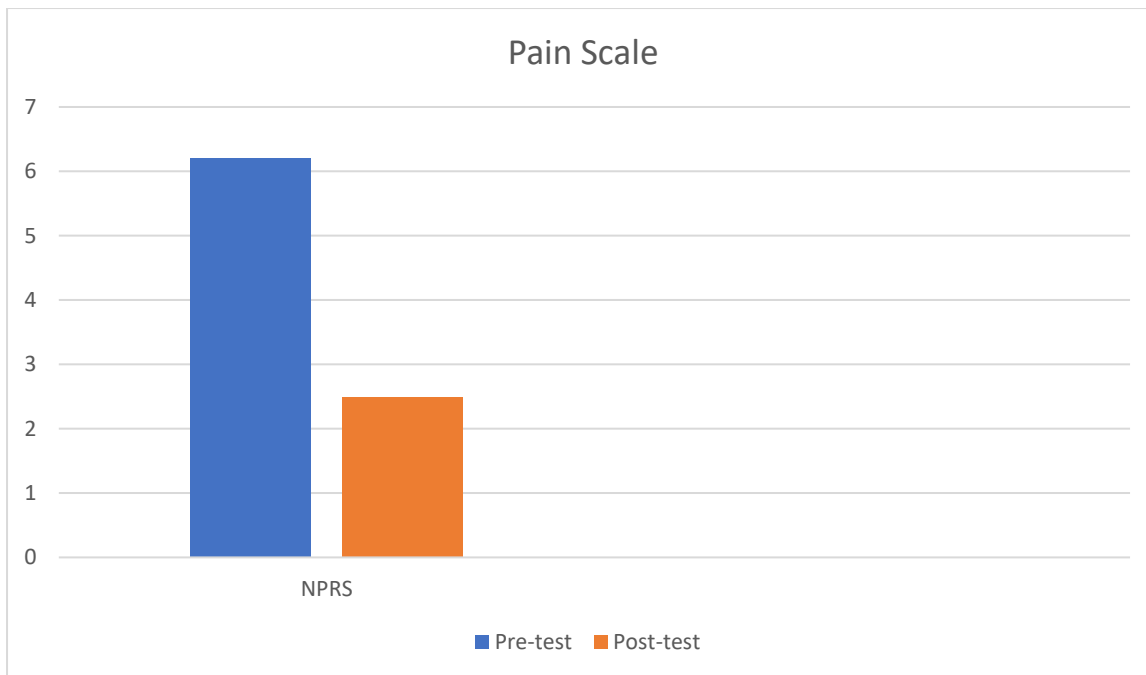
### 2. P-value

The p-value equals 0, ( $P(x \leq 19.5265) = 1$ ). It means that the chance of type I error (rejecting a correct H0) is small: 0 (0%). The smaller the p-value the more it supports H1.

### 3. Reporting results in APA style

Results of the paired-t test indicated that there is a significant large difference between before ( $M = 67.7, SD = 17.6$ ) and after ( $M = 104.6, SD = 18.3$ ),  $t(39) = 19.5$ ,  $p < .001$

### PAIN SCORE (NPRS)



Reporting results in APA style

Results of the paired-t test indicated that there is a significant large difference between Before (pre-test Mean = 6.2, SD = 1.1) and After (post-test Mean = 2.5, SD = 1),  $t(39) = 16.7$ ,  $p < .001$ .

Paired sample T-test, using T(df:39) distribution (two-tailed)[Validation]

### 1. H0 hypothesis

Since the  $p\text{-value} < \alpha$ , H0 is rejected.

The before population's average is considered to be not equal to the after population's average. In other words, the difference between the averages of before and after is big enough to be statistically significant.

## 2. P-value

The p-value equals  $2.233e-19$ , ( $P(x \leq -16.7146) = 1.117e-19$ ). It means that the chance of type I error (rejecting a correct  $H_0$ ) is small:  $2.233e-19$  (2.2e-17%). The smaller the p-value the more it supports  $H_1$ .

## DISCUSSION:

In 2012 Ilsojuneta, has done a study on EMG activity of Vastus medialis muscle at various angle isometrics exercises among Knee OA. He stated that EMG activity at 15° knee angle isometrics vasti was effective and active. In this study after exercises intervention, vastus medialis oblique muscle showed effective EMG activity when compared with before exercises.

Simon et al in 2008 stated that EMG activity of vastus medialis muscle among OA knee subject was altered due to imbalance. In this present study also EMG activity in prevention group were comparatively lesser than post group.

H.S. Longpoe stated in 2014 that knee adduction moment and quadriceps activation in OA knee through exercises. It was evidence with EMG signals of quadriceps and hamstrings. Pain and cartilage destruction leads to inactiveness of knee muscles which was evidenced in pre-test EMG analysis. After exercises to vasti muscle there was improvement in EMG signal.

In 2020, Brindajoshi explained about the vastus medialis activity in various positions of knee joint. This study highlighted the positions like high sitting knee extension, SLR, Adductor squeeze and Semi squat. In these positions vastus medialis muscle showed response to EMG activity. In present research after exercises intervention Vastus medialis showed good response which proved the acting muscle by these exercises.

Iswaryavardhini in 2021 proved that vastus medialis strengthening along with hip abductors might reduce the symptoms in OA knee. Here in this present study this was proved with reduction in NPRS scale.

An observational study by Dhruvi Patel et al in 2021, has stated that EMG activities of vastus medialis muscle improved with 3 different exercises and also in this study they have used terminal extension with medial rotation of hip, single leg stance with 30° knee squat and Straight leg raising were given to activate the vastus medialis muscle. Present study also a set of exercises were given to activate and strengthen vastus medialis muscle which included these exercises.

By this study biomechanically how vastus medialis was important to improve knee joint stability was proved with EMG activity before and after exercise intervention. Being observational study and less sample size could not recommend specific exercise to improve vastus medialis muscle. But all the exercises included in this study definitely improved vasti strength and activated it. These exercises can be examined with more sample size and longer study duration to find out better exercise for activating vasti.

In this study the exercise for VMO muscle not only helping the muscle to activate but also it was helping to improve joint function and reducing pain. It was proved by data Ali H. Alnahdi, PT, MS et al in 2012 stated that OA knee leads to muscle impairment, thus it reduced the joint function.

Iswaryavardhini et al, in 2021 stated that muscle activation may be useful to reduce pain and improve joint stability. This present study also after exercise intervention subject showed greater change in pain.

#### **LIMITATION:**

In this present study even though the duration for intervention was 4 weeks. But sample size was not sufficient and sample was not subjected to subcategory like age, gender and comorbid. In future this also taken into research variable.

#### **CONCLUSION:**

There were so many treatment protocols for osteoarthritis knee. Maximum were detailing about pain reduction and prevention of further disability. But very few studies and reviews were explained about exercises to improve joint function. In that aspect the exercises which were included to activate vastus medialis muscle in this study was justified the aim. 33 subject out of 40 showed improvement with EMG activity of vastus medialis muscle. The remaining subjects also definitely showed changes in EMG. In that way the selection of exercises were definitely useful to activate muscle. With this study the exercises to be specific to the muscle to activate its function thus improved functional status. Activating each muscle definitely showed improvement in muscle function and pain relief. In this study the EMG activity of Vastus medialis muscle was exposed by specific exercises and the post test score was proved with increased amplitude and electrical activity of the VMO muscle After interventions. Whether these subjects were given medication or modality to reduce pain, need to create awareness about exercises which would be a long term effect.

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