

**TO FIND OUT THE EFFECTIVENESS OF  
QUADRICEPS STRENGTHENING AND  
ENDURANCE EXERCISES ON DELAYED ONSET  
OF VASTUS LATERALIS ACTIVITY DURING  
STAIR DESCENDING IN WOMEN WITH  
SYMPTOMATIC OSTEOARTHRITIS**



By

**(Reg. No . 27101804)**

**PADMAVATH COLLEGE OF PHYSIOTHERAPY**

**PERIYANAHALLI**

**DHARMAPURI**

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Submitted in Partial fulfillment of the requirements for the

Degree of **Master of Physiotherapy**

From

The Tamilnadu Dr. M.G.R. Medical University,

Chennai

**PADMAVATH COLLEGE OF PHYSIOTHERAPY  
PERIYANAHALLI  
DHARMAPURI**

## **CERTIFICATE**

This is to certify that the project entitled **“TO FIND OUT THE EFFECTIVENESS OF QUADRICEPS STRENGTHENING AND ENDURANCE EXERCISES ON DELAYED ONSET OF VASTUS LATERALIS ACTIVITY DURING STAIR DESCENDING IN WOMEN WITH SYMPTOMATIC OSTEOARTHRITIS”**



Submitted by the candidate

**(Reg. No . 27101804)**

is a bonafide work done in partial fulfillment of the requirements for the

Degree of **Master of Physiotherapy** from

**The Tamilnadu Dr. M.G.R. Medical University,**

Chennai

**Guide**

**Principal**

Viva-voce Examination held on \_\_\_\_\_

**Internal Examiner**

**External Examiner**

## **DECLARATION**

I hereby declare and present my dissertation entitled entitled “**TO FIND OUT THE EFFECTIVENESS OF QUADRICEPS STRENGTHENING AND ENDURANCE EXERCISES ON DELAYED ONSET OF VASTUS LATERALIS ACTIVITY DURING STAIR DESCENDING IN WOMEN WITH SYMPTOMATIC OSTEOARTHRITIS**” the outcome of the original research work undertaken and carried out be me , under the guidance of **Mr. J. RAVI SHANKAR, M.P.T. , MIAP.,** Associate Professor , Padmavathi College of Physiotherapy, Periyanahalli, Dharmapuri , Tamilnadu.

I also declare that the material of this dissertation had not formed in any basis for the award of any other Degree previously from the Tamilnadu Dr. M.G.R. Medical University, Chennai.

**(RAMRAJ. S )**

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**(RAMRAJ. S )**



**DEDICATED TO MY BELOVED  
PARENTS , STAFFS  
AND  
LOVABLE FRIENDS**

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## INTRODUCTION

Osteoarthritis is the most common musculo-skeletal complaint characterized by pain, disability and progressive loss of function. The knee is the most frequently affected joint of the lower limb and onset of osteoarthritis increases with age commonly in obese women leads to pain on walking, difficulty in weight bearing during stair climbing and limitation in ambulation.

Controlled knee flexion is often described as loading response in knee flexion, which occurs when weight is loaded onto the limb at heel strike. This is achieved by the eccentric quadriceps contraction, which increases joint loading and gradually associated with osteoarthritis of knee. It has been proposed that impairments in quadriceps function and knee joint kinematics might be important in the pathogenesis and progression of knee osteoarthritis.

Osteoarthritis knee is associated with weakness and arthrogenous inhibition of quadriceps as well as proprioceptive deficits. Additionally joint effusion, pain and fatigue are common manifestations of knee osteoarthritis, which can inhibit the voluntary and reflexive motor output

of the quadriceps. As a result of these factors it is possible that knee osteoarthritis may be associated with delayed onset of quadriceps activity during stair descending in which more forces act on the joint.

Delayed onset of quadriceps activity may increase the force with which the foot hits the ground exposing the knee to damaging and jarring stresses. Hence it is necessary to study the purpose and effect of strengthening and endurance exercises to quadriceps for pain reduction and the delayed onset EMG-Interference pattern of quadriceps during stair descending in individuals with symptomatic knee osteoarthritis.

### **AIM OF STUDY**

The aim is to find out the effectiveness of quadriceps strengthening and endurance exercises on delayed onset of vastus lateralis activity during stair descending in women with symptomatic osteoarthritis.

### **OBJECTIVES OF STUDY**

1. To find out the effect of strengthening and endurance exercise on delayed onset of vastus lateralis by EMG-Interference pattern in osteoarthritis knee.

2. To find out the effectiveness of quadriceps strengthening and endurance exercises on pain reduction in osteoarthritis of knee.
3. To find out the effective treatment for patient having difficulty in stair stepping activities.

## **HYPOTHESIS**

### **Null Hypothesis**

The Null hypothesis states that there is no effect of quadriceps exercises on delayed onset of vastus lateralis activity during stair descending and pain reduction in osteoarthritis of knee.

### **Alternate Hypothesis**

The alternate hypothesis states that there is an effect in quadriceps exercise on delayed onset of vastus lateralis activity during stair descending and pain reduction in osteoarthritis of knee.

## **DEFINITION OF TERMS**

### **Osteoarthritis**

Osteoarthritis is a degenerative joint disease primarily affecting the articular cartilage.

## **Strength**

It is the ability of a contractile tissue to produce tension and a resultant force based on the demands placed upon the muscle.

## **Strengthening Exercise**

Strengthening exercise is defined as systematic procedure of a muscle (or) muscle group lifting, lowering, or controlling heavy loads for a relatively low number of repetitions or over a short period of time.

(Carolyn Kisner, 2003)

## **Endurance Exercise**

The ability to resist fatigue is endurance. Endurance exercise is characterized by having a muscle contract and lift (or) lower a light load for many repetitions (or) sustain a muscle contraction for an extended period of time. (Carolyn Kisner, 2003)

## Body Mass Index (BMI)

$$\text{BMI} = \frac{\text{Weight}}{(\text{Height in meters})^2}$$

< 20	-	Underweight
21-24.9	-	Normal
25-29	-	Overweight
30-39.9	-	Obese
Above 40	-	Severe Obesity (Mc Ardle, 2003)

## **REVIEW OF LITERATURE**

### **Hinman.R.S. et.al.,**

Conducted experimental studies with 25 symptomatic osteoarthritis and 33 a symptomatic controls to determine if the electromyographic onset of vastus lateralis in individuals with Osteoarthritis knee differed from that of a symptomatic controls during the task of stair stepping. Results showed that participants with osteoarthritis knee were having delayed onset of vastus lateralis activity during stair descent but not on ascent and having less knee flexion during early stance phase than controls.

### **Huang.MH, et.al.,**

Conducted experimental studies with 30 patients with bilateral osteoarthritis of knee for a period of 6 months to find out the therapeutic effects of muscle strengthening and endurance exercise. The subjects were divided into 2 groups with 15 in each group. The group A patients were given strengthening and endurance exercise and group B patients left with free exercise. After the stipulated periods of training they were assessed and data's were computed. Results showed that the group

received strengthening and endurance exercise had the greatest effect on strength, pain reduction, stability and improvement in walking later time.

**Bischof.HA, et.al.,**

Conducted experimental study on 40 patients with bilateral Osteoarthritis of knee to compare the effects of NSAIDS with quadriceps exercise programme. 20 patients were given NSAIDS alone and 20 patients were given exercise to quadriceps along with NSAIDS for a period 15 days. After the stipulated period results showed that pain reduction to a maximum and improved muscle power in-group who have undergone exercise intervention along with NSAIDS rather than NSAIDS alone. The study concluded that the exercise interventions along with NSAIDS are safe and improve through a direct effect on muscle strength, power and ADL functions.

**Rogind.H.et.al.,**

Conducted experimental studies over 25 patients with symptomatic Osteoarthritis of knee to find the effect of strengthening and endurance exercise to quadriceps along with general fitness exercise. They underwent exercise session for 3 months training thrice a week and focused on general fitness, balance, coordination and muscle strength.

After 3 months of intervention and follow-up it had been proved that muscle strength, power gets improved and reduction of pain in osteoarthritis of knee. A general physical training programme appeared to be beneficial in improving kinematics of knee in patients with osteoarthritis.

**Haten.WP.et.al.,**

Conducted an experimental study to compare the exercise effect in onset EMG interference pattern activity of vastus medialis oblique and vastus lateralis muscles in 30 patients with osteoarthritis of knee. The strengthening exercises were given to selected samples for 5 months. Pre and post data were collected and computed. The study results showed that there was statistically significant reverse in onset EMG interference pattern of vastus lateralis and less in vastus medialis oblique.

**Scrimshaw.S.V., et.al.,**

The aim of the study was to compare the responsiveness of the McGill pain questionnaire with the Visual Analogue Scale (VAS). 35 patients with anterior knee pain who had participated in a randomized controlled trail of rehabilitation were included in the study. All patients completed both a VAS and McGill pain scale to describe their pain over

the last 24 hours and separate VAS to describe their current pain. The results of this study suggested that the visual analogue scale (VAS) might be a better tool than the McGill pain questionnaire for measuring pain in clinical trials and clinical practice.

**Viton.JM, et al.,**

Conducted a study on osteoarthritis of knee to analyse the kinematics and kinetics of affected and unaffected knee joint. The studies had shown that subjects with unilateral knee osteoarthritis developed new strategies during stair descent. These new strategies implied that there was increased biomechanical constraints on the unaffected limb and might favour arthritis on the sound side. The study concluded that it was necessary to focus rehabilitation protocol to both unaffected and affected limb.

**Hart.DJ .et al.,**

Conducted experiment with 20 women aged 45-64 to find the effect of quantity and distribution of body fat on prevalence of radiologically confirmed osteoarthritis of knee, results conclude that excess body weight is a powerful predictor of osteoarthritis of the knee in the middle aged women.

**Slemenda.C.et.al.,**

Conducted study on osteoarthritis of knee to analyse difference in the quadriceps strength in 178 women and 164 men. The muscle strength was measured by isokinetic dynamometry and lean muscle mass by dual x ray absorptiometry. At last they found that osteoarthritis of knee was associated with an increase in body weight and reduced quadriceps power more in women than men.

**Toda.Y.**

Conducted experiment to compare the general body exercise and walking exercise in reduction of muscle mass and prevalence of osteoarthritis of knee with 228 women aged 45-60 yrs with symptomatic osteoarthritis to find association of body mass index greater than 26.4. They were divided into 2 groups. Group A received general body exercise and walking, group B received walking alone. After 2 months period of study the results showed that group obtained exercise and walking appears to be more efficacious for prevention of lower extremity loss of muscle mass than group obtained walking alone for obese women with knee osteoarthritis.

# **MATERIALS AND METHODOLOGY**

## **MATERIALS**

- Computerised EMG with accessories
- Couch
- Cotton
- Steps with rail
- Adhesive plaster
- Scissor
- Surgical spirit
- Quadriceps table with weights
- Visual analogue scale

## **METHODOLOGY**

### **Research Design**

- Experimental study design with Pre Vs post test

## **Research Setting**

This study has been conducted in EMG Laboratory in JKKMMRF College of Physiotherapy – PG Studies under the supervision of concerned authority.

## **Research Sampling**

A total of 15 females between age group of 45-60 yrs with symptomatic osteoarthritis were selected by random sampling method after due consideration to inclusion and exclusion criteria from out patient department of JKKMMRF College of Physiotherapy and Government General Hospital, Erode.

## **Inclusion Criteria**

- Only female subjects
- Age 45 – 60 yrs
- Symptomatic osteoarthritis
- Body mass index > 25 to 30 (Over weight) ( Mc.Ardle 2003)

## **Exclusion Criteria**

- Acute soft tissue injuries in and around knee
- Genu recurvatum

- Recent fractures in lower limb
- Limb length discrepancy
- Chondra malacia patella
- Osteoporosis
- Osteo arthritis with fixed deformities
- Rheumatoid arthritis
- Tumors
- Tuberculosis of knee

## **PARAMETERS**

### **EMG – Interference Pattern**

Onset EMG-Interference pattern of vastus lateralis activities were recorded in milliseconds. The model EMG with 2 surface electrodes and one ground electrode were used to measure the interference pattern of vastus lateralis during stair descending.

Sweep speed	-	100 ms/div
Low filter	-	50 Hz
High filter	-	500 Hz
Gain	-	1 mv/div

## **Visual Analogue Scale (VAS)**

Visual Analogue Scale was used to measure the severity of pain response that the patient experience before and after quadriceps exercises. It consisted of a 10 cm horizontal line with two ends labelled as no pain (0) and severe pain (10). The patients marked a point on the line, which corresponds to the intensity of pain what they experienced.

## **PROCEDURE**

The total of 15 females with symptomatic osteoarthritis of knee were selected randomly with due consideration to inclusion and exclusion criteria. They were examined by an orthopaedician after the informed consent was obtained and they were taken as one group for study.

Pre data were collected before giving strengthening and endurance exercises to quadriceps with the help of EMG – IP of vastus lateralis and VAS measurement for pain. Quadriceps muscle was given isotonic strengthening exercise with the quadriceps table for about 20 minutes daily with 1-minute interval for every 5 minutes. The initial weight of 1 kg was gradually increased by ½ kg weight weekly up to the maximum of 5 Kg for 6 months. The Endurance training was given by gradually increasing repetition of exercises to quadriceps.

The post test was conducted with EMG Interference pattern and VAS pain response after 6 months. The results were analysed and compared.

## **TECHNIQUE**

### **Electrode Placement**

After skin preparation, the electrodes were placed over the muscle belly using the easily identifiable patella as a reference point recommended by Besmajian and Blumenstein (1989) 10 cm superior and 6-8 cm lateral to the superior border of patella with an inter electrode distance of 3 cm. The ground electrode was placed over the tibial tubercle.

EMG – IP activity of vastus lateralis was recorded from heel strike to before foot flat during stance phase when descending stairs (18 cm).

**FIG. I : RMS - EMG AND EVOKED POTENTIAL SYSTEM WITH ACCESSORIES**



**FIG. II : ONSET EMG – IP OF VASTUS LATERALIS  
RECORDING WITH PATIENT**



**FIG. III : STRENGTHENING EXERCISE TO PATIENT**



## STATISTICAL TOOL

The following statistical tool was used to compare the Pre and Post test values of onset EMG – IP of vastus lateralis during stair descending and VAS pain response in osteoarthritis of knee.

### Formula: Paired t-test

$$S = \sqrt{\frac{\sum d^2 - \frac{(\sum d)^2}{n}}{n-1}}$$

$$t = \frac{\bar{d} \sqrt{n}}{S}$$

d = Difference between the Pre Test Vs Post Test

$\bar{d}$  = Mean difference

n = Total number of subjects

S = Standard deviation

## DATA PRESENTATION

TABLE – I

S.No	Onset EMG – IP of Vastus Lateralis (in milliseconds)		VAS pain response (in Cms)	
	Pre Test	Post Test	Pre Test	Post Test
1	35	32	7	4
2	40	36	5	3
3	47	44	4	2
4	60	55	6	3
5	30	25	3	0
6	27	23	4	1
7	50	46	8	5
8	29	25	8	6
9	32	28	5	2
10	38	33	6	3
11	44	35	7	4
12	55	47	4	2
13	36	32	6	3
14	30	25	9	5
15	28	24	3	1

## DATA ANALYSIS & INTERPRETATION

**TABLE – II**

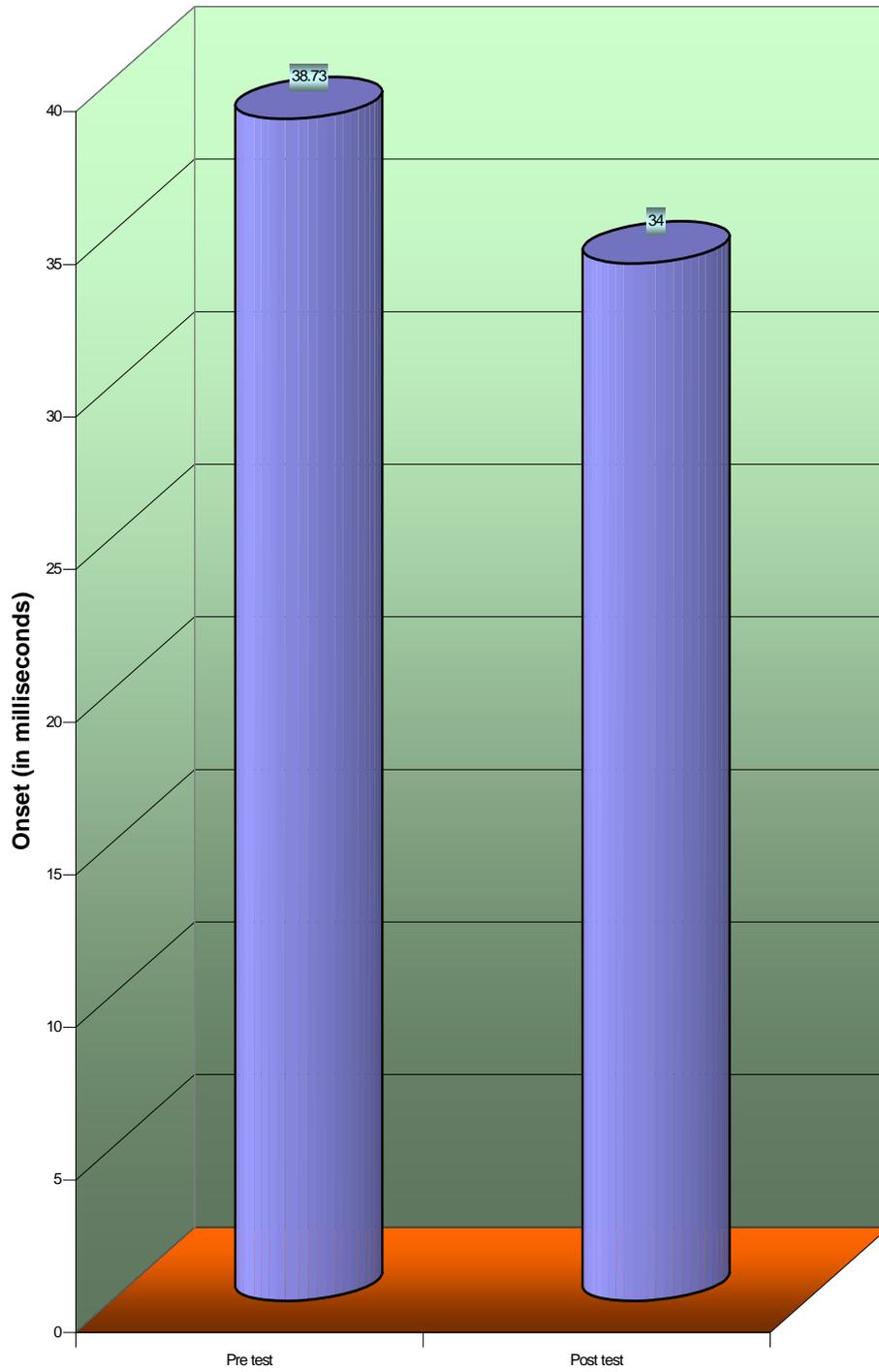
The comparative mean values mean differences, standard deviation and paired ‘t’ values between Pre and Post test of onset EMG interference pattern of vastus lateralis.

S.No	Onset EMG IP of Vastus Lateralis (in milliseconds)	Improvement			Paired ‘t’ values
		Mean	Mean Difference	S.D.	
1	Pre Test	38.73	4.73	1.66	10.976
2	Post Test	34		77	

Table II showed the analysis of onset EMG interference pattern of vastus lateralis. The Pre VS Post test mean difference was 4.73. The paired t-test value between Pre VS post test was 10.976 at 0.05% level, which was greater than the tabulated t-value (1.76).

This showed that there was statistically significant difference between Pre Vs. Post test results.

**Graph I : Pre Vs. Post test values of onset EMG - IP of Vastus Lateralis during Stair Descent**



**TABLE – III**

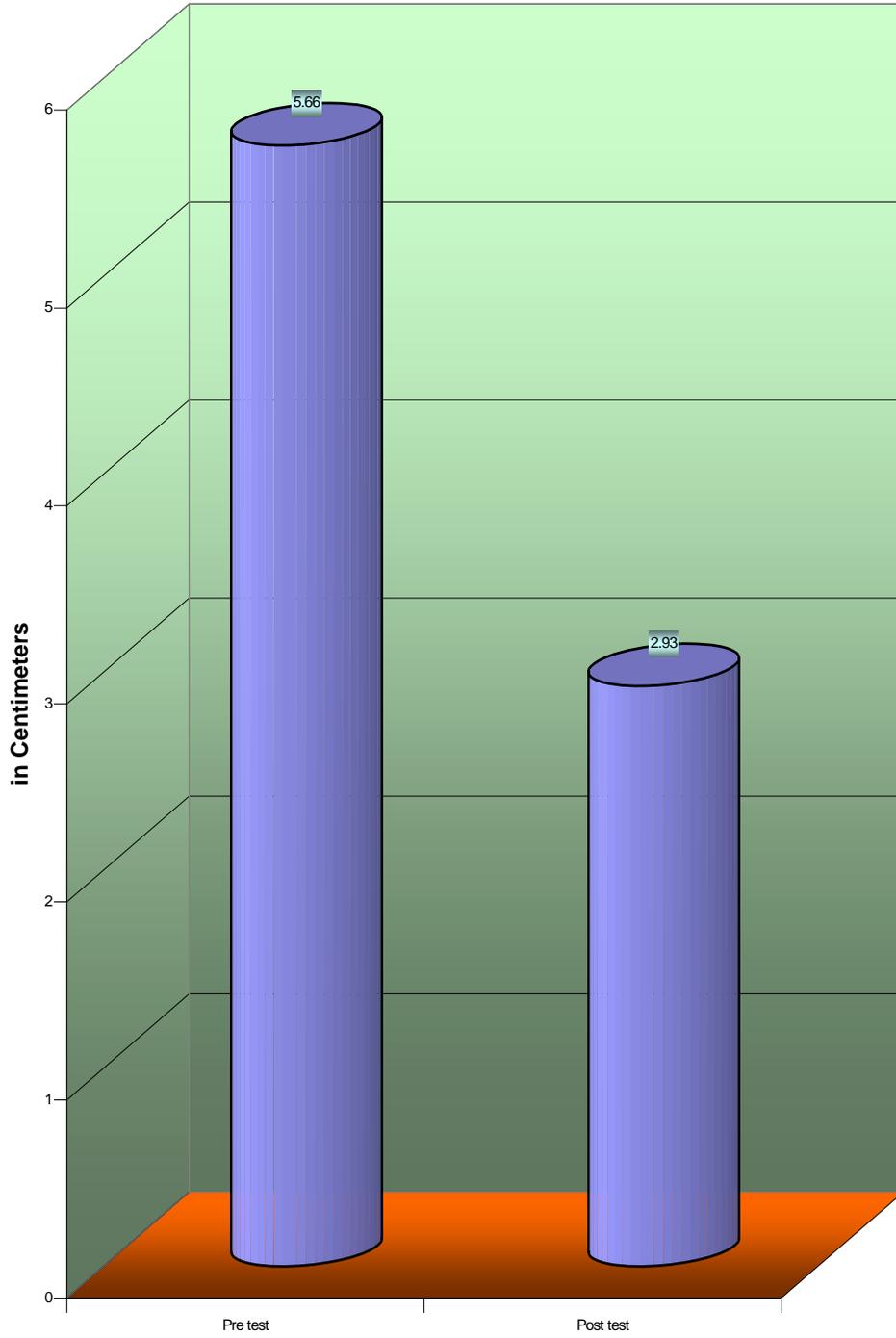
The comparative mean values mean differences, standard deviation and paired ‘t’ values between Pre and Post test of Visual Analogue scale score of osteoarthritis who have undergone strengthening and endurance exercise.

S.No	VAS Pain Response (in cms)	Improvement			Paired ‘t’ values
		Mean	Mean Difference	S.D.	
1	Pre Test	5.66	2.733	0.5940	17.78
2	Post Test	2.93			

Table III showed the analysis of VAS score. The mean difference between Pre Vs Post tests was 2.733. The paired ‘t’ test value of Pre Vs. Post test was 17.78 at 0.05% level, which was greater than the tabulated t-value (1.76) This showed that there was statistically significant difference between Pre Vs. Post test results.

Therefore the present study was accepting alternate hypothesis and rejecting null hypothesis.

**Graph II : Pre Vs. Post test values of VAS Pain Response in Osteo Arthritis**



## DISCUSSION

The purpose of the study was to find the effect of strengthening and endurance exercise on delayed onset EMG - IP of vastus lateralis and reduction of pain in chronic symptomatic osteoarthritic patients who have difficulty in stair stepping activities.

Hinman.RS, Bennel.KL, conducted an experimental study on 25 symptomatic osteoarthritis and 33 a symptomatic controls to find out EMG-IP of quadriceps during stair stepping. The results showed that the participants with osteoarthritis of knee showed delayed onset of vastus lateralis activity during stair descent and not in ascent. He proposed that delayed onset of vastus lateralis was due to proprioceptive deficits and impairment in afferent proprioceptive information to the supra spinal centers which lead quadriceps weakness and arthrogenerous inhibition in osteoarthritis of knee. The Author concluded that weak muscles fatigue more readily and was associated with slowing and inhibition of voluntary and reflex motor control. In his study a great relationship was found between pain and muscle activity. Subjects with greater pain showed a greater delay in quadriceps onset.

Scrimshaw.S.V.,et.al., (2001) conducted an experiment to compare the responsiveness of the McGill pain questionnaire with the Visual Analogue Scale (VAS). 35 patients with anterior knee pain who had participated in a randomized controlled trial of rehabilitation were included in the study. All patients completed both a VAS and McGill pain scale to describe their pain over the last 24 hours and separate VAS to describe their current pain. The results of this study suggested that the visual analogue scale (VAS) might be a better tool than the McGill pain questionnaire for measuring pain in clinical trials and clinical practice.

Based on the above study results of Hinman.RS and Scrimshaw.S.V., the present study has taken the onset EMG IP to measure the onset of vastus lateralis activities and VAS for pain intensity as parameters during stair descent in symptomatic osteoarthritis of knee.

Bischof.HA, Roos.EM, conducted experimental study on 40 patients with Hip and Knee Osteoarthritis to compare NSAIDS and therapeutic exercises. The twenty subjects were given NSAIDS and 20 were given therapeutic exercise interventions for ten days. The results showed that exercise interventions were safe and improved muscle strength and ADL functions.

Huang.M.H and Lin.Y.S conducted an experimental study over 30 patients with bilateral osteoarthritis to find out the therapeutic effects of different muscle strengthening exercise. The results showed that the isotonic exercise had the greatest effect in pain reduction, improving kinematics of knee, muscle power of quadriceps and walking endurance in later time.

Based on above study results, the present study has taken isotonic strengthening and endurance exercise of quadriceps to reverse delayed onset of vastus lateralis and pain reduction in osteoarthritis of knee during descending.

**In the present study,**

In analysis of onset EMG-IP of vastus lateralis, the paired 't' value of Pre Vs Post test was 10.976, which was greater, then the tabulated 't' value 1.76 at 0.05% level. This showed statistically significant difference between Pre Vs Post test results. The Pre test mean was 38.73 ms; the Post test mean was 34 ms, which showed that there was a reverse in onset EMG IP of vastus lateralis in Post test in response to intervention.

**In analysis of VAS for pain response,** the paired 't' test value of Pre Vs Post test was 17.78 cm, which was greater than the tabulated 't' value 1.76 at 0.05% level. This showed statistically significant difference between Pre Vs Post test results. The Pre test mean was 5.66 cms and Post test mean was 2.93cms, which showed that there was pain reduction in Post test in response to intervention. Therefore the present study is accepting alternate hypothesis and rejecting null hypothesis.

**Reason for reverse of onset EMG-IP activity of vastus lateralis during stair descending and pain reduction in osteoarthritis of knee:**

Strengthening and endurance exercise interventions play a major role in increasing nutrition to the muscle, joint and other structures and also increases the number of muscle fibres. The increased blood supply to muscles and structure in and around the knee joint eliminates pain substances. (Mc Ardle 2003). As pain is reduced, the quadriceps muscle activity gets improved and this causes reverse in the onset EMG IP of vastus lateralis during stair descending. (Hanten W.P. and Schulthies S.S. from Journal of Physical therapy, Vol.70: 1990).

## SUMMARY AND CONCLUSION

The aim of study was to find out the effect of safe strengthening and endurance exercise intervention on delayed onset EMG IP of vastus lateralis and pain reduction in patients with symptomatic osteoarthritis of knee during stair descending. The 15 female subjects of age group between 45-60 years whose body mass index greater than 25 to 29.9 were randomly selected for the study. They were given isotonic strengthening and endurance exercise for a period of 6 months.

In analysis of onset EMG-IP of vastus lateralis, the paired 't' value of Pre Vs Post test was 10.976, which was greater, then the tabulated 't' value 1.76 at 0.05% level. This showed statistically significant difference between Pre Vs Post test results. The Pre test mean was 38.73 ms; the Post test mean was 34 ms, which showed that there was a reverse in onset EMG IP of vastus lateralis in Post test in response to intervention.

In analysis of VAS for pain response, the paired 't' test value of Pre Vs Post test was 17.78 cm, which was greater than the tabulated 't' value 1.76 at 0.05% level. This showed statistically significant difference between Pre Vs Post test results. The Pre test mean was 5.66 cms and

Post test mean was 2.93cms, which showed that there was pain reduction in Post test in response to intervention.

Therefore the present study is accepting alternate hypothesis and rejecting null hypothesis.

The study concluded that isotonic strengthening exercises of quadriceps were beneficial to osteoarthritis of knee in initial stage and endurance exercise were useful in the later stage for improving walking and joint stability.

## **RECOMMENDATION**

Further study can be conducted with isokinetic exercise instead of Isotonic strengthening endurance exercise on delayed onset EMG – IP of vastus lateralis during descending stairs.

Males can be included in the studies. The same study can be conducted with isometric strengthening exercise of quadriceps on delayed onset EMG – IP of vastus lateralis during descending stairs. The same study can be conducted with other components of stance phase in slopes.

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## **APPENDIX**

### **INFORMED CONSENT OF SUBJECTS**

Name :

Age :

Sex :

Occupation :

Address for Communication :

Onset EMG IP of vastus lateralis: