

A Comparative Analysis of Electrical Stimulation, Versus TENS with Isometric and Isotonic Exercise of Quadriceps for the Chronic Osteoarthritis Knee Patients

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ABSTRACT

Background: Osteoarthritis (OA) is a disease that affects synovial joints causing degeneration and destruction of hyaline cartilage. The primary goals for OA therapy are to relieve pain, maintain or improve functional status, and minimize deformity.

Objective: To find out the effectiveness of isotonic and isometric exercise of quadriceps for OA knee with combination of modalities Subjects 30 subjects on the basis of inclusion and exclusion criteria.

Materials and Methods: The data for the study was collected from Acharya Physiotherapy clinic and rehabilitation centre and sumangali seva ashram. The research includes collection of data and questionnaire. Pain was measured by VAS and knee outcome survey scale for ADLS of knee.

Result: Results of this study showed that ES and TENS along with isometric and isotonic exercise of quadriceps is useful to treat the chronic OA knee, in which TENS combined with isometric and isotonic exercise is more beneficial when compared to ES modality of physiotherapy on relieving the decreasing PAIN and improving ADLS.

Conclusion: TENS combined with isometric and isotonic exercise of quadriceps is significantly reducing pain and improving functional performance in patients with chronic osteoarthritis of knee joint.

Keywords: VAS, knee outcome scale, osteoarthritis knee, TENSs, electrical stimulation

INTRODUCTION

Knee Osteoarthritis is the leading cause of chronic disability in older person. Osteoarthritis is the 2nd most common rheumatic problem and is most frequent joint disease with prevalence of 22% to 39% in India.

Pain is frequently the first symptom and is often associated with swelling. Crepitus can often be detected and muscle atrophy is seen secondary to disuse. Bilateral osteoarthritis is twice as prevalent in women as in men.^[1]

Osteoarthritis (OA) is primarily a disease of cartilage as it is characterized by the degradation of hyaline cartilage in the joints. It is believed to be a dynamic disease that reflects the balance between destruction and repair. The destruction processes of cartilage: softening and fibrillation, exposure of the subarticular bone plate, and

fragmentation of the subchondral trabeculae are accompanied by hyperactive new bone formation, osteophytosis and bone remodelling.

OA is the most common form of arthritis and one of the most important causes of long-term disability in adults. In addition to increasing age, OA of the knee is associated with obesity, trauma, history of inflammatory arthritis and certain metabolic diseases such as acromegaly and calcium pyrophosphate dihydrate (CPPD) arthropathy.

Common complaints in people with knee OA are pain exacerbated by movement or weight bearing, stiffness, swelling and deformity (genu varum or genu valgum), and restricted walking distance.^[2]

The Strength of the quadriceps musculature is one of the intrinsic factors that have been shown to affect the knee

joint functions. It is evident that lower extremity strength has a major role in knee joint shock attenuation during weight bearing activities; however, research is still ongoing regarding investigation of the role of strengthening in the treatment of OA of the knee. There is increased risk of development or progression of disease due to greater or uncontrolled loading on the joint; therefore, quadriceps strength needs to be considered in the study of knee OA. Reduced quadriceps strength has been shown to be associated with the presence of OA in the knee.^[3]

Transcutaneous Electrical Nerve Stimulation

Transcutaneous electrical nerve stimulation (TENS) is a therapy that uses low-voltage electrical current for pain relief.^[5] Transcutaneous electro stimulation, the application of any electrical current through the skin with the aim of pain modulation, is a frequently used modality in knee osteoarthritis.

It is based on the 'Gate-Control Theory' of pain perception as described by Melzack and Wall. The theory suggests that the stimulation of large diameter, (A-beta) primary sensory afferent cutaneous fibers activates inhibitory interneurons in the spinal cord dorsal horn and, thereby, may attenuate the transmission of nociceptive signals from small diameter A-delta and C fibers. Other suggested mechanisms include a stimulation of β endorphin production and even the potential for articular cartilage repair.^[2, 5]

One review from 2007 felt that the evidence supports a benefit in chronic musculoskeletal pain. While another review (from the Cochrane Collaboration in 2008) deemed the evidence of poor quality and thus no conclusions were possible regarding chronic pain. Results from a task force on neck pain in 2008 found no clinically significant benefit to TENS for the treatment of neck pain when compared to a placebo treatment. As of 2015, the efficacy of TENS therapy for phantom limb pain is not known as no randomized controlled trials have been performed.^[6]

Electrical stimulation

Electrical muscle stimulation (EMS), also known as neuromuscular electrical stimulation (NMES) or electro myostimulation is the elicitation of muscle contraction using electric impulses. This is distinct from transcutaneous electrical nerve stimulation (TENS), in which an electric current is used for pain therapy. In EMS training few muscular groups are targeted at the same time, for specific training goals.^[7]

It is an alternating current named after the inventor Dr Michael Faraday. This unevenly alternating current

consist of two unequal phases in each cycle, with the first phase having a peak EMF of 1 ms followed by a train of damped oscillations with a frequency of 1000 Hz. This short duration interrupted surged direct and alternating currents are capable of producing a titanic like contraction of muscle.

- Pulse shape: saw tooth, triangular, trapezoidal
- Pulsed lengths: 0.02 to 1.0 ms
- Current frequency: 50- 100 Hz
- Pulse types: Unsurged or plain faradic, surged faradic, interrupted surged faradic^[8]

Electrical stimulation may ease pain and strengthen the quadriceps muscles supporting the knee. It also may delay total knee replacement^[9]

MATERIALS AND METHODS

Study Design: Experimental Study

Study Type: Pre and Post test

Sample Technique: Simple random sampling

Study Duration: three months

Study Centre: Acharya Physiotherapy Clinic and Rehabilitation centre & Sumangali Seva Ashram, Bangalore.

Sample Size: 30 patients included in this study

Group A: 15 samples (with isometric and isotonic exercise of quadriceps)

Group B: 15 samples (with isometric and isotonic exercise of quadriceps)

Inclusion Criteria:

- Age: 40-60 years
- Both male and female
- Subjects who is willing to participate in the study
- Chronic OA knee

Exclusion criteria:

- Recent fractures in lower limb
- Acute OA knee
- Open wounds in lower limb
- Ligament injuries in lower limb
- Subjects not willing to participate in the study

Materials Used:

Electrical stimulation, TENS, electrode gel, velcro straps, VAS scale, scissors, towel & pen, questionnaire, knee outcome survey of ADLS and consent forms.

PROCEDURE

The study was held in Sumangali Seva Ashram and Acharya Physiotherapy Clinic and Rehabilitation Centre. The subjects assigned for the study were given

questionnaire and clinical symptoms were match with OA. The patients were selected based on the inclusion and exclusion criteria.

Prior to the commencement of the procedure, informed written consent was taken from those participants only who are willing to a take treatment intervention for 3 days for 4 weeks. The 30 subjects were randomly allocated to two groups of fifteen each. Random method was used for the purpose of allocation of the subject to the two groups.

About 30 subjects who were assessed with chronic osteoarthritis of knee joint are selected for the study. They are categorized at random into two groups as TENS group – A along with isometric and isotonic exercise of quadriceps and electrical stimulation Group - B isometric and isotonic exercise of quadriceps.

Patients in both groups I (TENS) and group II (electrical stimulation) are assessed before starting treatment.

- VAS, this is carried out on both (Pre treatment evaluation) and on last (post treatment evaluation) for all the patients.

- ADLS activities of daily living will be assessed to get the information about the grades of disability of osteoarthritis of knee joint for functional outcome on the first day (pre-treatment) and on the final day of the treatment (post treatment).

Finally, the scores of pre and post treatment are compared for both visual analog scales VAS and ADLS for functional outcome.

Intervention

In this study 30 subjects assessed clinically with osteoarthritis of knee joints are taken. These subjects are categorized into two groups. Each group consist 15 subjects.

GROUP A

This group is given TENS. After routine physiotherapy assessment 15 subjects were positioned on a treatment plinth in their preferred position of comfort. Before the application of TENS, the therapist evaluated the participant thoroughly sensory evaluation done on treatment part and all metal objects, synthetic materials clothing and electronic devices from the treatment part were removed.

And the therapist carried out necessary operating and safety checks of apparatus after a detailed explanation by the physiotherapist the TENS unit was switched on and the current intensity gradually increased until the

subject report first mild tingling sensation and then a strong but comfortable sensation.

To maintain a continuous level of intensity, the intensity was increased by a physiotherapist whenever the subject reported a diminution of the TENS current session. All TENS treatment sessions were 15 minutes long.

Time: 15 min

Frequency: 10 Hz

Intensity: as the patient comfort and tolerable level

After the TENS session the patient were told to do the exercise i.e. isotonic and isometric exercise.

GROUP B

This group is given Electrical stimulation therapy i.e. quadriceps inhibition. Before the application of electrical modalities, the therapist evaluated the participant thoroughly and carried out necessary operating and safety checks of electrical stimulation apparatus.

Participant's sensory evaluation of the body part to be treated were done and all metal objects, synthetic materials clothing and electronic devices form the body part to be treated were removed.

Participants were positioned in supine lying or long sitting and treated with Electrical stimulation i.e Quadriceps inhibition technique.

One electrode was placed around femoral triangle and one electrode was place on the mass bulk of Quadriceps muscle. These sessions were given for 15 minutes.

Time: 15 min

Intensity:

when the first contraction is seen and after the session the participants were given isometrics and isotonic exercise.

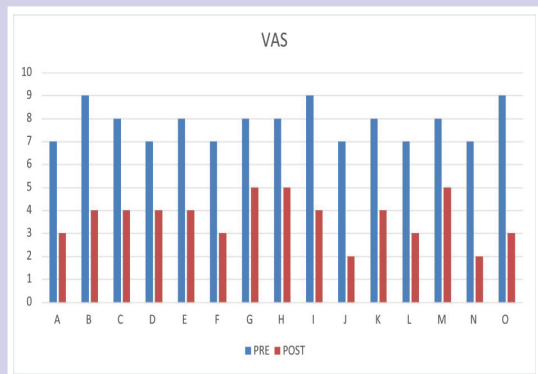
OUTCOME

Every treatment was given for 15 minutes for Modalities and 10 min for exercise per session for a total of 3 days per week for 4 weeks' treatment and patient were told to do exercise in home for the remaining days.

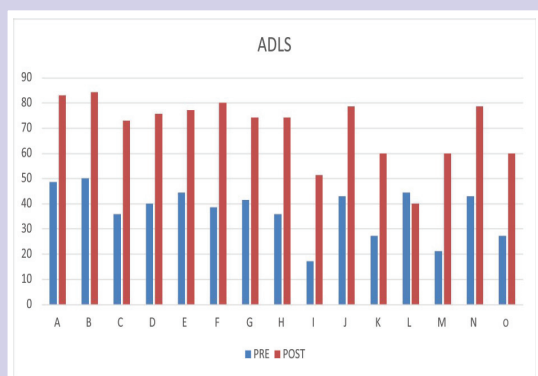
If any subject misses any session they are to be excluded from the study. Pre and post therapy session included assessment by VAS, functional outcome scale by using knee outcome survey scale (ADLS).

Also both groups were advised not to take any painkillers to get the desired results. At the end of treatment session of 4 weeks the post test was taken and data was tabulated and compared with Pre test.

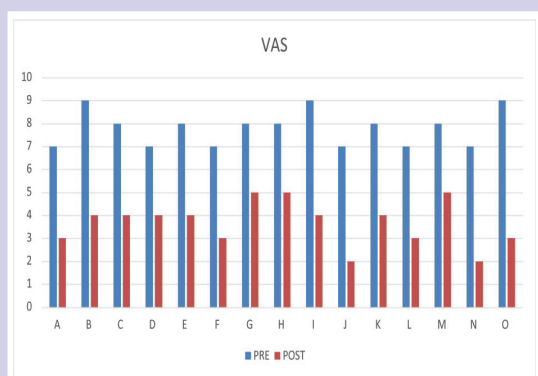
RESULTS



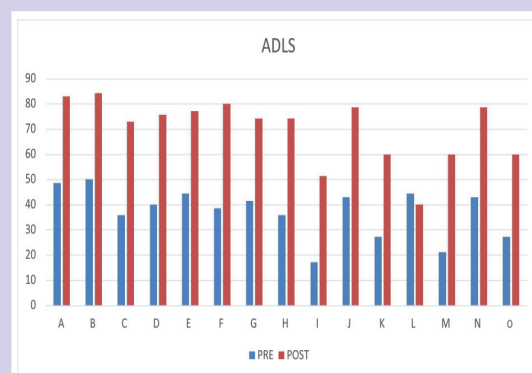
Group A: Table 1 : Pre and Post VAS Scale



Group A: Table 2 : Pre and Post ADLS



Group B: Table 3 : Pre and Post VAS Scale



Group B: Table 4 : Pre and Post ADLS

Table 1: Analysis of VAS between Group A and Group B

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
VAS_PRE	GROUP A	15	7.8	0.7745	0.27735
	GROUP B	15	7.8	0.6761	0.17457
VAS_POST	GROUP A	15	3.667	0.9759	0.25198
	GROUP B	15	5.53	0.8338094	0.21529

Table 2: Analysis of ADLS between Group A and Group B

Group Statistics					
	Group	N	Mean	Std. Deviation	Std. Error Mean
ADLS_PRE	GROUP A	15	37.1287	9.82527	2.53687
	GROUP B	15	38.7660	8.09635	2.09047
ADLS_POST	GROUP A	15	70.0033	12.79087	3.30259
	GROUP B	15	63.7180	5.2839	1.36432

This table is calculating the mean, standard deviation, standard error for ADLS in Group A and Group B.

Statistically, significant difference exists between post ADLS of group A and Group B.

As can be seen from the output TENS with combination with isometric and isotonic exercise of exercise is effective in treating the chronic OA knee patients.

Isometric quadriceps exercise

Patients lay in a supine position. A rolled up towel was put beneath the knee. They were instructed to maximally activate their thigh muscles in order to straighten their knee and hold the contraction for 5 seconds. For 10 repetition for 2 times a day i.e. morning and evening.



Figure - 1: Isometric Quadriceps exercise

Isotonic quadriceps exercise

a. Patient in standing position:

-Patients were told to stand on the uninvolved limb and to move the exercising leg in to flexion (hip flexion). In case of fear of fall or discomfort patients were allowed to take support of any object from both hands.



Figure 2: Hip Flexion and Extension

b. Patient in supine position

Patients were told to drag or bend and straight their leg towards their hips. And do this exercise for 10 repetitions/counts.



Figure 3: Knee bending exercise

c. Straight leg raise

Patients in supine lying. Patients were told to perform SLR for 10 repetitions without bending the knee.



Figure 4 : Straight leg raise

All the exercises are told to do in their home 2 times a day i.e. morning and evening with 10 repetitions. And depends on the outcome, progress of the repeat carry out.

DISCUSSION

The purpose of the study was to compare the effect of TENS combined with isometric and isotonic exercise of quadriceps versus Electrical stimulation combined with isometric and isotonic exercise of quadriceps for chronic OA knee patients.

The VAS scale is a subjective outcome measures used in this study to identify pain severity of the subjects during movement in chronic OA knee. The objective outcome measure used in the study is (ADLS) measurement of activities of daily living scale through which functional limitation is usual activities caused by various pathologies was measured. This measure was helpful to relate pain severity and functional limitation of knee joint in the case of chronic OA.

Within the group A and Group B has showed statistical significant result in VAS and ADLS after the intervention though the magnitude of these results was very small. The short time interval between measurements could be the reason for such minor differences.

ES has been given to the patients for decreasing pain and improving functional limitation by a researchers Laura A Talbot, Jean M Gainer, Shari M ling (2003)^[7] and In the study also show the significant result in improving functional limitation and decreasing pain in my research.

Isotonic and Isometric exercise of quadriceps muscle strength, pain and function was improved as shown by researcher Shahnawaz Anwer, Ahmad Alghader^[3] and

Madhusudna Tiwari^[10] and In the study also show the significant result in improving functional limitation and decreasing pain in my research.

Tens has been given to relief pain and improve functional ability by the researcher Jean M Gainer, Laura A ^[9] and in the study also show the significant result in improving functional limitation and decreasing pain in my research.

Results of this study showed that Electrical Stimulation and TENS along with isometric and isotonic exercise of quadriceps is useful to treat the chronic OA knee, in which TENS combined with isometric and isotonic exercise is more beneficial when compared to Electrical Stimulation modality of physiotherapy on decreasing Pain and improving ADLS.

The present study showed that a TENS combined with isometric and isotonic therapy was superior than ES combined with isometrics and isotonic exercise.

CONCLUSION

In the present study the TENS combined with isometric and isotonic exercise of quadriceps has been shown to be more effective than ES combined with isometric and isotonic exercise of quadriceps in reducing pain and improving function in patients with Osteoarthritis of knee joint.

LIMITATION

It is suggesting that the further studies can be done keeping some points in consideration as given below.

- Sample size taken was small.
- Follow up was not done after the last assessment.
- BMI is not taken in to consideration
- Duration of study is of short period.

RECOMMENDATION

- Further studies can be done on larger samples
- Similar studies can be carried with different age group.
- A similar study comparing males and females can be done.
- Further studies should investigate whether these results may be replicated with a home exercise program.

ACKNOWLEDGEMENT

The authors are grateful to the Management of Acharya institute of health sciences for providing research facilities.

CONFLICT OF INTEREST :

The authors declared no conflict of interest.

FUNDING : None

ETHICAL CLEARANCE : It has obtained from ethics committee Acharya Institute of Health Sciences, Bangalore.

REFERENCES

1. Elboim-Gabyzon M, Rozen N, Laifer Y. Does neuromuscular electrical stimulation enhance the effectiveness of an exercise programme in Subjects with knee osteoarthritis? A randomized controlled trial. *Clin Rehabil.* 2013; 27:246-257.
2. Osiri M, Welch V, Brosseau L, Shea B, McGowan J, Tugwell P, Wells G. Transcutaneous electrical nerve stimulation for knee osteoarthritis (Review). *Cochrane Database Syst Rev.* 2000; 4:CD002823.
3. Shah Nawaz A, Ahmad A. Effect of Isometric Quadriceps exercise on muscle strength, pain, and function in patients with knee osteoarthritis: A Randomized Controlled Study. *J Physical Ther Sci.* 2014; 5:745-748.
4. Susan B. O'Sullivan, Thomas J Schmitz, George D Fulk. *Physical Rehabilitation*, 6th Ed, 2014, FA Davis; 1043.
5. Carol Grace TV, Barbara AR, Nicole PB, Josimari MD, Annunziato A, Miriam BZ, Deirdre MW, Kathleen AS. Effects of transcutaneous electrical nerve stimulation on pain, pain Sensitivity, and function in people with knee osteoarthritis. *Physical Ther.* 2012; 97:898-910.
6. Johnson MI, Mulvey MR, Bagnall AM. Transcutaneous electrical nerve stimulation for phantom pain and stump pain following amputation in adults. *Cochrane Database Syst Rev.* 2015; 6:CD006142.
7. Laura AT, Jean MG, Shari ML, Jeffrey E. A home-based protocol of electrical muscle stimulation for quadriceps muscle strength in older adults with osteoarthritis of the knee. *J Rheumatol.* 2003; 30:1571-8.
8. Srinivasan. *Rimathi's Electrotherapeutic Agents Manual*. 2nd Ed, Jaypee Publishers, New Delhi. 2011:40.
9. Gaines JM, Metter EJ, Talbot LA. The effect of neuromuscular electrical stimulation on arthritis knee pain in older adults with osteoarthritis of the knee. *Applied Nursing Res.* 2004; 17:201-206.
10. Madhusudan T. Effects of combined isotonic exercises protocol on unilateral Symptomatic osteoarthritis knee. *Int J Ther Rehab Res.* 2015; 4:132-137.