

ORIGINAL ARTICLE

TO COMPARE THE EFFECTIVENESS OF CRYOTHERAPY VERSUS TRANSCUTANEOUS ELECTRIC NERVE STIMULATION IN THE MANAGEMENT OF KNEE OSTEOARTHRITIS

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ABSTRACT

To compare the effectiveness of Cryotherapy therapy and Transcutaneous Electric Nerve Stimulation in the Management of knee osteoarthritis. This Quasi experimental study was carried out at Institute of Physical Medicine and Rehabilitation Dow University of Health Sciences Karachi. Total 60 Individuals with complain of painful knee osteoarthritis fulfilling inclusion criteria were selected on voluntarily basis. Selected patients were evenly divided and randomly allocated into two groups with age and gender matching. The group (A) received Cryotherapy along with exercises and (B) Group received a high frequency stimulation of TENS along with exercises. Individuals were treated four days per week for five consecutive weeks. Outcome was analyzed in both groups, on initial session and on last session using Numeric pain rating Scale.

The results of this study shows that both interventions helped in reduction of pain. On numeric pain rating scale lesser values were for cryotherapy as compare to that of TENS. The results it is suggest that cryotherapy is more effective than use of TENS and also the use of ice in Cryotherapy is much more cost effective procedure as compared to TENS.

Keywords: Knee Osteoarthritis, TENS, Cryotherapy, Exercise Therapy.

1. INTRODUCTION

Arthritis is a common joint disease, which affects the functioning, stability and joint range of motion. Most common form of arthritis is Osteoarthritis (OA) which commonly affects weight bearing joints of the body, in particularly knee joint. It affects one third of adults and tends to increase with age¹.

Osteoarthritis is defined as a chronic, progressive deteriorating disorder of multifactorial origin characterized by loss of articular cartilage and peri articular bone remodeling. Symptoms of Osteoarthritis are joint pain (typically worse with weight bearing activities), swelling, instability and decrease joint range of motion².

Primary osteoarthritis is related to aging whereas

secondary arthritis is caused by any disease or condition like diabetes. However, to exclude the presence of any other disease, blood tests are always performed. Symptomatic knee OA is more common in females as compared to males, which accounts for 13% and 10% respectively^{3,4}.

There is a high chance of individuals who might develop knee OA because of aging and obesity (both are increasing in local population day by day). Furthermore, on average 25% people with age over 55 exhibits knee pain, but only one out of six patients consulted medical practitioner. It is also documented that 10% of the patients aged over 55 have disabling knee OA out of which, one quarter is severely disabled⁵.

Normally treatment of osteoarthritis is divided into two categories i.e. Pharmacological and non-pharmacological. There is also a third category i.e. surgical intervention (which would be the last option). Pharmacological approach involves medications which help in alleviation of pain, reduces inflammatory process, whereas surgical intervention is the last option in patients if all other strategies are exhausted⁶.

Physiotherapy is regarded as non-pharmacological approach, which has the most beneficial effects in managing the patients with knee OA. It involves electrical stimulation, cryotherapy and heating modalities, exercise focusing on stretching, strengthening and flexibility, which helps in reducing the torsional forces acting on knee joints^{7, 8}.

Pain is the key trait, which affects the functioning and stability of a patient in performing activities of daily livings (ADLs). Physiotherapy is the most profound technique, which effectively reduces the level of pain. Currently the application of ice to painful area of body is becoming a common practice and studies have proved that it helps in decreasing the pain^{9, 10}.

Early exercises either static or dynamic have the foremost impact in decreasing the healing time, increasing strength of muscles and tendons, increasing collagen combination and adding proteoglycan content in ligaments and periosteal improvements in bone tissue¹¹.

Exercises especially isometric training remains helpful in recovering functional capacity and reduces pain. The patients suffering from knee OA are unable to do day-to-day activities, hence there is a direct association with reduced power of quadriceps femoris muscle^{12, 13}.

Muscular power is enhanced at almost similar ratio by isometric and isotonic exercises regimes together. However, effectiveness, groupings and combinations of exercises and therapies are still unclear¹⁴.

Physiotherapy comprises of variety of interventions to deal with painful process in OA of knee. These interventions includes manual therapy strategies, Cryotherapy, usage of heating modalities, electro-physical agents, TENS, stretching, balancing, reinforcing and functional retraining techniques, knee taping methods, electrical stimulation (incorporates interferential, faradic, galvanic, Transcutaneous Electric Nerve Stimulation) and foot orthosis. These interventions are found helpful in achieving the better level of performance in daily activities.

The aim of this study is to determine the viability of physical therapy methods i.e. Cryotherapy and TENS along with exercises. The findings of this study will help to recognize cost effective approach (particularly in developing countries like Pakistan where the treatment is cost dependent) to reduce knee pain, reduce disability and enhancing personal satisfaction of individual with excruciating knee pain.

The reasons for this study are to investigate : (1) the effectiveness of Cryotherapy and Transcutaneous Electric Nerve Stimulation, most of physical therapist utilize these strategies to reduce painful movement, diminish functional dependence, enhance exercise execution to smooth joint range of motion and early recovery, (2) to identify the uses of Cryotherapy and TENS, and (3) To, figure out which intervention has more impact on sensitivity of people with pain, in the management of knee osteoarthritis.

1.2 Definition of Key Terms

1.2.1.Cryotherapy:

Cryotherapy is the local or general use of low temperatures in Physiotherapy on body part subsequent to an injury to decrease pain and swelling.

1.2.2.Osteoarthritis:

Degeneration of joint cartilage and the underlying bone, most common from middle age onward. It causes pain and stiffness.

1.2.3.TENS(Transcutaneous Electrical NerveStimulation):

Transcutaneous electrical nerve stimulation is the use of electric current produced by a device to stimulate nerves for therapeutic purposes.

2. METHOD

This study was conducted at IPM&R (Institute of Physical Medicine and Rehabilitation) of Dow University of Health Sciences. Quasi experimental study design. Inclusion Criteria are all patients of either gender with age between 40-65 years. Having knee torment (gentle to serious) with mellow to direct radiographic knee changes in knee osteoarthritis. Additionally satisfying The American College of Rheumatology Clinical Classification Criteria for Osteoarthritis of the knee joint [38]. Willing to participate in the study of either group. While the Exclusion Criteria are severe knee Rheumatoid arthritis. Infection or an acute inflammatory disease of knee joint neoplastic disorders. Previous bilateral total knee Arthroplasty. Advance osteoporosis/ fracture. Severe cardiopulmonary disease. Intra-articular knee injection for pain within four weeks of study commencement. Altered skin sensation around knee joint /Skin disease around knee. Patient who cannot comprehend the effects of electrical stimulation. Total duration of study was five weeks. Four days per week patient had to visit the clinic for interventions. The patients were counseled that they are not allowed to take medicine, during this time frame of study.

There are two groups on the basis of different interventions. Group A (cryotherapy) and Group B (TENS). Both group receive there interventions for 20min followed by further 20 min of exercises. Using PASS Repeated Measures ANOVA, a repeated measures design with 1 between factor and 1 within factor has 2 groups with 4 subjects each for a total of 8 subjects. Each subject is measured 2 times. But it is decided to enroll 30 patients per group. To cover dropout patients, increase sample size to reasonable figure²⁸.

The study was approved by the Board of Advance Study and Research of Dow University of Health Sciences. All patients, who fulfilled selection criteria, were registered from Institute of Physical Medicine and Rehabilitation of Dow University of Health Sciences Karachi. Study objectives and background were discussed with patients in details, furthermore

written and informed consent was taken from all patients and they were randomly divided into two groups with age and gender matching. Each group comprised of 30 participants. Interventions were carried to all participants of both groups by the principal investigator. The treatment given to the patient was free of cost. All patients had got a manual with rules on how not to over-burden the knee amid every day exercises and directions, on utilization of ice packs if there would be an occurrence of agony and aggravation of symptoms. Clinical assessment was done with all patients at the initial session and at the last session utilizing Numeric Pain Rating Scale. Results were analyzed and compared with initial assessment for any significant change.

2.1 Statistical Calculation:

Data was analyzed by SPSS 20 version. Descriptive statistics like Mean, Standard Deviation, Maximum and Minimum values were calculated and presented in tables and graphic form. For within group comparison, Wilcoxon sign rank test applied to see the Pre-Post difference. For comparison between groups (TENS and Cryotherapy) maan-whitney test was applied to calculate the difference.

3. RESULTS AND DISCUSSION

Overall 60 patients were selected fulfilling the inclusion criteria from both genders with painful knee osteoarthritis. Out of these sixty patients, 30 individuals were distributed in each group through non probability purposive sampling.

In cryotherapy group there were 56.7% male and 43.3% females, however, in TENS group there were 40% male and 60% female

TABLE 1. Exhibits gender distribution among both groups.

Study Groups	Male	Female
CRYOTHERAPY	56.7%	43.3%
TENS	40%	60%

TABLE 2. Shows Mean & Standard Deviation of patient's age.

Study groups	Mean Age	Standard Deviation
Cryotherapy	55.7	5.25
TENS	54.9	4.52

The tabular presentations of the outcomes of this study are in the table 3, 4, 5 and figure 1, 2, 3, 4 & bar charts. Mean, standard deviation maximum, minimum, are considered to acknowledge descriptive statistics.

For assessing outcomes of this study non parametric test was used. To quantify pre-post differences Mann Whitney test was used. Evaluation of group was done by using wilcoxon sign rank test. Bar chart also produced for better understanding of results.

According to outcome of the study, perception of agony from the pre and post session was analyzed through Mann Whitney test. There was a noticeable difference in the perception of agony from the first and final session of the study. The difference in mean and standard deviation between pre intervention and post intervention was found statistically significant at $p < 0.001$. It is therefore proven evident that there is noteworthy variation in the intensities of pain before and after sessions and both interventions (cryotherapy and TENS) can battle with painful progression and both are reliable in decreasing levels of pain (Mean pain score drops to 2.53 from 6.20). These outcomes are not helpful in quantifying, which intervention group has better results produced in diminishing perception of agony among patients. (Table 3)

TABLE 3.

GROUP	Mean $\pm$ SD	Mini-Max.	p- Value
PRE	6.20 $\pm$ 0.776	4-8	0.898
POST	2.53 $\pm$ 0.947	1-4	<0.001

The outcomes which are tabulated in the table 4 in the form of mean, standard deviation, maximum and minimum are the analyzed values which were listed by number of patients and severity of pain by using numeric pain rating scale. Wilcoxon sign rank test has been used to compare both groups and to

predict which intervention has foremost effect in alleviating the pain progression.

Description regarding the patient's response on first and on last treatment session of Group A (cryotherapy), the mean pain score was 6.233 on first session, 2.00 on last sessions which is a significant change. P-value also shows noteworthy change among the pre and post values in patients of group A (Table 4). Similarly, to determine the usefulness of TENS therapy, the patients responses of group B were assessed through mean scores of first and last session which also shows a positive indent in decreasing the pain. Mean pain score on first day was 6.166 which dropped to 3.06 on last day. The difference was found statistically significant at $P < 0.001$. These findings predict that TENS is also helpful in alleviating the painful process. (Table 4)

TABLE 4.

Intervention	Pre		Post		P- Value
	Mean $\pm$ SD	Mini-Max.	Mean $\pm$ SD	Mini-Max.	
Cryotherapy	6.23 $\pm$ 0.77	5-8	2.00 $\pm$ 0.78	1-4	<0.001
TENS	6.16 $\pm$ 0.79	4-7	3.06 $\pm$ 0.78	1-4	<0.001

Comparing the results of table 4 in order to determine, which intervention has produced better results among patients. On taken post mean values of both groups (Group A is 2.00 and group B is 3.06), it confirms that group A has shown better performance as compared to group B in diminishing knee pain. Therefore, it is proven that cryotherapy possesses much better result in comparison with TENS.

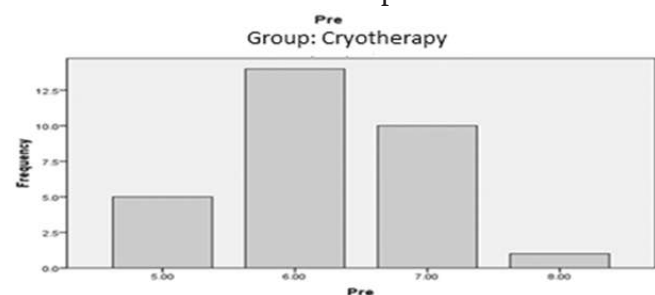


Fig. 1. Pre Value of Cryotherapy intervention

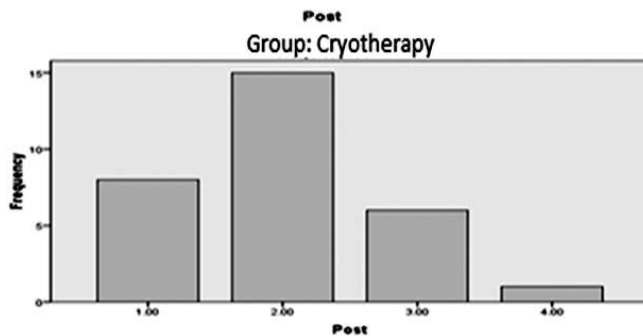


Fig. 2. Post Value of Cryotherapy intervention

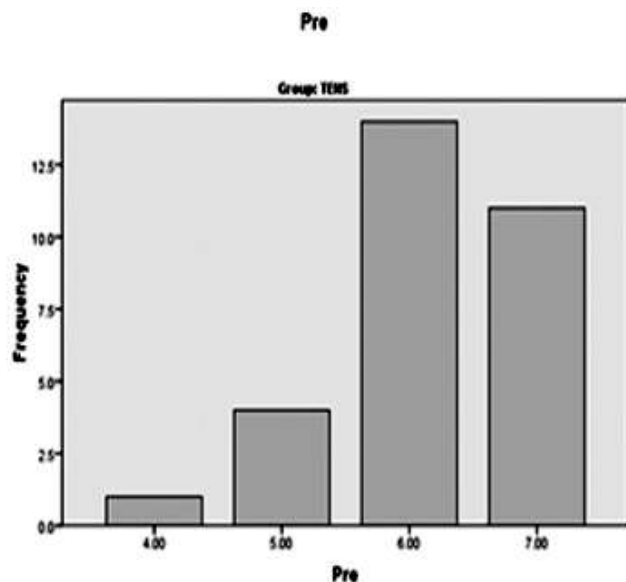


Fig. 3. Pre values of TENS intervention

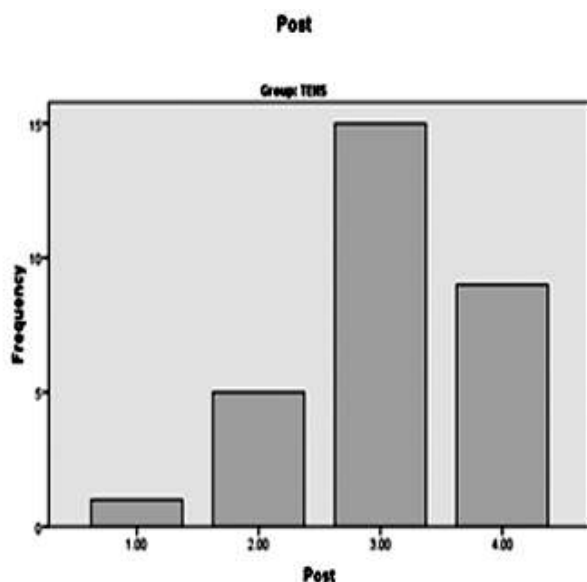


Fig. 4. Post values of TENS intervention

3.1 ILLUSTRATION

The bar graphs showing in figures 1, 2, 3 and 4 are pre and post values for both interventions separately. The bar graph describes the different responses of pain among the patient on numeric pain rating scale on their first and last session of the treatment.

The responses of pain demonstrated through table 4, figure 1 and 3 gives clear picture that on initial assessment, most of patient showed their pain level at mean 6 whereas few complained severe on 7 and some complained more severe on 8 on mean of pain rating scale. There are only few patients who showed their response to moderate level which is at 4 and 5.

The detail of mean patient responses of pain demonstrated in table 4, figure 2 and 4 about treatment efficacy of cryotherapy and TENS on last treatment session. It is quite clear from the above bar chart that cryotherapy post results are better than TENS because more patient response were at 2 on numeric pain rating scale while in other group most of patient response were at 3 on numeric pain rating scale. On the basis of bar chart, we can say that intervention of cryotherapy is more effective as compared with the usage of TENS.

Osteoarthritis of knee is a fairly common condition in local population and it can consequently be claimed that it also poses a considerable economic burden to the country. Apart from the usual and well established risk factors such as age, obesity, female gender and genetic predisposition³⁹, certain other factors are also culpable for the progression of this degenerative condition. These factors include excessive squatting^{39, 40} which the society has inherited as a custom. Many activities of the daily living in this region involve squatting such as excessive floor sitting, floor sweeping and mopping, and usage of squatting pan. In addition obesity which is reportedly present in a quarter of Pakistani population⁴¹, is also serving to further augment the stresses to which diseased knees are already subjected^{40, 42}. It is the amalgamation of all these factors that are resulting in the increased prevalence of knee osteoarthritis in Pakistan⁴⁰. Being a

degenerative condition the treatment of knee osteoarthritis is often directed towards prevention and amelioration of symptom⁴³. Since pain and stiffness are among the foremost symptoms associated with Knee osteoarthritis⁴⁴, treatment options which address these symptoms are consequently given importance. This study had been conceived in order to evaluate the effectiveness of two of these options i.e. Cryotherapy and Transcutaneous Electrical Nerve Stimulation (TENS).

The results of this study have shown that both the cryotherapy and TENS have significantly reduced the self-reported intensity of pain. One important aspect that merits attention is that the intensity of pain was assessed by Numeric Pain Rating Scale (NPRS), which is a subjective measure of intensity of pain. Bearing a fickle nature, pain perception is a subjective experience and hence has a tendency to be over documented and under documented owing to the variation in traumatizing tendency among different individuals⁴⁵. The resultant decrease in the pain intensity is an insightful evidence that these two treatment modalities have in effect hampered pain transmission before it could set into motion the vicious cycle of pain perception. The underlying cause of this decrease is by and large the gate control mechanism that is located at the spinal cord level^{46, 47}. Gating of pain pathways is usually considered as a first line of defense against pain and is largely responsible for the consequent decrease in pain intensity as reported by the individual.

The possible reason behind the greater decrease in mean pain scores in the cryotherapy group is perhaps the two fold effect icing has to offer in decreasing inflammation. First and foremost is the inherent quality of ice (or cold packs in this case) to reduce swelling through alternate phases of vasoconstriction and vasodilatation, also known as ‘‘Hunting response’’^{48, 49}. The consequent effect is that various pain inducing chemicals are driven back into the blood stream from the interstitial fluid which reduces pain intensity in return. Second effect icing has, involves the reduction in Nerve Conduction Velocity (NCV) itself which in turn causes increased Pain

threshold and Pain tolerance⁵⁰. In addition to that, location of the tracts responsible for the transmission of temperature and pain, can also be responsible for the consequent decrease in pain as both these tracts lie in proximity to each other in lateral spinothalamic tracts⁵¹. This adjacency of tracts makes the pain transmission pathways more susceptible to get inhibited with fluctuations in temperature probably through lateral inhibition. On the other hand high frequency TENS reduced pain through peripheral and central pain modulation only rather than having much effect on inflammation as well, which later became evident as relatively lesser difference in the pain intensity as compared to before the administration of treatment⁵². It clearly shows that more than just endogenous pain control mechanisms are required to manage pain effectively.

Even though the mechanisms of actions of these modalities have previously been established, this study has provided with empirical evidence to implicitly corroborate these phenomena through improvement that is evinced. And therefore the null hypothesis is rejected that both the treatment modalities are equally effective in reducing pain, and accept the alternate hypothesis that cryotherapy is significantly better in reducing pain intensity than TENS. However equally important is the fact that the improvement that was observed was the fruit of 20 treatment sessions which were delivered over a period of 5 weeks with 20 minutes for each session. Although conventionally confined to the treatment of acute soft tissue injuries, this study has established that it has its clinical benefits in treating chronic condition as well such as Osteoarthritis. Other studies have been conducted in the past affirming this claim that cryotherapy in effect is not only beneficial in reducing pain associated with arthritic knees, but also swelling around the joint^{43, 53}. In their study Fredrikus G. J Oosterveld and Johannes J. Rasker have concluded that cryotherapy causes significant reduction in the intraarticular temperature, suggesting one possible pathway for the amelioration of Knee OA symptoms⁵⁴.

Although Knee OA is not restricted to one gender,

obese and post-menopausal women are particularly susceptible to acquiring this degenerative condition of the knee. After manipulation of the gathered data it became apparent that there was some disparity of post mean pain scores of both the groups between the two genders. Prior to the administration of treatment most women had a pain intensity of 7 whereas that score among males lay over 6 on NPRS. After the treatment most of the males reported their pain to be 3 whereas most females ranked their pain to be 4 on NPRS, reflecting that women were more sensitive towards perceiving pain even after the treatment. Similar results were also noticed by Michael E Robinson and colleagues in their study. They concluded that women were more susceptible to lesser pain tolerance than men⁵⁵.

The frequency distribution curves of the groups also shed light into important insights into the subtle details of results of this study. The Pre-treatment scores of majority of the participants were concentrated over the score of 6 on NPRS (6.233 ± 0.773), while the range for the cryotherapy group being 5-8. However, after 20 sessions, with 20 minutes of ice pack application each, majority of the participants reported their pain to be 2 on NPRS (2.00 ± 0.787) with a range of 1-4. On close inspection one may notice that the bar charts shown for the Cryotherapy group were somewhat positively skewed and the shape of the data itself remained unchanged for both the Pre and Post-Treatment scores. By the looks of the chart it can be hypothesized that the same people who rated their pain as 8 on NPRS evinced 4 after the treatment.

On the other hand a glance at the pre and post treatment bar charts for TENS group tell a similar story in which the data tended to be negatively skewed. As for as the cryotherapy group same can be inferred for the TENS group that the after 20 sessions of TENS application for 20 minutes majority of the participants rated their pain to have decreased from 6 (6.166 ± 0.791) to 3 on NPRS (3.06 ± 0.784). As in cryotherapy group similar frequencies suggest that the subjects who had a pain of rating 4 went down to 1 after the treatment was administered. In

either of the groups the shape of the data remained similar even after 20 sessions of treatment. This has got important implications as it shows that the pain scores reduced proportionally in both the groups and it can be safely deduced that the participants of the Cryotherapy Group in general experienced a recovery equivalent to 4 units on NPRS whereas for TENS group that figure remained 3 for each participant. To the authors knowledge no such study has been conducted in the past and it would be fair to regard these findings as novel. Since ancient times inflammation has been considered as a combination of five cardinal signs including Calor, Rubor, Tumor, Dolor, Functio Laesa, which are somewhat also present in knee OA. It is not very surprising to witness better results for cryotherapy for Knee Osteoarthritis as cryotherapy serves to lessen inflammation through specifically improving some of these inflammatory signs

4. CONCLUSION

Both the administered treatments i.e. Cryotherapy with therapeutic exercises (stretching and strengthening) and TENS with therapeutic exercises, significantly reduced pain intensity in patients with Knee Osteoarthritis. However, the group receiving Cryotherapy showed significantly better improvements in that regard than its counterpart receiving TENS.

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CONFLICT OF INTEREST

THE authors declare no conflict of interest

ETHICAL APPROVAL

A prior consent was taken in writing from the all patients

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