International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Conventional Transcutaneous Electrical Nerve Stimulation versus Cryotherapy for Pain Relief in Patients with Total Knee Replacement Surgery: A Comparative Study

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Abstract: ***Osteoarthritis is a condition in population above 60 years.Total knee replacement surgery is performed for severe Osteoarthritis. Rehabilitation plays an important role post surgery. The aim of the study is to find the effectiveness of Cryotherapy versus Conventional Transcutaneous Electrical Nerve Stimulation(TENS) for pain relief in patients with total knee replacement surgery. A study with total 30 patients were allotted groups by chit method into Group A, B and C which were given Cryotherapy, TENS or TENS and Cryotherapy for 20 minutes for 5 days. Pain was noted on NUMERICAL PAIN RATING SCALE pre treatment, day 3 and day 5.Data was analysed after 5 days post which results was drawn, there is maximum reduction in pain in group given TENS and Cryotherapy with P value less than 0.05. This concludes that combination of TENS and Cryotherapy is better than Cryotherapy or TENS alone.***

Keywords: Osteoarthritis, Total Knee Replacement, Pain, Numerical Pain Rating Scale

1. Introduction

Osteoarthritis is one of the most prevalent conditions resulting to disability particularly in elderly population. It can be due to many causes such as rotator deformity, trauma or rheumatoid arthritis. 80% of patients develop medial compartment Osteoarthritis and eventually bow legs deformity.[1]

Risk factors for Osteoarthritis are Obesity, age, previous trauma, previous knee surgery. Controversial risk factors are physical activity, genetics, smoking and estrogen deficiency. Two factors of kneeling, squatting are considered the main primary risk factors in correlation with knee disorders.[2]

The findings indicating the presence of knee Osteoarthritis are symptoms like pain with activity and stiffness. Signs are joint line tenderness, effusion, crepitation, decreased range of motion, angular deformity. The radiographic changes commonly seen in patients with Osteoarthritis are subchondral sclerosis, loose bodies, joint narrowing and irregularity, subchondral cysts.[3]

Non operative Management includes Hyaluronic acid injections in the knee appear to work best before there is bone on bone crepitus. Studies by researchers have found that these injections are of equal benefits to non steroidal anti-inflammatory drugs. Also medial compartment osteoarthritis, patients had more reduction in pain score with the use of lateral wedged insole in their shoes.[4]

Weight loss should be encouraged. Physiotherapy management includes strengthening on quadriceps, active range of motion exercises.

The surgical management of Osteoarthritis consists different procedures like Osteotomy, arthroscopy and debridement and Total knee Replacement. Knee osteotomy is used when you have early-stage Osteoarthritis that has damaged just one side of the knee joint. Arthroscopy is performed debride bone and cartilage fragments that cause pain and inflammation. Another surgery indicated for moderate to severe Osteoarthritis is Total Knee Replacement. The primary indication for Total knee arthroplasty (TKR is also referred to as total knee replacement) is relief of significant, disabling pain caused by severe arthritis. [15]

In a knee implant, the femoral component, the tibial component, the patellar button is a dome-shaped piece of ultrahigh molecular weight polyethylene that replicates the surface of the kneecap.[15]

Out of the various rehabilitation techniques used for patients after total knee surgery, cryotherapy and Transcutaneous electrical nerve stimulation form an important part of the entire rehabilitation to relieve the pain and improve the knee joint function.

Cryotherapy is used to reduce pain and inflammation post surgery. It is general or localized application of cooling agent used for reduction in pain by lowering the local tissue temperature provokes a arrange of motion of thermoregulatory responses. Decreased muscle spasm, Decreased inflammatory effects, Decreased pain, Decreased metabolism, Decreased nerve conduction velocity are the physiologic effects of cryotherapy. Ice is used in acute trauma and sub-acute injury. It is also used to reduce post operative pain and to reduce inflammation.[6]

Ice pack is held into place by dry toweling or plastic sheet wrapped around the pack and the part. Skin cooling is rapid

at first but after a minute or so the layer of water in contact with skin warms up a little and the pack is tolerable for longer while.[6]

Transcutaneous electrical nerve stimulation (TENS) is a non-invasive analgesic technique which is used to relieve nociceptive, neuropathic, and musculoskeletal pain.[9]

Selective activation of large diameter non-noxious afferents to elicit segmental analgesia. Conventional Transcutaneous electrical nerve stimulation is high-frequency Transcutaneous electrical nerve stimulation at site of pain to produce strong but comfortable Transcutaneous electrical nerve stimulation paraesthesiae. Frequency is about 80-120 Hz and pulse duration is short about 50 microseconds. Amplitude is strong tingling sensation which is caused below motor threshold this combination of parameters stimulates the Group II (Aß) afferent nerve fibres. [9]

2. Procedure

An Experimental study with 30 Patients was conducted in Dr D.Y Patil Hospital IPD, Hardikar Hospital for an intervention period of 5 Days (From Post operative Day 1 to Day 5).The Outcome Measure used was Numerical Pain Rating Scale.

Inclusion criteria include Patients operated for Unilateral or Bilateral TKR above 60 years of age. Patients operated for TKR with pain and restricted range of motion. Patients till post operative day 5 of knee replacement surgery. Patients on regular pain medication post surgery and following the conventional set of exercises simultaneously.

Exclusion criteria includes Patients with altered sensations. Patient with any neurological deficit. Patients with any complications following surgery. Patients with Rheumatoid Arthritis.

In the Procedure, Study and study design was approved by ethical committee. Subjects were selected according to inclusion and exclusion criteria. Patients written consent was taken and patient documentation was done. Patients with Total knee replacement surgery were divided by Randomized sampling by chit method. In Group A, 10 patients were evaluated and assessed for pain prior to treatment on day 1 on Numerical pain rating scale. The patients were given Cryotherapy using a Cryotherapy pack for 20 minutes on the site of pain for 5 days. In Group B 10 patients were evaluated and assessed for pain prior to treatment on day 1. Patients were given Conventional TENS for 25 minutes using 4 electrodes on the site of pain around the suture site for 5 days. Similar procedure was followed as Group A and Group B. In Group C 10 patients were evaluated and assessed for pain prior to treatment on day 1. The patients were given combination treatment which consisted of TENS followed by Cryotherapy 20 minutes each for 5 days. Similar procedure was followed as Group A and Group B

The patients were following the conventional set of exercises simultaneously following which they were evaluated again on Day 3 and Day 5. The Conventional Exercise Protocol was Day 1-4 Ankle pumps with leg in elevation, Passive knee extension. Straight leg raise, Quadriceps set. Knee extension exercises from 90 to 30 degrees, Gentle knee flexion exercises. Day 4 onwards Knee range of motion till 90 degrees, Ankle pumps with leg in elevation, Passive knee extension, Straight leg raise, Hip abduction and adduction, Quadriceps set, Knee extension exercises from 90 to o degrees, Gentle knee flexion exercises[14]. Similar procedure was followed as above. Data was collected and analyzed and documented. Intervention of 5 days was given post which conclusion was drawn.

3. Data Analysis

Table 1: Mean Age of sample size.

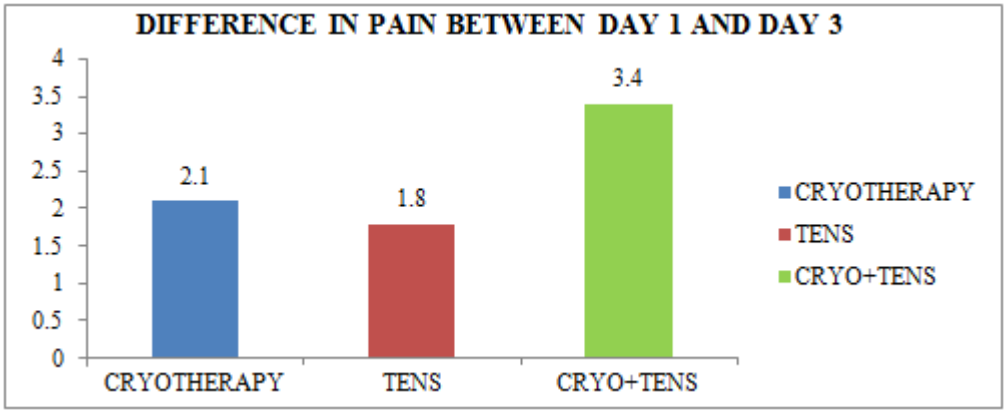
Total Patients	30
Mean Age	70.233
Std. Deviation	5.8291

Table 2: Number of males and females in each group

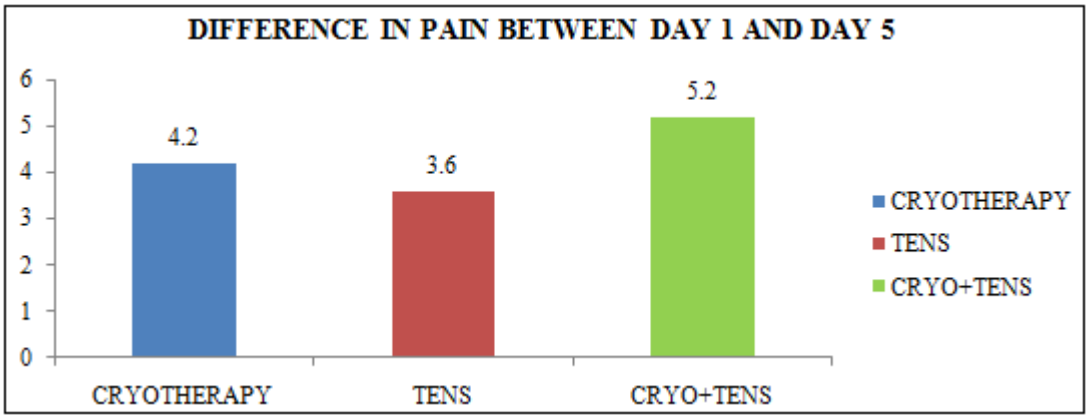
Gender	A	B	C
	Number	Number	Number
Male	5	5	6
Female	5	5	4
Total	10	10	10

Table 3: Mean values of pain parameter

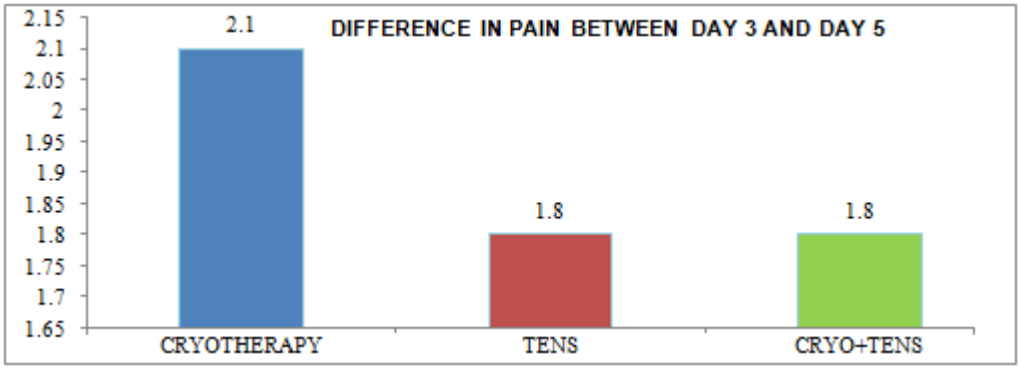
Pain	Group	Mean
Pre Treatment Pain	A	8.600
	B	8.400
	C	8.700
Pain Difference on Day 1 and Day 3	A	6.500
	B	6.600
	C	5.300
Pain Difference on Day 1 and Day 5	A	4.400
	B	4.800
	C	3.500
Pain Difference on Day 3 and Day 5	A	2.110
	B	1.854
	C	1.849



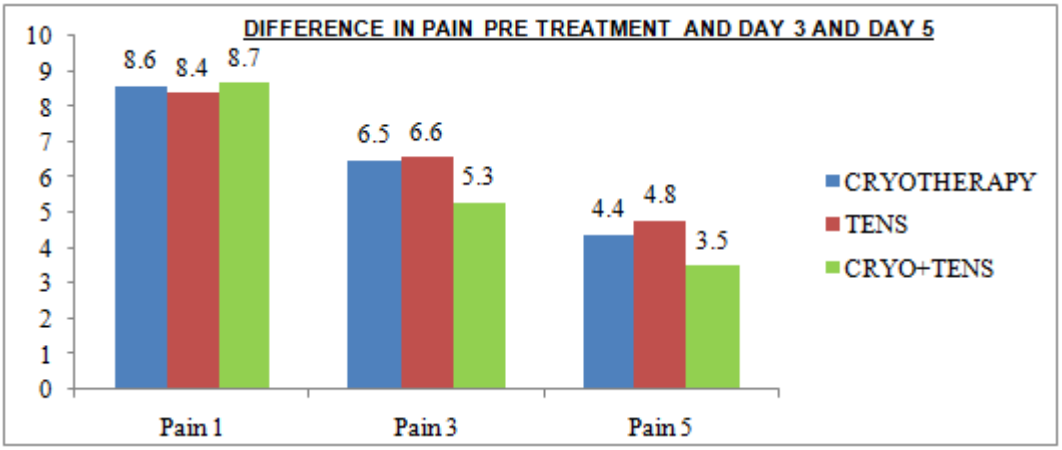
Graph 1: This graph demonstrates the difference between the Pain parameters between Day 1 and Day 3 on the basis of mean values derived from the statistical tests.



Graph 2: This Graph demonstrates the difference between the Pain parameters between Day 1 and Day 5 on the basis of mean values derived from the statistical test.



Graph 3: This Graph demonstrates the difference in pain between day 3 and day 5 on the basis of mean values derived from the statistical test



Graph 4: This graph demonstrates the Comparisons in pain parameters between Pre treatment, Day 3 and Day 5.

4. Results

Results were obtained from the Data for each subject Pre treatment and Day 3 and Day 5 during treatment protocol. Data was collected for each subject by documenting the Numerical Pain Rating Scale of all the 30 subjects and then the statistics were conducted.

Multivariate Tests by Repeated Anova for Pain Parameter

Effect		Value	F	Hypothesis df	Error df	Sig.
Time Factor	Pillai's Trace	0.948	238.009	2	26	0
factor1 * Group	Pillai's Trace	0.526	4.82	4	54	0.002

The Pillai's Trace test shows that the factor one that is time factor has P Value less than 0.05 which means there is a reduction in pain over the time. The Within the Group Factor has P Value of 0.002 which is less than 0.05 which shows the significance within the group is also present for the pain component.

Results for comparison between Pain Parameter in Graph 4 shows that Comparisons in pain parameters between Pre treatment, Day 3 and Day 5.The graph concludes that all 3 groups are comparable at baseline. Mean and standard deviation of all three groups are relatively close to reach other.

There is no stastically significant difference which indicates that randomization is proper and groups are comparable. The graph also shows reduction in all 3 groups but significant reduction is seen in the Group C given Transcutaneous electrical nerve stimulation and Cryotherapy

5. Discussion

In this study, it can be discussed that Osteoarthritis is a common disabling condition more prevalent in elderly population with a mean age of 70 years. Total knee replacement is a commonly performed surgery for severe disabling arthritis. A proper rehabilitation protocol includes Cryotherapy, neuromuscular electrical stimulation, Transcutaneous electrical nerve stimulation and muscle strengthening exercises from day 1 post operative.

This study shows that Group A which was given Cryotherapy is statically significant. Standard 20 minute application of cryotherapy may have reduced the degree of secondary cell injury, thereby minimising the magnitude of the inflammatory response. This may also be associated with reduced swelling, nerve damage, muscle spasm, and cell mediators, all of which may influence subjective pain after injury. In addition, by providing optimal cooling, intermittent ice applications provide sufficient analgesia which may have allowed earlier mobilization of the knee joint. There is much evidence that controlled mobilisation aids soft tissue healing and is associated with enhanced collagen fibre growth and realignment and less soft tissue fibrosis, and therefore decreased pain which is why there is exercise rehabilitation also plays an important role in the immediate post operative period. Few recommendations state that 10 minutes of cryotherapy can induce sufficient analgesia to allow therapeutic exercise, and much of the scientific evidence suggests that superficial tissues reach their peak temperature reduction after about 10 minutes of cooling.[6]

The study shows a statistical significance in Group B given Transcutaneous electrical nerve stimulation Treatment for 20 minutes. The first pain modulatory mechanism called the "Gate Control" theory was proposed by Melzack and Wall in the mid 1960s.The theory suggests that collaterals of the large sensory fibers carrying cutaneous sensory input activate inhibitory interneurons, which modulate pain transmission information carried by the pain fibers. Non-noxious input suppresses pain, or sensory input closes the gate to noxious input. The gate theory predicts that at the spinal cord level, non-noxious stimulation will produce presynaptic inhibition on dorsal root nociceptorfibers that synapse on nociceptors spinal neurons, and this presynaptic inhibition will block incoming noxious information from reaching the CNS.[13]

The pain Gate effect on both A-Delta fast fibres and C slow fibers in the posterior horn is due to stimulation of mechanoreceptors (A-Beta) fibers. This is best achieved by applying high frequency, low in Transcutaneous Electrical Nerve Stimulationity electric pulses. The input of mechanoreceptors reduces the excitability of the nociceptor responsive cells to pain-generated stimuli thus producing segmental inhibition. This means that using electrical pulses to stimulate the A-Beta fibres mechanoreceptors can reduce pain perceptions. These are the larger diameter myelinated nerves which are stimulated at lower current in Transcutaneous Electrical Nerve Stimulation than A-Delta or C fibres. [13]

The combined increased effect achieved in group C which is Cryotherapy and Transcutaneous Electrical Nerve Stimulation owes vasomotor effects with decrease in oedema which is due to ongoing inflammatory process and lack of muscle contractions. Cryotherapy promotes alternate phases of vasoconstriction and dilatation (Lewis Hunting Reaction) which affects the capillary blood flow and allows metabolic exchange to take place. The increases circulation allows more nutrients and repair substances into the damaged areas thus aiding repair. The probable mechanism through which cryotherapy works is stimulation of cold receptors which send back impulses which have to pass into the spinal cord via the posterior root. These impulses which arrive through a relatively large diameter nerves effectively block out other pain impulses that is the pain gate is closed and this reduces the pain temporarily. Also Conventional Transcutaneous Electrical Nerve Stimulation optimally stimulates A-Beta fibres results in preferential recruitment of largest diameter nerve fibres will block afferent activity in large diameter fibres that may be contributing to pain. Therefore we can maximum reduction in pain in the Group of Cryotherapy and Transcutaneous Electrical Nerve Stimulation.[6, 7, 9, 10]

Exercises protocol was followed during all 5 days. The mechanisms underlying arthrogenic quadriceps muscle

inhibition which is commonly seen post knee surgeries are thought to be altered afferent signaling from the operated knee joint due to swelling, inflammation, and damage to joint afferents, which affects the CNS by changing the excitability of multiple spinal and supraspinal pathways.[14]

6. Conclusion

It is concluded that the treatment with Cryotherapy and TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION continuously for 5 days can provide better pain relief as compared to only Cryotherapy or TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION alone though all three groups are statistically significant, there is higher improvement in Combination of Cryotherapy and TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION group.

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