Effectiveness of Muscle Energy Technique and Proprioceptive Neuromuscular Facilitation in Knee Osteoarthritis

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Abstract: This study was undertaken to determine the effectiveness of techniques such as muscle energy technique and proprioceptive neuromuscular facilitation in reduction of pain levels, improvement in flexibility of hamstring muscle and functional mobility, in patients with osteoarthritis of knee. An experimental study was carried out using a pre test and post test study design. The study was carried out in Krishna Hospital, Karad with a sample size of 36 individuals suffering from osteoarthritis of knee using a random sampling method. Individuals with Osteoarthritis of knee within the age group 40-60 years have been included. The collected data was analysed using paired and unpaired ‘t’ tests. When the data was analysed, the results showed that the patients in Group A and B receiving PNF stretching and MET respectively, the pain levels measured using NPRS shows more improvement in group A(7.66 ±1.02) as compared to group B(3.44 ±0.92). Hamstring flexibility in group A (10.63 ±4.89) was also found to be higher than in group B (4.37±2.01) when Active knee extension test was performed as a measure for hamstring flexibility, when functional mobility was measured using Western Ontario and McMaster universities arthritis index, improvement seen in group A (27.21 ±12.31) was significantly higher than in group B (14.11±7.88). The primary finding was that the patients of group A receiving PNF stretching along with the baseline protocol showed better improvement in pain levels, hamstring flexibility and level of functional mobility as compared to the patients in group B receiving MET along with baseline protocol.

Keywords: Osteoarthritis, Proprioceptive neuromuscular facilitation, Muscle energy technique, Pain, Hamstring flexibility, Functional mobility.

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I. INTRODUCTION

Osteoarthritis (OA) is a chronic disorder which is degenerative in nature having a multifactorial etiology characterized by subchondral sclerosis, loss of the articular cartilage, hypertrophy of the marginal bone along with morphological and biochemical changes in the joint capsules and synovium. The prevalence of OA knee in India is 28.7%. There are possibilities for a rise in the prevalence of Osteoarthritis due to an improvement in the expectancy of human life, it is a condition that causes severe pain and disability adversely affecting the quality of life of the individuals suffering. Among the age group of 40 years and above, Osteoarthritis is considered as a major factor for impairment in mobility. Studies and evaluation conducted worldwide indicates that 18% of women and 9.6% of men which are above the age of 60 years suffer from symptomatic OA. Knee Osteoarthritis has been commonly observed to be occurring after 40 years of age with a gradual development over a period of time. There are several reasons for the high rates of prevalence of OA in India in which the genetic factor is one of the major causes, while the other factors involve sedentary lifestyle, squatting habits, and dietary conditions. Diagnosis of OA knee is made by radiological investigations and clinical examinations which include findings of palpation, special function tests and joint range of motion. The impairments in muscles associated with this condition may be the primary cause of the functional impairment. Muscle dysfunction has been observed as an important factor preceding and accelerating the deterioration of the joint cartilage. Studies show that muscle dysfunction is related to the pathogenesis of OA knee. Individuals suffering from Osteoarthritis have heterogeneous manifestations, and it has variations in terms of appearance in different patients. Thus, it may appear differently in men and women, in obese patients, in athletes and in patients with or without trauma, this supports the fact that for patients with different profiles different treatments may be required. There is a wide range of treatment methods available for OA knee but there remains still scope for interventions which help in improving the symptoms with very less side effects. The treatment for OA knee involves a variety of pharmacological and non-pharmacological approaches. Currently not many disease modifying approaches are present, and the pharmacological interventions are directed towards alleviating symptoms to prevent loss of function and inactivity. The pharmacological treatment options involve Non-steroidal anti-inflammatory drugs (NSAIDS), Acetaminophen, Opioids, Intra articular injections, Chondroitin sulfate, Glucosamine sulfate whereas the non-pharmacological approach involves Massage therapy, Hydrotherapy, Thermotherapy, Manual therapy, Electrotherapy, other physiotherapeutic modalities and Surgery. Pharmacological approaches have been majorly used for the management of Osteoarthritis knee. Pharmacological interventions have been observed to improve the condition but they have to be taken for a long period of time and also have significant side effects. Physiotherapeutic approaches have been found to have positive effects in reducing disability and pain in individuals with OA knee, apart from the above mentioned modalities, proper use of canes, tapping of knee, orthotics, balance training and isometric exercises to prevent muscle atrophy are used. Physiotherapeutic techniques such as Proprioceptive Neuromuscular Facilitation (PNF) and Muscle Energy Technique (MET) have also been used for the management of OA knee. Intervention like PNF stretching is proven to be safe and effective in improving the symptoms of OA knee with minimal side effects by the patients. The term stretching is generally used to describe any therapeutic technique to elongate the structures which are shortened pathologically and thus effective in improving the range of motion. PNF stretching (hold-relax) technique involves a short isometric contraction of the agonistic muscles which are targeted to be stretched and is useful in improving the range of motion. Intervention like MET is observed to lengthen the shortened muscles, for strengthening weakened muscles, for mobilization of restricted joint range of motion and to reduce localized edema. It is an active technique in which the patient utilizes his muscles voluntarily from a specifically controlled position in a particular direction against a precisely executed counterforce. Post isometric relaxation and reciprocal inhibition are the principles used. Electrotherapeutic modality such as Interferential Therapy is used for the treatment of deeper tissues as the skin resistance is overcome by a lower pulse amplitude. It has physiological effects on the tissues such as relief of pain, absorption of exudates and motor stimulation. Since there is paucity in literature available which examines the effect of both the techniques over each, this study is being carried out to determine the effectiveness of PNF as compared to MET in management of pain, hamstring flexibility and functional mobility in OA knee.

2. MATERIALS AND METHODS

An experimental study was conducted in the department of physiotherapy Krishna institute of medical sciences, Karad. All procedures performed in this study involving human participants were in accordance with the ethical standards of the Institutional ethics committee of Krishna institute of medical sciences (Ethics committee Registration No. ECR/307/Inst/MH/2013/RR-16) on 4th October 2019. About 36 patients were selected based on the inclusion criteria (1) Radiologically and clinically diagnosed cases of Osteoarthritis knee by certified Orthopaedic surgeon or Physiotherapist. (2) Between the age group of 40-60 years including both men and women. (3) Patients with Grade 2 or 3. Osteoarthritis knee using Kellgren - lawrence classification, and exclusion criteria (1) Other knee joint pathologies eg. Chondromalacia patella, plica syndrome, (2) Neurological disorders, (3) Post traumatic knee patients, (4) Post surgical patients. A written informed consent has been taken from all the participants. The study has been approved by the Ethics committee of Krishna institute of medical sciences. The participants have been divided into 2 groups, Group A (18 participants) received PNF stretching and Group B (18 participants) received MET, baseline treatment given to both groups included HMP and IFT.

2.1 (a) Group A – Treatment protocol will consist of the following:

- Hot moist pack

The patient will be made to lay in a supine position with the affected knee in slight flexion. A hot moist pack will be applied around the knee for 15 minutes.
Muscle energy technique: combination of Post-isometric relaxation (2 sets of 5 repetitions) and Reciprocal inhibition (2 sets of 5 repetitions)
- Post-isometric relaxation
  The subject will be placed in a prone lying position while the hip is flexed to 90°. The subject will be asked to flex their knee further using 20% of their strength. The contraction will be maintained for 5 seconds while resistance is applied to the agonist muscle. 2 sets with 5 repetitions will be performed with a 5 seconds relaxation phase in between each repetition31.
- Reciprocal Inhibition
  The subject will be placed in a prone lying position while the hip being flexed to 90°. The subject will be asked to flex their knee further using 20% of their strength. The contraction will be maintained for 5 seconds while resistance is applied to the antagonist muscle. 2 sets with 5 repetitions will be performed with a 5 seconds relaxation phase in between each repetition31.
- Interferential therapy
  Interferential therapy will be applied using the four pole vector method for 20 minutes.

2.1 (b) Group B – Treatment protocol will consist of the following:
- Hot moist pack
  The patient will be made to lay in a supine position with the affected knee slightly flexed. A hot moist pack will be applied around the knee for 15 minutes.
- Proprioceptive neuromuscular facilitation technique: PNF stretching Hold Relax (2 sets of 5 repetitions)
  The subject will be positioned in supine lying with 90° hip flexion. Therapist extends the patient's knee until a mild stretch is felt in the hamstrings. An isometric contraction is achieved by asking the subject to flex his knee against resistance by the therapist. Contraction is held for 8 seconds after which the therapist commands to relax the hamstrings, immediately after which the muscle is extended until a mild to moderate painless stretch is felt which is held for 30 seconds. The procedure is performed in 2 sets with 5 repetitions and 10 seconds relaxation phase in between35.
- Interferential therapy: Interferential therapy will be applied using the four pole vector method for 20 minutes.

2.2 ETHICAL CLEARANCE
Approval for the study was obtained from the protocol committee and institutional ethical committee of Krishna Institute of Medical Science ‘Deemed to be University’ (Ethics committee Registration No. ECR/307/Inst/MH/2013/RR-16)

2.3 OUTCOME MEASURES

2.3.1 Numerical Pain Rating Scale
This scale was found to be one of the most reliable outcome measurements for pain. A straight line indicating 0 at the start and 10 at the end of the line was drawn on the evaluation sheet, the patients were asked to mark on the line based on their perception of pain with ‘0’ indicating no pain and ‘10’ indicating severe pain55.

2.3.2 Active Knee Extension Test
This test was used to determine the tightness of hamstring muscles. The patient was made to lie supine with hip and knee flexed to 90° and stabilizing the hip joint by grasping the thigh. With fulcrum of the goniometer placed on the lateral femoral condyle with proximal arm parallel to femur and distal arm parallel to the lower leg the patient is asked to extend his knee with hip held in 90°55.

2.3.3 WOMAC
The Western Ontario and McMaster Universities Arthritis Index is used to assess patients with OA knee56. This scale includes the measurements of the levels of functional mobility and pain levels of the participants based on their subjective ratings out from 0-4.

3. STATISTICAL ANALYSIS
A total of 36 subjects were selected on the basis of the inclusion and exclusion criteria and were randomly divided into two groups Group A (PNF) Group B (MET); the outcome measures used were the NPRS, AKET, WOMAC. PNF stretching was given to group and MET was applied to group B along with baseline protocol to both groups respectively. The data was analysed using parametric tests such as paired’ t’ test (before and after treatment) and independent ‘t’ test (comparisons between group) using the GraphPad instat version 3.1.

4. RESULTS AND DISCUSSION

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group A (PNF)</th>
<th>Group B (MET)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td></td>
<td>54.05</td>
<td>3.63</td>
</tr>
<tr>
<td>Gender</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td></td>
<td>76.66%</td>
<td>23.33%</td>
</tr>
</tbody>
</table>

The mean age and percentage of gender of the participants has been described in the above table number 1.

<table>
<thead>
<tr>
<th>Statistical measures (NPRS)b</th>
<th>Group A (Pnf)</th>
<th>Group B (Met)</th>
<th>Pre Post Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Test</td>
<td>Post-Test</td>
<td>Pre-Test</td>
</tr>
<tr>
<td>Mean</td>
<td>7.66</td>
<td>2.88</td>
<td>8.16</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>1.02</td>
<td>0.32</td>
<td>1.64</td>
</tr>
<tr>
<td>Minimum</td>
<td>6.00</td>
<td>2.00</td>
<td>6.00</td>
</tr>
</tbody>
</table>

The mean pre and post treatment statistics
The above table number 2 represents that in Group A the mean pre-treatment NPRS was 7.66 ±1.02 with a reduction in the post–treatment NPRS as 13.16 ±1.54 . The value was found to be <0.0001 by paired ‘t’ test which is extremely significant. In Group B the mean pre-treatment NPRS was 27.16 ±9.2 with a reduction in the post–treatment NPRS as 22.16±11.61 . The value was found to be <0.0001 by paired ‘t’ test which is extremely significant.

The above table number 3 represents that in Group A the mean pre-treatment AKET was 25.00 ±2.22 with a reduction in the post –treatment AKET as 23.257 . The value was found to be <0.0001 by paired ‘t’ test which is extremely significant. In Group B the mean pre-treatment AKET was 13.16 ±1.54 . The value was found to be <0.0001 by paired ‘t’ test which is extremely significant.

The above table number 4 represents that in Group A the mean pre-treatment WOMAC score was 82.50 ±5.33 with a reduction in the post –treatment WOMAC score as 70.44± 4.51. The value was found to be <0.0001 by paired ‘t’ test which is extremely significant. In Group B the mean pre-treatment WOMAC score was 85.55 ±3.41 with a reduction in the post–treatment WOMAC score as 70.44± 4.51. The value was found to be <0.0001 by paired ‘t’ test which is extremely significant.

The statistical analysis of the data collected during the pre and post treatment sessions determines that the results obtained were significant. When NPRS was taken as an outcome measure for indicating the levels of pain in the subjects of both the groups A and B receiving PNF stretching and MET respectively, the mean difference improvement seen in group A(7.66 ±1.02 ) was higher than in group B (3.44 ±0.92) and proven significant. The mean difference improvement seen in group A (10.63 ±4.89) was significantly higher than in group B (4.37±2.01) when Active knee extension test was taken as a measure for hamstring flexibility and the mean difference improvement seen in group A (27.21 ±12.31) was significantly higher than in group B (14.11±7.88) when Western Ontario and McMaster universities arthritis index was used to evaluate the subjects. Osteoarthritis is a degenerative disorder which is chronic in nature and in the older age groups knee is the most common joint affected by osteoarthritis18. Knee osteoarthritis has been identified as one of the leading causes of functional limitation and disability in the elderly 29. The muscles play a significant role in joint structure and functioning. In OA knee, impairment of the muscles lead to loss of knee joint stability causing a decline in the performance and independence in daily activities and also reduction in the confidence levels ultimately leading to disability and dysfunction30. The main features of OA knee include joint pain and stiffness along with a marked reduction in the joint range of motion31. Out of the 291 disorders identified as the highest cause of disability OA knee ranked 11th 32. OA knee affects an individual’s quality of life, social participation and body fitness33. The primary aim of conducting this study was to determine the effectiveness of PNF and MET in patients with OA knee on the symptoms such as pain, hamstring flexibility and functional mobility. This study determines that, the patients who received PNF stretching along with the baseline protocol including IFT and HMP resulted in having better improvement in pain, hamstring flexibility and functional mobility as compared to the patients who received MET along with the baseline protocol. MET seemed to have effects on reducing pain, improving range of motion and functional mobility but less significant as compared to PNF. The mean age of the participants in this study was found to be 54.05 in Group A and 57.72 in Group B. This determines the fact that the grade 2 and grade 3 OA knee affects individuals above the age of 50 years as this age group are subjected to joint degeneration due to the wear and tear in the earlier years.

### Table no. 3 : The mean pre and post treatment statistics

<table>
<thead>
<tr>
<th>Statistical measures (AKET)</th>
<th>Group A (PNF)</th>
<th>Group B (MET)</th>
<th>Pre Post Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Test</td>
<td>Post-Test</td>
<td>Pre-Test</td>
</tr>
<tr>
<td>Mean</td>
<td>25.00</td>
<td>13.16</td>
<td>27.16</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>2.22</td>
<td>1.54</td>
<td>0.92</td>
</tr>
<tr>
<td>Minimum</td>
<td>21.60</td>
<td>10.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Maximum</td>
<td>29.00</td>
<td>16.00</td>
<td>28.00</td>
</tr>
<tr>
<td>Lower 95% CI</td>
<td>24.39</td>
<td>12.39</td>
<td>26.70</td>
</tr>
<tr>
<td>Upper 95% CI</td>
<td>26.60</td>
<td>13.93</td>
<td>27.62</td>
</tr>
<tr>
<td>‘t’ value</td>
<td>28.830</td>
<td>16.529</td>
<td></td>
</tr>
<tr>
<td>‘p’ value</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
</tbody>
</table>

### Table no. 4 : The mean pre and post treatment statistics

<table>
<thead>
<tr>
<th>Statistical Measures (WOMAC )</th>
<th>Group A (PNF)</th>
<th>Group B (MET)</th>
<th>Pre Post Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-test</td>
<td>Post-test</td>
<td>Pre-test</td>
</tr>
<tr>
<td>Mean</td>
<td>82.50</td>
<td>51.61</td>
<td>85.55</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>5.33</td>
<td>5.48</td>
<td>3.41</td>
</tr>
<tr>
<td>Minimum</td>
<td>74.00</td>
<td>40.00</td>
<td>80.00</td>
</tr>
<tr>
<td>Maximum</td>
<td>91.00</td>
<td>61.00</td>
<td>91.00</td>
</tr>
<tr>
<td>Lower 95% CI</td>
<td>79.84</td>
<td>48.88</td>
<td>83.85</td>
</tr>
<tr>
<td>Upper 95% CI</td>
<td>85.15</td>
<td>54.34</td>
<td>87.25</td>
</tr>
<tr>
<td>‘t’ value</td>
<td>23.257</td>
<td>14.690</td>
<td></td>
</tr>
<tr>
<td>‘p’ value</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
</tbody>
</table>
and early as the literature suggests affects individuals in their 40's. The percentage of female participants in group A is 76.66% whereas 23.33% of males and in group B IS 66.66% for females and 33.33% for males which shows that females are seen in majority as compared to males suffering from this degenerative joint disease. In this study, the rationale for an increase in the hamstring muscle flexibility by applying PNF (Hold-relax) stretching could be due to neural inhibition that is caused by PNF, which causes a reduction in the reflex activity\(^{35}\) which is supported by a similar study conducted. MET seemed to have effects on reducing pain, improving range of motion and functional mobility but less significant as compared to PNF. According to a study, PNF stretching causes relief of pain via the pain gate control, stimulates the proprioceptive muscle fibres by isometric contraction of muscles\(^{36}\). Passive extension of a hypertonic muscle to a new resting length can be done after an isometric contraction immediately. According to a study, the inhibition of the golgi tendon organ and muscle spindle occurs by PNF stretching\(^{33}\). During the hold and relax technique involving an isometric contraction of the hamstrings, autogenic inhibition of the hamstring muscles occurs causing muscle relaxation and reduction in stretch resistance, thus improving ROM. On the other hand, the viscoelastic properties of muscle tendon junctions determine the flexibility of hamstrings\(^{35}\). Due to the viscoelastic properties of the muscles, the musculotendinous junction can increase in length in response to the amount of load applied and its duration. Thus, if a muscle is repeatedly exposed to specific loads for specific durations can cause a change in the muscle length, this reduction in resistance is termed as stress relaxation. Since there is a paucity of literature determining the effectiveness of PNF over MET in management of symptoms in OA knee, this study was carried out which resulted in improved status of the patients in terms of pain, flexibility of hamstrings and functional mobility in the patients who received PNF stretching as compared to MET.

5. CONCLUSION

This study resulted in conclusion that PNF stretching and MET both are effective in decreasing pain levels, enhancing hamstring flexibility and improving functional mobility in patients with OA knee. However, the patients who received PNF stretching along with the baseline protocol involving Interferential therapy and Hot moist pack showed significantly better improvement in their pain levels, the flexibility of the hamstring muscles was seen to be increased and the functional mobility status as compared to patients who received MET. Thus concluding, the application of PNF stretching in protocol for OA knee patients yielded better results on pain reduction, increased flexibility of hamstrings and an independency in functional mobility.

6. ACKNOWLEDGEMENT

We acknowledge and thank the authors and coauthors of this manuscript.

7. AUTHORS CONTRIBUTION STATEMENT

Ms.Minal Masekar devised the project, designed the model and the computational framework and analysed the data as well as the main conceptual ideas and proof outline. Dr.Amrutkar Rayjade and Dr.Khushboo Chotai performed the numerical calculations for the suggested experiment. All authors discussed the results and commented on the manuscript. Ms.Minal Masekar and Dr.Trupti Yadav drafted the manuscript.

8. CONFLICT OF INTEREST

Conflict of interest declared none

9. REFERENCES


