

**Research Paper**

Can Mechanoreceptors Stimulation Ease Pain -A Neuroanatomical Approach

Authors

Dr K.Nirmal Kumar¹, Dr U.K. Gupta², Dr Vinay Kumar Singh³

¹Research Scholar, Corresponding author, Department of Anatomy, National Institute of Medical Science and Research, NIMS, University, Jaipur, Rajasthan 303121& 8209206048

²Professor and Head, Department of Anatomy, Research Supervisor, National Institute of Medical Science and Research, NIMS, University, Jaipur, Rajasthan 303121& 8949563439

³Director, Department of Orthopedics, Research Co-Supervisor, National Institute of Medical Science and Research, NIMS, University, Jaipur, Rajasthan 303121& 8279731117.

Abstract

There are many theoretical concepts in Neuroanatomy, of those how stimulation of mechanoreceptors can ease pain in humans, still needs to be explored. So the aim of this study was to find out the acute effectiveness of mechanoreceptors in patients of osteoarthritis knee joint, where pain is the primary concern. A prospective study was conducted at National Institute of Medical Science and Research, Jaipur on 150 patients of which, Group A (n=50) was control group, Group B (n=50) and Group C (n=50) were experimental groups. All the 3 groups underwent pain measuring tool- Numeric Pain Rating Scale (NPRS), Range of motion (ROM) measuring tool -Universal Goniometer and Functional activity measuring tool -Short form Western Ontario and Mc Master Universities Osteoarthritis Index (WOMAC) pre and post treatment. All the three groups received Moist hot pack (MHP) for 5 minutes. Proprioceptive Neuromuscular Facilitation (PNF) for 3 minutes and Passive Joint Mobilization (PJM) for 10 minutes were given to Group B and C respectively. Results were recorded in Excel sheet and Paired T- Test was used to evaluate the statistical significance between these groups. Both Group B and C was statistically significant in comparison to the group A, who only received MHP. On comparing Group B and C, Group C patients shown statistically better improvement in OA knee symptoms. Thus the stimulation of mechanoreceptors masked the OA knee pain through gating theory and the same was proved cost effectively.

Keywords: Mechanoreceptors, Proprioceptors, Receptors, PNF, PJM, OA.

Introduction

Receptors are modified sensory nerve endings, present in various parts of human body. There are different types of receptors which are meant for various functions. Of these Mechanoreceptors like muscle receptors (Muscle spindle and Golgi tendon organ) and Joint receptors (Golgi type endings,

Ruffini endings and Paciniform endings) performs proprioception function and responds to mechanical forces^{1,2}. When two receptors of different functions (Pain and Proprioception) are stimulated simultaneously, proprioception masks the sensation of pain perceived by brain (The Gating theory)^{1,3}. In Osteoarthritis (OA), the major concern is pain⁴. To

stimulate the mechanoreceptors in muscles and joints there are techniques used by clinicians. They are Proprioceptive Neuromuscular Facilitation (PNF) to evoke muscle receptors and Passive Joint Mobilization (PJM) to excite joint receptors. These both techniques uses normal biological mechanism of human body to ease pain. Based on above said idea this study was designed to find out whether stimulation of muscle receptors by Proprioceptive neuromuscular facilitation or stimulation of joint receptors by passive joint mobilization brings rapid improvements in symptoms of OA knee patients and also to prove the authenticity of gating theory.

Subjects and Methods

A prospective study was conducted after approval of Human ethical committee from 2017 to 2018 at National Institute of Medical Science and Research, Jaipur. 150 patients were enrolled in this study. OA knee patients of both gender, age 40 years and above with grade 1 or grade 2 OA on radio graphs were included. Patients with grade 3 or 4 OA knee, history of knee trauma, steroid injection, any other disorder of knee joint other than inclusion criteria were excluded. After explaining the procedure and consent form signed. Patients were divided into 3 groups randomly. Group A (n=50) was control group, Group B (n=50) and Group C (n=50) were experimental groups. All the three groups underwent pain measuring tool- Numeric Pain Rating Scale (NPRS), Range of motion (ROM) measuring tool -Universal Goniometer and Functional activity measuring tool -Short form

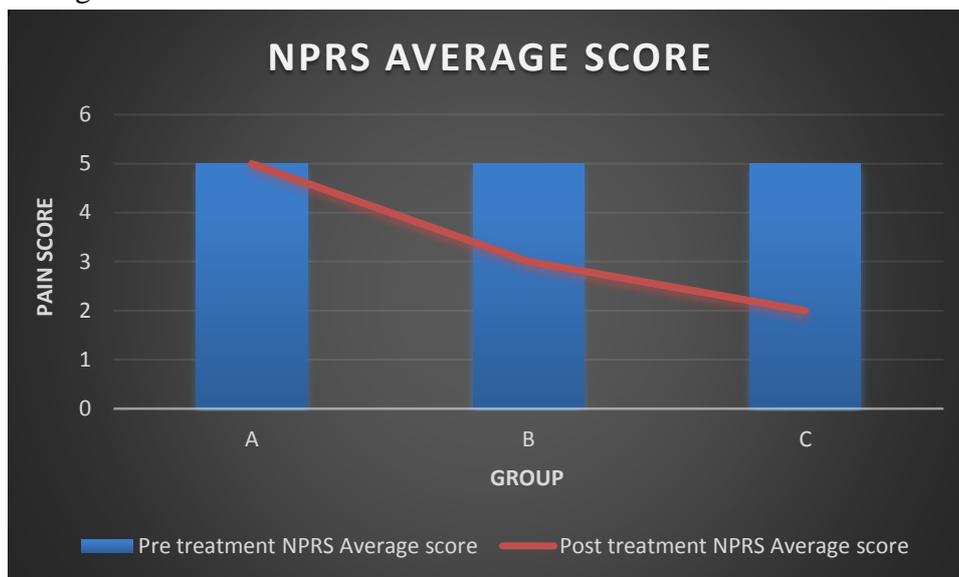
Western Ontario and Mc Master Universities Osteoarthritis Index (WOMAC) pre and post treatment. Moist hot pack (MHP) was given to all the three groups for 5 minutes. In addition PNF (Contract Relax - Antagonist Contract) for 3 min and PJM for 10 minutes were given to Group B and C respectively. In Group B, patients were subjected to hamstring muscle stretching for 7 seconds, followed by isometric contraction of same muscle for 3 to 6 seconds, relax period for 5 seconds and concentric contraction of quadriceps femoris muscle for 7 seconds. This sequence was repeated 5 times with 20 seconds interval between each sequence. In Group C, patients were made to lie in comfortable position over treatment table, pad is kept under the target knee joint and Grade 1 and 2 oscillatory movements were given for knee joint lasting 1 to 2 minutes for reducing pain .Grade 3 and 4 mobilization was given for knee joint lasting 1 to 2 minutes for reducing tightness. This sequence was repeated 3 times with 20 seconds interval between each sequence. The pre and post treatment data were recorded in Microsoft Excel sheet and Paired T-Test was used to evaluate clinical significance between groups. P value <0.01 was considered as statistically significant.

Results

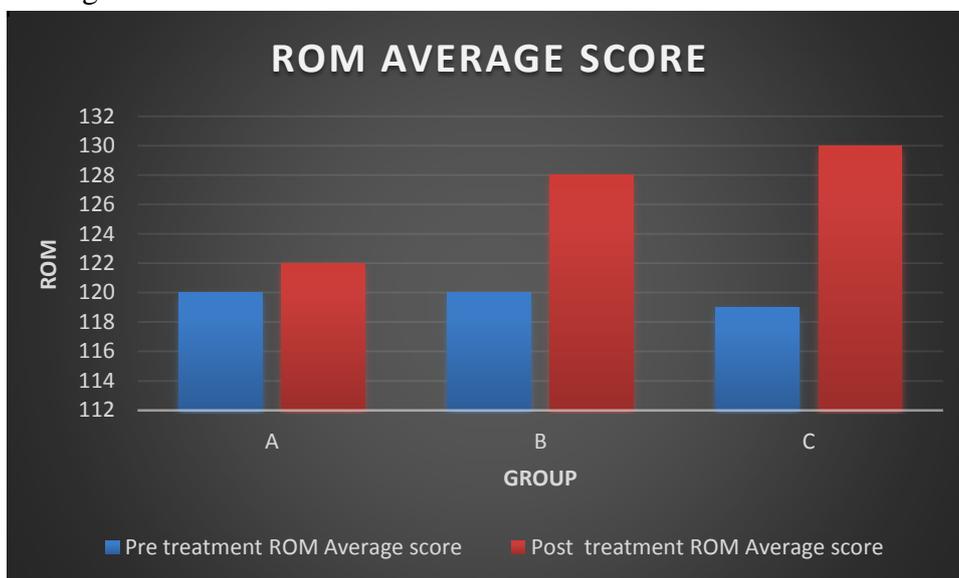
Table 1: Average value for Pre and Post treatment NPRS, ROM and Short form WOMAC scores of Group A, B and C.

Group	Pre treatment NPRS Average score	Post treatment NPRS Average score	Pre treatment ROM Average score in degree	Post treatment ROM Average score in degree	Pre treatment short form WOMAC Average score	Post treatment short form WOMAC Average score
A	5	5	120	122	15	14
B	5	3	120	128	14	9
C	5	2	119	130	14	7

Graph 1: NPRS Average Score



Graph 2: ROM Average Score



Graph 3: Short form WOMAC Average Score

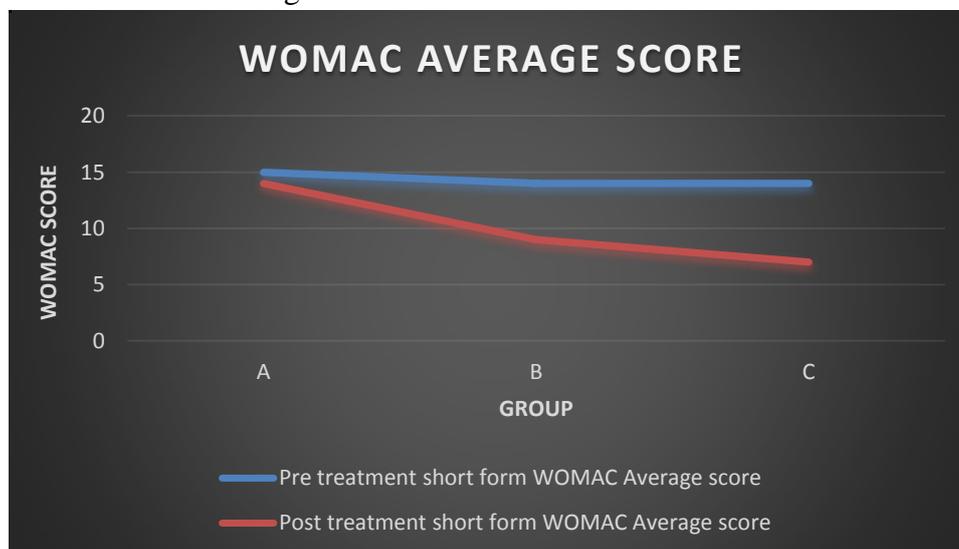


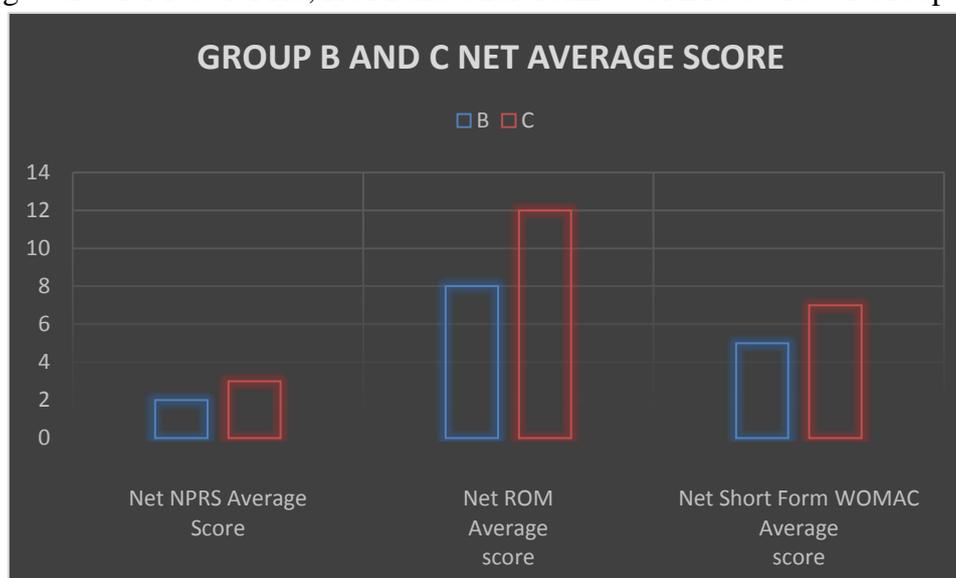
Table 2: P value for Pre and Post treatment NPRS, ROM and Short form WOMAC scores of Group A, B and C.

GROUP	NPRS P Value	ROM P value	Short Form WOMAC P Value
A	0.05	0.39	0.06
B	<0.0001	<0.0001	<0.0001
C	<0.0001	<0.0001	<0.0001

Table 3: Average value for Net NPRS, ROM and Short form WOMAC scores of Group B and C

GROUP	Net NPRS Average Score	Net ROM Average Score in degree	Net Short Form WOMAC Average score
B	2	8	5
C	3	12	7

Graph 4: Average value for Net NPRS, ROM and Short form WOMAC scores of Group B and C



In Group A (Control group), Pre and Post NPRS average score was 5 and 5 respectively, Pre and Post ROM average score was 120 and 122 respectively and Pre and Post Short form WOMAC score was 15 and 14 respectively. P value of NPRS, ROM and Short form WOMAC score was 0.05, 0.39 and 0.06 respectively. In Group B (PNF group) Pre and Post NPRS average score was 5 and 3 respectively, Pre and Post ROM average score was 120 and 128 respectively and Pre and Post Short form WOMAC average score was 14 and 9 respectively. P value of NPRS, ROM and Short form WOMAC score was <0.0001. In Group C (PJM group) Pre and Post NPRS average score was 5 and 2 respectively, Pre

and Post ROM average score was 119 and 130 respectively and Pre and Post Short form WOMAC score was 14 and 7 respectively. P value of NPRS, ROM and Short form WOMAC score was <0.0001. On comparing the average and P value of Pre and Post test scores in both Control and Experimental groups it was noted that Group A had negligible effects (Statistically insignificant) in OA knee patients with respect to Pain, ROM and Functional activities. On comparing the both experimental groups statistically, Group B and Group C patients shown improvement in symptoms of OA. (Refer Table 1 and 2, Graph 1, 2 and 3). But Group C patients gained the best results than Group B both

clinically and statistically by comparing their Net NPRS, ROM and WOMAC average scores. (Refer Table 3 and Graph 4). No patients in both control and experimental groups reported any adverse events like local skin or general complications with the treatment.

Discussion

When receptors of two different sensations (Nociceptors and Mechanoreceptors) are stimulated, pain gate theory comes into existence. Mechanoreceptors or Proprioceptors which are connected to large diameter myelinated (type A nerve fibers) carries impulse faster than nociceptors which are connected to small diameter unmyelinated nerve fibers (type C nerve fibers). When both receptors are stimulated simultaneously type A fibers carries nerve impulse faster to spinal cord than type C fibers. In spinal cord type A fibers inhibit inhibitory inter neurons (gate keeper) and closes the gate at spinal cord level, so that pain is not perceived by brain^{1,3}. This neuroanatomical concept evoked an interest in researchers to test its authenticity practically. Previously researchers used low, medium and high frequency currents to stimulate the mechanoreceptors to ease pain for short terms in OA knee (Atamaz FC et al)⁵. Similarly Palmer shea et al⁶ used electrical current to reduce pain in Osteoarthritis knee patients but the results can't be generalized because studies were done with small sample size.

But in our study body's own biological mechanism like autogenic inhibition, reciprocal inhibition and stress relaxation were used to stimulate muscle receptors (muscle spindle and golgi tendon), while joint receptors in knee joint was stimulated by oscillatory movements. Sambajon et al 2003⁸ explained that alteration in local chemical environment and reduction in inflammatory substances were the reasons behind hypoalgesic effects after mobilizing the joint. On the other hand Wright in 2002 and Souvlis et al in 2004 stated that hypoalgesic effects was due to activation of descending pain inhibitory system^{9,10}. Arthrokinematics are believed to produce

mechanical effects like release of adhesion, realignment of collagen fiber and its glide, which restored increased ROM⁷. Kaur M et al¹¹, Gopi S et al¹² and Laura D et al¹³ used PNF to increase length of muscle and in turn increased range of motion of joint which was similar to our study but those authors not concentrated on pain factor.

OA patients in Group B and C yielded improvement in terms of pain, ROM and functional activity whereas Group A patients did not shown any improvement post treatment with MHP. On comparing the results of Group B and C, Group C patients yielded better improvement in symptoms of OA both clinically and statistically. Acute effect of increase in pain threshold was noted immediately after applying mobilization in group C patients which was similar to the findings of Moss P and Sluka K¹⁴. They also stated that hypoalgesic effects were produced after mobilizing OA knee.

Conclusion

On analyzing the results of three groups, it was observed that control group has negligible effects in improving symptoms of OA knee patients. PNF and PJM both showed statistically significant improvement in symptoms of knee arthritis. But stimulation of joint receptors by PJM produced better outcome in reducing pain, range of motion of joint and functional activities of patients both clinically and statically than PNF and authors would like to recommend its routine use in patients with early knee osteoarthritis. Thus the stimulation of mechanoreceptors masked the OA knee pain through gating theory and the same was proved cost effectively.

Limitations

Our study was limited by its acute follow up ie we have assessed the effects of mechanoreceptors stimulation in easing symptoms of OA immediately after treatment. We believe that if sessions of PNF and PJM repeated then it would lead to improvement in patients symptoms for longer term. We suggest a study with longer follow up to see if this is true and simultaneously the duration of

analgesic effects of mechanoreceptors stimulation has to be evaluated.

Conflicts of Interest

There were no conflicts of interest in our study

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