

## Do Mechanoreceptors bear significance in osteoarthritis knee patients?

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### Abstract:

*Prevalence rate of osteoarthritis patients older than 40 years in India and across globe has emerged as a concern for which treatment has become absolute for survival. Empirical evidences and evidence based practices in the last few decades reveals that significant attempts have been made to treat and manage osteoarthritis. These*

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*interventions used in treating osteoarthritis have adverse effects as well as, burden of treatment cost due to long duration of treatment. Such interventions though have noticeable short term effects but their long term effects are rarely studied due to a number of problems and issues involved in conducting longitudinal studies. Therefore, the need is felt for increasing efficiency in treatment of osteoarthritis patients, where the present researcher attempted to analyze the role of mechanoreceptors in osteoarthritis knee patients with regard to Proprioceptive Neuromuscular Facilitation (PNF) stretching and Passive Joint Mobilization (PJM). There have been studies on PNF stretching and PJM in India as well as in western world. However these studies were limited by smaller sample size . Hence authors are currently conducting a study with larger sample size to assess effectiveness of PNF stretching and PJM in osteoarthritis of knee joint patients in a tertiary care superspeciality hospital in India. In the context of the designed study, attempt has been made to discuss the conceptual framework on osteoarthritis patients in relation to PNF stretching and PJM in the form of present article as a scholarly contribution.*

**Key words:** Mechanoreceptors, osteoarthritis knee patients

## **INTRODUCTION**

Osteoarthritis is one of the most prevalent degenerative condition which leads to pain and disability among adults (Allen KD et al<sup>1</sup>). It often affects hip, knees, feet, shoulder, hands and spine . Although Osteoarthritis is age related disease , the risk factors associated with it are obesity, sedentary life style, hereditary, low bone density, job related injury, trauma, and gender (Haq I et al<sup>2</sup>). As part of the Global Burden of Disease 2010 study, a systematic review reported that the global age-standardized prevalence of knee osteoarthritis was 3.8% (Allen KD et al<sup>1</sup>). According to the United Nations, by 2050 people aged over 60 will account for osteoarthritis more than 20% of the world's population.

Prevalence of osteoarthritis is 22% to 39% in India. Osteoarthritis causes pain and affects mobility of joints (Chandra Prakash Pal et al<sup>3</sup>). It is evident that osteoarthritis will be a major concern in future as a result of increasing number of aging population due to improved human life expectancy. Despite many available treatment options there is scope for treatments which improves symptoms with minimal or negligible side effects.

Evidence based practices in the treatment and management of osteoarthritis can be broadly classified into pharmacological and non pharmacological treatment. Pharmacological treatment includes acetaminophen, Non steroidal anti inflammatory drugs (NSAIDs), Opioids, Intra articular injections, Glucosamine sulfate and chondroitin sulfate. Non pharmacological treatment includes hydrotherapy, massage therapy, thermotherapy, electrotherapy, Manual therapy and surgery (Yusuf E<sup>4</sup>). Each of these treatments are discussed below with its current evidence based practices .

## **THEORETICAL AND CONCEPTUAL FRAMEWORK**

Significance of mechanoreceptors in reducing pain and increasing range of motion (ROM) in the primary reference that has been influencing clinical practices and have been mentioned in scholarly contributions in medical sciences in terms of theoretical constructs. Four major theoretical propositions in human physiology supports in easing pain and increasing ROM of joints are Autogenic Inhibition, Reciprocal Inhibition, Stress relaxation (Kindle KB et al<sup>5</sup>) and pain gate theory (Ronald Melzack and Patrick D. Wall<sup>6</sup>).

### **Autogenic Inhibition**

Autogenic Inhibition is the self inhibition of contracted muscle, occurs due to activation of Golgi tendon organ. When a muscle undergoes isometric contraction the tension in muscle increases

leading to activation of Golgi tendon organ, which in turn through afferent nerve fibers reaches the spinal cord. In spinal cord these fibers inhibit the alpha motor neurons of the target muscle via activating inhibitory interneurons. Simultaneously alpha motor neurons of antagonist muscle to target muscle gets activated by inhibiting the inhibitory interneurons. There by the target muscle relaxes and antagonist muscle contracts (Kindle KB et al<sup>5</sup>).

### **Reciprocal Inhibition**

Reciprocal Inhibition occurs when antagonist to target muscle is contracted. As antagonist muscle contracts its neural activity gets increased and afferent nerve fibers reaches spinal cord. In spinal cord these fibers stimulate inhibitory inter neurons, which in turn inhibit firing of alpha motor neuron of target muscle. Therefore target muscle is relaxed (i.e) neural activity and proprioceptors activity is minimized (Kindle KB et al<sup>5</sup>).

### **Stress Relaxation**

When a muscle is under prolonged stress, the Musculotendinous Unit (MTU) of muscle due to their viscoelastic property undergoes a phenomenon known as stress relaxation. So viscous material loses its ability to overcome the stretch, MTU slowly increase in length known as creep of MTU, which resulted in increase in length of muscle and joint ROM (Kindle KB et al<sup>5</sup>).

### **Pain gate theory**

When receptors of two different sensations (pain and pressure) are stimulated pain gate theory comes into existence. Mechanoreceptors which is connected to large diameter myelinated (type A nerve fibers) carries impulse faster than pain receptors which is 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 (Ronald Melzack and Patrick D. Wall<sup>6</sup>).

## **TREATMENT METHODS OF OSTEOARTHRITIS**

### **Pharmacological treatment:**

Pharmacological treatment as commonly practiced medical interventions have their significance in the context of osteoarthritis patients. Though this approach is prevailing across last decade, adverse effects of treatments with pharmacological interventions (through application of pharmaceuticals) are reported and therefore have been vehemently criticized. Among most commonly recommended drugs for treating osteoarthritis patients, Acetaminophen (ER 1300mg 3 times daily) is found to be effective drugs by Prior MJ et al<sup>7</sup> to relieve signs and symptoms of osteoarthritis patients with knee pain. Its reported adverse effects include angina pectoris, hypertension, dehydration, gastritis, urosepsis, atrial fibrillation, renal cyst, renal mass, congestive cardiac failure and dyspnea. Paracetamol as a pharmacological treatment is reported to have negligible effects in relieving signs and symptoms of osteoarthritis patients with knee pain. Cardiovascular problems, gastro intestinal bleeding, kidney problems, liver failure and toxicity has been reported with use of paracetamol (Machado GC et al<sup>8</sup>). While reporting about use of acetaminophen and NSAIDs, Richette P et al<sup>9</sup> recommended low dose for short duration to minimize its side effects on cardiovascular and gastrointestinal tract. Contradictory to above findings Verkleij SPJ et al<sup>10</sup> concluded that diclofenac and paracetamol do not exhibit significant difference in KOOS pain scale and diclofenac exposed group experienced greater adverse effects on gastrointestinal, respiratory, skin and

psychiatric problems than the group exposed to paracetamol alone.

Keller HL et al<sup>11</sup> reported that use of celecoxib and diclofenac slow release plus omeprazole in geriatric arthritis patients produced gastro intestinal adverse effects and death were reported in some cases who used celecoxib and diclofenac slow release plus omeprazole. Pareek A et al<sup>12</sup> concluded aceclofenac 100mg bid showed better gastro intestinal tolerability than diclofenac 50 mg tid, with reduced adverse events like abdominal pain, dyspepsia, dysphagia, nausea, constipation, diarrhoea and vomiting. Even Sugano K et al<sup>13</sup> and Rogoveanu OC et al<sup>14</sup> commented that prolong usage of NSAIDs in arthritis patients is associated with gastrointestinal events. On the other hand Bello AE et al<sup>15</sup> found that usage of ibuprofen 800 mg plus famotidine 26.6mg resulted in better gastro intestinal protection than Ibuprofen alone in osteoarthritis patients. However, certain side effects like nausea, dyspepsia, upper abdominal pain, gastritis and hypertension were noticed. In addition to gastro intestinal adverse events Essex MN et al<sup>16</sup> noticed central nervous system adverse events in Asian patients using NSAIDS like celecoxib and naproxen. In 2017 Gordo AC et al<sup>17</sup> concluded celecoxib usage resulted in better tolerability in osteoarthritis knee patients with reduced gastrointestinal adverse events.

Opioids are also used commonly to treat symptoms of Osteoarthritis knee patients. Steigerwald I et al<sup>18</sup> and Etropolski M et al<sup>19</sup> suggested that tapentadol (50-250mg bid) usage in chronic Osteoarthritis knee patients showed better gastro intestinal tolerability but with diarrhoea, dyspepsia, headache, nausea, dizziness, constipation, hyperhidrosis, drug withdrawal syndrome, fatigue as adverse events. They also noticed adverse effects in nervous system.

Glucosamine and Chondroitin sulfate are nutritional supplements used to treat Osteoarthritis knee patients.

Hochberg MC et al<sup>20</sup> & Roman Blas J A et al<sup>21</sup> noticed allergic dermatitis, dizziness and gastritis with its use.

Intraarticular injection is an alternate mode of treating Osteoarthritis knee. Corticosteroids, hyaluronic acid and plasma rich platelets (PRP) injections have been used in treating Osteoarthritis of knees. Steroid injections does not result in improved symptoms in all patients. Hyaluronic acid injection is an expensive viscosupplement and it is under debate whether it can be a treatment choice for Osteoarthritis knee patients. Glucocorticoid injection in Osteoarthritis patients resulted in post injection flare up to 10% patients and may cause septic arthritis in 0.08% (Yusuf E<sup>4</sup>). Huang PH et al<sup>22</sup> conducted a study on PRP injection in treatment of Osteoarthritis knee. They found PRP treatment to be expensive and single or two injection per month found improvement in knee function only after 12 months of treatment, whereas 3 injections per month yielded significantly improved results in short term follow up.

Though the above discussed pharmacological treatments had some beneficial effects it is also associated with side effects. This is predominantly due to longer duration of treatment needed in these cases. Intraarticular injections, especially Hyaluronic acid and PRP can be expensive and may be not affordable by all patients. This is extremely important in India where majority of patients with Osteoarthritis knees are poor and struggle to bear the cost of treatment. Pharmacological treatments are not curative and improvement in symptoms is dose dependent. Considering all the above inhospitable events caused by pharmacological treatment there is need for a non pharmacological treatment which is safe and effective in treating knee osteoarthritis.

### **Non Pharmacological Treatment**

Non pharmacological treatments are practiced as surrogate ways to treat Osteoarthritis knee patient. Among them

following are ubiquitously used methods. Thermotherapy which is one of the conventional method to treat Osteoarthritis knee patient, where heat, cold and combination of two (contrast bath) are used. Thermotherapy reduced symptoms of Osteoarthritis knee patients in short term in study of Amal E. shehata & Manal E. Fareed<sup>23</sup>. Dantas L.O et al<sup>24</sup> reported that use the of cryotherapy improves functional activities of Osteoarthritis knee patients but its effect is only for short term.

Considering exercise as a treatment option for Osteoarthritis knee, it cannot be given as primary treatment methods when pain factor is reckoned, rather it can be given as auxiliary. More over supervening exercise protocols by patients periodically may not be viable. There were minimal or negligible clinical trail evidence to substantiate exercise can alter mechanical load and structural disease progression in Osteoarthritis knee patients (Bennell K et al<sup>25</sup>) with their sequel decline over time (Bennell K L et al<sup>26</sup> and Beumer L et al<sup>27</sup>)

In Electrotherapy low, medium and high frequency currents were used to ease pain for short terms. Accretion of Transcutaneous Electrical Nerve Stimulator (TENS), Interferential current (IFT) and Short wave diathermy with exercise program not showed superfluous effects in Osteoarthritis knee patients (Atamaz FC et al<sup>28</sup>). TENS reduces pain in Osteoarthritis knee patients but the results can't be generalized because studies were done with small sample size (Palmer shea et al<sup>29</sup>). On the other hand ULUS Y et al<sup>30</sup> and Cakir S et al<sup>31</sup> commented that Ultrasound (US) produced short term effects in relieving pain and improving functional activities and it can't be used as treatment adjunct.

Waller B et al<sup>32</sup> showed therapeutic aquatic exercise improves symptoms of Osteoarthritis. But muscle cramps, dizziness, fall and contact dermatitis were some of the adverse events reported with this treatment modality. Maintaining pool

temperature and its hygiene which is imperative for this treatment can be arduous.

Though massage is a form of non pharmacological treatment for Osteoarthritis patients and yields beneficial effects in patients with knee osteoarthritis. However, this form of treatment is time consuming posing logistical challenge (Atkins DV et al<sup>33</sup>). Also massage when combined with exercises, produced negligible short term effects in Osteoarthritis knee patients (Godoy VC et al<sup>34</sup> and Bervoets DC et al<sup>35</sup>).

Besides the treatments mentioned above, these days researchers are focusing on regenerative medicine to treat Osteoarthritis knee patients. Injection of mesenchymal stem cells into knee joint has shown to relieve pain ,improve cartilage quality, improve ROM and functional activity of knee joint (Koh YG et al<sup>36</sup>, Orozco L et al<sup>37</sup>, Vega A et al<sup>38</sup>, Yokota N et al<sup>39</sup>). Concept of mesenchymal stem cells is attractive but its results in human knee joint are primitive and majority of well documented results have been shown only in animal studies.

Finally when all the pharmacological and Non pharmacological treatments fails, surgical treatment may be necessary. This predominantly involves arthroplasty. Total Knee Arthroplasty is a very successful operation but it also has many potential complications. These include post operative deep infection, stiffness of knee joint, deep vein thrombosis ,pulmonary embolism, patellar subluxation, intraoperative fracture and joint instability(Skou ST et al<sup>40</sup>) . In some cases there can be intraoperative and postoperative blood loss requiring blood transfusion (Jia li et al<sup>41</sup>). A high quality evidence with large sample size study is desirable comparing total knee replacement with non surgical interventions (Skou ST et al<sup>42</sup>).

Patients are skeptical for surgical treatment as because of its associated complications as mentioned above. On the other hand patients who choose pharmacological and non

pharmacological treatments know that its effect is dose dependent and these treatments are not curative. Due to this there is scope for new innovative treatment for Osteoarthritis which can control symptoms without significant side effects. Using the body's own biological mechanism (ie) stimulation of mechanoreceptors in muscle and joint relieves pain, increase Active Range of Motion (AROM) and functional activities of Osteoarthritis knee patients. Mechanoreceptors which responds to mechanical stimulus are present in muscle and joints. Mechanical forces can be produced by PJM and PNF stretching techniques. By supporting the above statement, Nor Azlin MN and K. Sulyn<sup>43</sup> reported passive joint mobilization with conventional physiotherapy treatments provided good results in Osteoarthritis knee. Kadu SS et al<sup>44</sup> commented that PJM is safe, effective and well tolerated by Osteoarthritis knee patients and yielded colossal effects in controlling symptoms of Osteoarthritis when combined supervised clinical exercise. In Osteoarthritis knee patients, Maitland mobilization resulted in greater relief in pain and increase range of motion. Manual therapy are effective and safe for reducing pain, stiffness and increase functional activities of joints (Rangey PS et al<sup>45</sup> and Courtney CA et al<sup>46</sup>).

PNF stretching, when applied to shortened hamstring muscle increased muscle flexibility and muscle activity which in turn end up in reduced pain and increased AROM of knee joint (LIM KL et al<sup>47</sup> and Kaur Mandeep<sup>48</sup>). PNF technique when applied alone (Hold relax technique) produced increased muscle strength, range of motion and reduced pain in Osteoarthritis patients. Moreover modified hold relax resulted in increasing hamstring flexibility and reduced pain and disability overtime (Mistry GS et al<sup>49</sup> and Singh AK et al<sup>50</sup>). Similarly when PNF combined with Dynamic stretching and myofascial release altogether increased passive knee extension with  $\geq 20^\circ$  deficit (Deuyzman L et al<sup>51</sup>). In case of patello femoral pain syndrome,

PNF stretching produced positive effects (Golpayaegani M and Emamai SH<sup>52</sup> ).

All the available treatment methods for Osteoarthritis knee discussed above are good in relieving symptoms. However results yielded by mechanoreceptors unveils that PNF stretching and PJM techniques produced good results without side effects. Besides being safe they are also cost effective and may provide long term relief form symptoms with regular treatment sessions. These techniques are simple, can be easily taught to patients and can be done by patients on their own in domiciliary setting.

## CONCLUSION

Pharmaceutical interventions currently dominate the treatment of Osteoarthritis knees. Non-pharmacological interventions in form of PNF stretching and PJM is safe and have potential to provide long term improvement in symptoms with negligible side effects. These treatment options are both underutilized and under reported. Authors feel that there is scope to explore these innovative treatment through mechanoreceptors to fill the existing gap in treatment of Osteoarthritis knee.

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