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A comparative study on the effectiveness of PNF stretching versus static stretching on Pain and Hamstring flexibility in osteoarthritis knee patients

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ABSTRACT

Osteoarthritis (OA) knee is a long-term chronic disease characterized by the destruction of articular cartilage and underlying bone. Pain, limitation of motion and functional impairment are common clinical features. Poor hamstring flexibility is a major problem for patients with OA knee. The stretching of the hamstring is a necessary intervention in the management of the OA knee. This study is therefore intended to compare the effectiveness of static stretching vs PNF stretching for pain, hamstring flexibility and functional mobility in OA Knee patients. 30 patients were randomly divided into two groups. Group A (N=15) received PNF stretching, wax therapy and isometric quadriceps exercises, and group B (N=15) received static stretching, wax therapy and isometric quadriceps exercises. The intensity of the pain was measured using the NPRS (Numerical Pain Rating Scale), hamstring flexibility by AKET (Active Knee Extension Test) and functional mobility by TUG (Timed up and go) test. The results showed that significant differences in NPRS (Z=4.64, P=0.001), AKET (t=9.61, P=0.001) and TUG (t=8.19, P=0.001) were observed in group A patients when compared to group B. In conclusion, the PNF stretching treatment program is effective in reducing pain, improving hamstring flexibility and functional mobility in patients with OA knee compared to static stretching.

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INTRODUCTION

Osteoarthritis (OA) is the most widely recognized reason for musculoskeletal pain and disability in the knee joint. It is a chronic degenerative disorder of multifactorial etiology characterized by articular cartilage loss, marginal bone hypertrophy, subchondral sclerosis and biochemical and morphological changes in the synovium and joint capsules (Hinto *et al.*, 2002).

OA is the most common joint disease with a prevalence of 22 to 39 percent in India (Chopra *et al.*, 2001). This is often the main common cause of locomotive disability in elderly people. Worldwide evaluations indicate that 9.6% of men and 18% of women over 60 years have symptomatic OA. OA knee most commonly occurs after 40 years and typically develops gradually over a period of years (Behzad, 2011).

Patients with OA knee have reduced functional capacity in the lower extremity muscles due to joint pain, stiffness and loss of muscle strength (Liikavainio *et al.*, 2008). While OA is diagnosed and defined as a loss of hyaline cartilage in the joint, muscle impairments associated with the disease may be the main cause of functional impairment.

Muscle dysfunction can actually precede and accelerate cartilage deterioration (O'reilly *et al.*, 1998). Therefore, OA knee can not only be considered a cartilage disease and related muscle impairments must also be considered in the clinical management of the disease.

There is evidence that muscle dysfunction is associated with the OA knee pathogenesis (Slemenda *et al.*, 1997). Since the lower limb muscles are the natural brace of the knee joint, the weakness of the quadriceps or the weakness of the hamstrings in relation to the quadriceps can cause significant muscle dysfunction, which is usually assessed by the quadriceps: hamstrings ratio (Q: H) (Aagaard *et al.*, 1995).

In general, the lack of flexibility in the muscles increases the risk of injury. Muscle weakness and poor flexibility are two important components of joint pain and dysfunction. In the appearance and progression of the OA in the knee joint, muscle imbalance plays an important role. Changes in muscle function lead to changes in ground reaction forces, degenerative changes and pain development (Bennell *et al.*, 2008). The resulting lack of flexibility in muscles can result in changes in joint function and may be a risk factor for injury during activities requiring a full range of movement (Kaur *et al.*, 2014). The stiffness of the OA knee can be observed while walking in patients (Dixon *et al.*, 2010). In this way, regular stretching exercises increase muscle flexibility, ROM and provide functional benefits for OA knee patients and can delay the need for surgical interventions.

Physiotherapy interventions have been found to be effective in reducing pain and disability in OA knee patients. Effective interventions include therapeutic exercises that specialize in strengthening and reducing pain by heat or cold, Ultra Sound Therapy (UST), Short Wave Diathermy (SWD), Transcutaneous Electrical Nerve Stimulation (TENS), mobilization, knee taping, supply of canes or orthotics to patients, balance training and exercise of isometric quadriceps to prevent atrophy of muscle (Fitzgerald and Oatis, 2004).

Stretching is the general term for describing any therapeutic method for elongating the pathologically shortened structure of the soft tissue and thus increasing ROM. Both PNF (hold-relax) and static stretching are effective in improving the joint ROM. Static stretching is described as a way of stretching the soft tissue to the point of resistance or tolerance of the tissue in this position. While the PNF technique (hold-relax) uses a short isometric contraction of the agonist's muscle to be stretched and then perform static stretching during muscle relaxation (Shanthi, 2014).

According to Sonal (2016); Vamsidhar *et al.* (2014), different stretches, such as PNF (hold- relax) and static stretching have been incorporated into the tightness of the hamstring in the OA knee, and normal individuals have been given. However, only a few literature examining the effect of PNF (hold-relax) stretching and static stretching for pain and ham- string tightness have been evaluated in OA knee patients. So the purpose of the study is to compare the effectiveness of PNF (hold-relax) stretching and static stretching in patients with OA knee.

METHODOLOGY

Participants

This study was conducted in the outpatient of the Division of Physical Medicine and Rehabilitation, RMMC&H, Annamalai University. Thirty patients with a primary OA knee were selected. The criteria for the inclusion in the study were (1) Age between 40-60 years. (2) Both males and females (3) Flexor tightness of knee with extension limitation greater than 20 degrees in Active Knee Extension Test. (4) Unilateral involvement. The main exclusion criteria were (1) Intraarticular corticosteroid injection into the affected knee joint over the last three months. (2) Previous surgery on the affected knee joint. (3) Low back pain with sciatica (4) History of trauma in the involved lower extremity.

Table 2 shows that the mean NPRS was 7.60±1.12 in group A and the mean reduction after treatment was 3.60 ± 0.98 and the difference is statistically significant (z=0.346, P=0.001). The mean pre-NPRS for group B was 6.87±1.24 and was statistically reduced to 4.93±1.21 after treatment (z=3.53, P=0.001). The mean difference improvement in group A was significantly (z=4,64, P=0,001) higher in group A (M=4,00±0,75) than in group B (M=1,93±0,59).

Table 3 shows that the pre mean AKET in group A was 48.40±3.87 and after treatment was significantly reduced to 31.93±3.05. The pre mean AKET for group B was 48±2,83 and after treatment was significantly reduced to 36,27±2,37. In group A comparison, the improvement in AKET (M=16.47±1.30) was significantly higher than in group B (M=11.73±1.38).

Table 4 shows that the pre-mean TUG in group A was 20.89±2.51 and significantly reduced (t=30.77, P=0.001) to 11.35±1.94 after treatment. The pre-mean TUG in group B was 22.38±3.57 and significantly reduced (t=23.03, P=0.001) to 16.19±3.34

Table 1: Baseline Characteristics of Group A and Group B

Characteristics	Group A		Group B	
	Mean	SD	Mean	SD
Age	47.07	5.91	49.81	5.26
	Sex, n (%)			
Male	8	53.3	8	53.3
Female	7	46.7	7	46.7
	Side of Involvement	n (%)		
Right	6	40	7	46.7
Left	9	60	8	53.3

Table 2: NPRS Comparison

Measure ment	Group A				Group B				Pre Post Difference			
	Pre		Post		Pre		Post		Group A		Group B	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
NPRS	7.60	1.12	3.60	0.98	6.87	1.24	4.93	1.21	4.00	0.75	1.93	0.59
't' value		0.346				3.53				4.64		
'p' value		0.001				0.001				0.001		

Table 3: AKET Comparison

Measure ment	Group A				Group B				Pre Post Difference			
	Pre		Post		Pre		Post		Group A		Group B	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
AKET	48.40	3.87	31.93	3.05	48	2.83	36.27	2.37	16.47	1.30	11.73	1.38
't' value		48.98				32.76				9.61		
'p' value		0.001				0.001				0.001		

Table 4: TUG Comparison

Measure ment	Group A				Group B				Pre Post Difference			
	Pre		Post		Pre		Post		Group A		Group B	
	Mean	S.D	Mean	S.D	Mear	S.D	Mean	S.D	Mean	S.D	Mean	S.D
TUG	20.89	2.51	11.35	1.94	22.38	3.57	16.19	3.34	9.55	1.20	6.19	1.04
't' value		30.77				23.03				8.19		
'p' value		0.001				0.001				0.001		

after treatment. The mean improvement in TUG in group A (M=9, 55±1,20) was significantly higher (t=8,19, P=0,001) than in group B (M=6,19± 1,04).

Study procedure

In the study, 30 subjects were selected using a random sampling method based on selection criteria. The purpose of the study was explained, and informed consent was obtained from each participant. Demographic data were collected. Subjects were allocated randomly into two groups. Group A (N=15) received PNF Stretching, wax therapy and isometric quadriceps exercise and group B (N=15) received Static stretching, wax therapy and isometric quadriceps exercise. The pain intensity was measured with the Numerical Pain Rating Scale (NPRS), hamstring flexibility by Active Knee Extension Test (AKET) and functional mobility by Timed up and Go test (TUG). The above evaluation was performed on the first visit with the patient before the beginning of treatment and again on the last day of treatment at the end of the 6^{th} day.

Outcome measures

Pain

The NPRS was found to be a reliable and effective pain measurement outcome. The straight line was drawn on the evaluation sheet with two endpoints '0' and '10' from left to right. The end marked with '0' indicates no pain, while the other end marked with '10' indicates severe pain. Patients were asked to mark a point on the line that corresponds to the amount of pain they perceived during the evaluation.

Timed up and go Test (TUG)

TUG is an easy and low-cost test developed to evaluate the functional mobility of patients during daily activities. The test consists of the following sequence of movements: standing up from a standard chair, walking for 3 m, turning back to the chair and sitting again. The time taken by patients to complete this sequence of movement is recorded and compared before and after treatment (Podsiadlo and Richardson, 1991).

Active knee extension test (AKET)

AKET is used to identify hamstring muscle tightness. The patient lies supine with hip and knee flexed to 90 degrees and grasps the thigh in order to stabilize the hip joint. The subject was then asked to extend the knee by holding the hip in a 90- degree flexion. The fulcrum of Goniometer was centered on the lateral condyle of the femur with the proximal arm securing the femur and the distal arm aligned to the lower leg. If the knee is bent more than 20° at the end, the tightness of the hamstring is present (Odunaiya *et al.*, 2005).

Experimental conditions

Technique: 1PNF (Hold-relax) stretching

Patient with 90° hip flexion in supine. The therapist stands near the patient's leg region. The therapist should extend the knees of the subjects until the patient has a mild stretching feeling in the hamstring muscle. The subject is asked to bend his knee against the therapist's hand resistance and thus gain an isometric form of contraction in the hamstring muscles. The subjects have eight seconds of contraction, and the therapist is commanded to relax the hamstring muscles. The therapist extends the hamstring muscle immediately after muscle relaxation to a point where the subject reported a mild to moderate, painless stretch and holds for 30 seconds. This procedure is repeated 3 times in each session with a rest of 10 seconds between the stretches. The duration of PNF stretching is given for one week, 6 sessions per week.

Technique: 2 Static stretching

Patient with 90° hip flexion in supine. The therapist stands near the patient's leg region. The therapist should passively extend the knees of the subjects until the patient has felt a mild to the moderate sensation of stretching without any pain and the position is maintained for 30 seconds. Then repeat the procedure three times, with the rest of 10 seconds between the stretches. The duration of static stretching is given for one week, 6 sessions per week (Meena and Madhavi, 2016).

Isometric Quadriceps Exercise

Patient Supine lying, Isometric quadriceps exercise with knee extension by placing a rolling towel under the knee and the subject is asked to contract the quadriceps muscle isometrically, and the ankle dorsiflexes, causing the patella glides proximally. 3 sets of exercise were performed. Each set had 10 repetitions. Time to hold 10 seconds (Zakir, 2016).

DATA ANALYSIS AND RESULT

The entire statistical procedure is performed through the Statistical Package Social Sciences (SPSS-21). A total of 30 subjects was chosen and divided randomly into two Group A and Group B; the outcome measures were NPRS, AKET and TUG. PNF stretching for group A has been applied, and static stretching for group B has been applied. As NPRS was a discrete variable, non-parametric tests such as the Wilcoxon signed rank test (before and after treatment), and the Mann Whitney U test (between-group comparison) is selected. Other outcome variables are studied by parametric tests such as the paired 't' sample (before and after treatment) and the Independent 't' sample test (between-group comparisons).

The Mean age of the study population was 47.07years with the corresponding Standard deviation of 5.91 in Group A. The other baseline characters of group A and group B are presented in Table 1.

DISCUSSION

Muscle plays an important role in the joint structure and function. In OA knee, tight muscles, increase joint compression while tightening the hamstring muscles leads to poor coordination and slower response time. The American Academy of Orthopedic Surgeons has noted that quadriceps muscle weakness is a risk factor for structural damage to the knee (Adegoke *et al.*, 2007).

The muscle impairment affects the anteroposterior knee joint stability and makes the patients feel unstable, leading to reduced personal confidence and performance and independence in daily activities, leading to disability and dysfunction in patients with OA knee (Emrani *et al.*, 2006). Therapeutic exercise regimes concentrate on strengthening and stretching the muscle. The primary aim of the study was to compare the effectiveness of PNF stretching Vs static stretching for pain, ham- string flexibility and functional mobility in patients with OA knee.

The increased flexibility of the hamstring can be due to several factors. The viscoelastic and neural properties of the musculotendinous unit are the most prominent. Musculotendinous units work viscoelastically and thus have the properties of creep and stress relaxation. Creep is characterized by the lengthening of muscle tissue because of the fixed load. The stress relaxation is characterized by the reduction in force overtime required to hold a tissue at a certain length. The musculotendinous unit deforms or lengthens as it is stretched and passes through elastic and plastic deformation before rupturing completely (Taylor *et al.*, 1990).

In group B, who received static stretching, wax therapy and isometric quadriceps exercise, this means that static stretching with wax therapy reduces pain and improves hamstring flexibility. The reduction of pain after static stretching may be due to the inhibitory effect on the Golgi tendon organ, which reduces neuronal motor discharges and relaxes the musculotendinous unit by resetting its resting length and modifying the Pacinian body. This reflection helps to relax in musculotendinous tension and reduces the perception of pain (Frontera, 2003).

This study shows, patients who received PNF stretches with wax therapy, and isometric quadriceps exercise showed better improvement in pain, hamstring flexibility and functional mobility than subjects who received static stretching, wax therapy and isometric quadriceps exercises. Our study supports the previous study conducted by Meena. V, et al., on " The effectiveness of PNF stretching VS Static is stretching for pain and hamstring flexibility after moist heat in 30 people with OA knee" and concluded that PNF stretching together with moist heat showed significant improvement in hamstring flexibility and pain reduction compared to static stretching.

In the present study, the possible explanation for a significant improvement in hamstring flexibility through PNF (Hold-Relax) stretching may be due to the mechanism that the PNF stretching causes neural inhibition, which reduces the reflex activity in turn. An inhibitory interneuron reduces the al- pha motor neuronal activity of the hamstring muscle, resulting in relaxation of the muscle and de- creased stretch resistance (Ebrahimian, 2013).

According to Addala and Kumar (2013), PNF stretching involves isometric muscle contraction, which stimulates the proprioceptors of muscle fibers and causes pain relief through the theory of pain gate control. A hypertonic muscle can be passively extended to a new resting length immediately after an isometric contraction.

This finding is consistent with the results of Maryam Ebrahimian, who showed that PNF (Hold and Relax) is more effective than static stretching to improve flexibility in the hamstring. According to Gribble *et al.* (1999), PNF stretching causes an inhibition of the function of the muscle spindle and the Golgi tendon organ within the tendon. The hold and relax technique includes an isometric contraction of the hamstring, which allows an Autogenic inhibition within the hamstring muscle group, leading to muscle relaxation and reduced stretch resistance, thereby increasing ROM.

But according to Taylor *et al.* (1990) the flexibility improvement by PNF stretching revolves around the viscoelastic properties of muscle-tendon junctions. Because of the viscoelastic properties of the muscles, the musculotendinous junction can lengthen in response to the loads applied and the duration for which they are applied. Therefore, if a muscle is exposed to certain loads repeatedly for certain durations, a change in muscle length can occur. This decrease in resistance over time is called stress relaxation.

Recommendations and future direction

Long- term studies are recommended with long-term follows- up for access to long- term benefits.

Future studies can be conducted on large sample size. The subjects can be advised by the home stretching program in order to maintain the increased flexibility of hamstring.

CONCLUSION

The results of the study conclude that PNF stretching and static stretching is effective in reducing pain, improving hamstring flexibility and functional mobility in OA knee patients. However, subjects receiving PNF stretches with wax therapy, and isometric quadriceps exercises showed a better pain reduction, hamstring flexibility and functional mobility than subjects receiving static stretching, wax therapy and isometric quadriceps exercises. In conclusion, the PNF stretching treatment program is effective in reducing pain, improving hamstring flexibility and functional mobility in patients with OA knee compared to static stretching.

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