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Comparison between the effects of Maitland's mobilization versus its combination with vastus medialis oblique neuromuscular stimulation on two scales (NPRS & WOMAC) in knee osteoarthritis patients

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***Background & objectives*: Osteoarthritis (OA) is the most common form of arthritis that increases with age affecting the population from the middle age to the elderly. The present study was undertaken to find whether neuromuscular stimulation of vastus medialis oblique (VMO) in combination with Maitland's mobilization and exercises was more effective as compared to Maitland's mobilization with exercises alone in patients with knee OA.**

***Methods*: Sixty patients with knee OA were purposively selected and randomly distributed to two groups that received an intervention for eight weeks. Group A patients received Maitland's mobilization in combination with exercises and group B patients received the same intervention as group A in combination with neuromuscular stimulation of VMO muscle. After eight weeks, outcome measures, *i.e.* Numeric Pain Rating Scale (NPRS) and Western Ontario and McMaster University Osteoarthritis Index (WOMAC) index, were reassessed.**

***Results*: Both groups showed significant (P<0.05) within-group improvement in the knee pain levels and stiffness as reflected by NPRS and WOMAC index.**

***Interpretation & conclusions*: Patients of both the groups (A and B) were found to be improving significantly in pain and disability, group A patients receiving Maitland's mobilization in combination with exercises were found to get more relief in pain and disability.**

Key words Mobilization - neuromuscular electrical stimulation - NPRS - osteoarthritis - vastus medialis oblique - WOMAC

Osteoarthritis (OA) tends to increase with age affecting the population from the middle age to the elderly[1]. It is defined as a chronic, progressive musculoskeletal disorder characterized by gradual loss of cartilage in joints which results in bones rubbing together and creating stiffness, pain, and impaired movement. The disease most commonly affects the joints in the knees, hips, hands, feet, and spine[2]. According to the American College of Rheumatology (ACR) Diagnostic and Therapeutic Criteria Committee, OA is defined as 'a heterogeneous group of conditions that lead to joint symptoms and

signs which are associated with defective integrity of articular cartilage, in addition to related changes in the underlying bone at the joint margins'[2]. Clinically, it is characterized by joint pain, tenderness, limitation of movement, crepitus, occasional effusion and variable degrees of local inflammation leading to functional impairment and increased risk of morbidity and mortality. Multiple factors such as instability, fracture, patellar subluxation, increased Q angle, inefficient vastus medialis muscle, poor post-traumatic alignment, excessive lateral pressure syndrome and posterior cruciate ligament injury have been identified as potential causes underlying OA onset and progression[3].

Exercises strengthen the muscles, reduce pain, improve physical function and are therefore considered a major intervention in the conservative treatment of patients with knee OA[4]. Neuromuscular electrical stimulation (NMES) is defined as the application of electrical stimulation using surface electrodes placed over skeletal muscles to produce visible muscle contraction through the activation of intramuscular nerve branches. The rehabilitation protocols that include NMES provide additional stimulus to increase muscle strength in patients with knee OA[5].

Mobilization/manipulation is defined as "a manual therapy technique comprised of a continuum of skilled passive movements that are applied at varying speeds and amplitudes, including a small amplitude/high velocity therapeutic movement"[6]. The intensity of mobilization is commonly categorized based on a 5-grade classification system defined by Maitland[7,8]. In Maitland's mobilization, passive physiological and accessory oscillatory movements are applied to gain range of motion (ROM), lost due to pain or stiffness, and to restore optimal kinematics between the joint surfaces, where the grade, frequency and dosage of mobilization are determined by severity, irritability and nature (SIN) of the disorder[9].

Both NMES and Maitland's mobilization have been found to be effective in reducing the pain and restoring the function in knee OA when used alone[10], but limited studies are available regarding the added effect of vastus medialis oblique (VMO) stimulation[11]. Numerous studies are available where individual effects of these techniques were studied[12], but there is no study reporting their added effect. Hence, the present study was undertaken to assess whether neuromuscular stimulation of VMO in combination with Maitland's mobilization and exercises was more effective as compared to Maitland's mobilization with exercises alone in patients with knee OA.

Material & Methods

Study design: *Experimental*: For the present prospective study, 60 patients with knee OA were recruited from the Orthopaedics outpatient department, Sharda Hospital, Greater Noida, Uttar Pradesh, India, from July 2016 - July 2017, using purposive sampling. The study was approved by the Institutional Ethics Committee, School of Medical Sciences & Research, Sharda Hospital, Greater Noida, Uttar Pradesh, India. All participants provided written informed consent. The sample size was calculated by the following formula[13]:

$$n = \frac{t^2 \times p(1-p)}{m^2}$$

where, n = required sample size, t = confidence interval at 95 per cent (standard value of 1.96), p = estimated prevalence of knee OA in this study, and m = margin of error. The power of the study was 85 per cent (α=0.05).

Both male and female patients between the age groups of 40-60 yr, diagnosed cases of knee OA as per the criteria established by the ACR[14], diagnosed cases of knee OA (grade 2 or more) based on the radiographic classification developed by Kellgren and Lawrence[15] and willingness to participate in the study were selected[16]. As a part of screening, manual muscle, ROM, muscle tightness, gait and special tests of the knee were also performed during the subjective examination and knee OA patients were included if they had restricted ROM and muscle tightness around the knee.

Those who had medical co-morbidities (*e.g*. hypertension, cardiovascular diseases and diabetes), implanted electrical devices or metallic implants, neurological disorders, inflammatory arthritis, non-ambulatory status, significant cognitive impairment, participation in an exercise programme within the last six months, involvement in a previous similar study, anticoagulant therapy, recent surgery (within three months), pain due to other knee structures, hip or lumbar spine, traumatic injury to the lower limb and history of any systemic disease were excluded.

Methods: Selected participants were randomly allotted to two groups. Participants were blind to group assignment. Group A (n=30) patients received Maitland's knee mobilization and a combination of stretching, strengthening and ROM exercises. Group B

(n=30) patients received the same treatment as group A in addition to neuromuscular stimulation of VMO muscle.

Western Ontario and McMaster University Osteoarthritis Index (WOMAC) was used as the outcome measure[17] to evaluate the patients' disability. WOMAC is the best-validated and most widely used outcome measure for knee OA. It is a 24 item questionnaire focussing on pain, stiffness and functional limitation. The questionnaire was freely available online (*http://www.rheumatology.org/practice/clinical/clinicianresearchers/outcomes-instrumentation/WOMAC.asp*), hence required no permission. Numeric Pain Rating Scale (NPRS) was used as an outcome measures[18] for pain intensity. Patients of group A performed the following set of exercises along with knee mobilization:

1. *Strengthening exercises*: The following strengthening exercises were performed (three sets, 10 repetitions and 10 sec hold); (*i*) isometric quadriceps; (*ii*) resistance band knee extension in sitting; (*iii*) squats with Swiss ball; and (*iv*) straight leg raise.
2. *Stretching exercises[1]*: Calf, hamstring, quadriceps and iliotibial band stretching was given (3 repetitions and 30 sec hold).
3. *Range of motion exercises[19]*: The following exercises were performed; (*i*) knee in mid flexion to full extension: two 30 sec bouts with 3 sec hold at end range; and (*ii*) knee in mid flexion to full flexion: two 30 sec bouts with 3 sec hold at end range.
   All exercises (strengthening, stretching and ROM were given for three sessions in a week.
4. *Knee joint mobilization*: Patellar mobilization; oscillatory movements were given to the patella in different directions (medial, lateral, superior and inferior) as required. Individuals were in the supine position and the therapist stood by the affected side[20]. A total of 10-15 repetitions were given three times a week. Tibiofemoral distraction[21] was given three times a week with 3-5 repetitions and 10 sec hold.

Group B patients allocated to the NMES group underwent similar exercises as group A in addition to NMES. Prior to the application of NMES, the patient was supported comfortably in a good light. The area to be stimulated was exposed and washed with soap water to remove the natural oils and dirt[22] and reduce the resistance. For the stimulation of VMO, a dot was drawn on the muscle belly, 4 cm above the superomedial patella border, orientated 55° to the vertical[23]. Each patient was seated on a chair, with 90° of hip and knee flexion. The patient was instructed to perform a contraction of the quadriceps whenever NMES was received.

For NMES application, two carbon electrodes were positioned on VMO muscle. The parameters used were frequency of 50 Hz; pulse duration of 250 msec; time on: 10 sec and time off: 30 sec, for 10 min. The intensity of the NMES used was the maximum tolerated by each patient, although this intensity was not recorded. The waveform used was pulsed rectangular biphasic and symmetrical. The equipment used was the Muscle Stimulator Diagnostic and Therapeutic (International Electro Medical Co., Delhi, India). Three sessions per week were given for NMES.

Both the groups received the intervention for eight weeks following which outcome measures were recorded.

Data analysis: The data were analyzed using SPSS 22 software (IBM Statistics V22, Armonk, NY, USA). Unpaired t test was used to make comparisons between groups. Within-group comparisons were made using the paired Student's t test.

Results & Discussion

The age of patients in group A was 44.25±6.43 yr with seven males and 23 females. The age of group B patients was 45.6±4.7 yr with six males. Both groups were comparable on baseline characteristics.

Table I shows within-group comparison of the mean for NPRS score for groups A and B. Both groups showed a significant (P<0.05) improvement in NPRS scores after eight weeks. Table II shows within-group comparison of the mean for WOMAC score for groups A and B. Both groups showed a significant (P<0.05) improvement in WOMAC scores after eight weeks.

Table III shows the comparison of mean values of NPRS and WOMAC scores between groups A and B after eight weeks of intervention. Significant differences were observed for both the outcome measures with group A showing more improvement as compared to group B (mean difference −1.4 and −10.6, respectively).

Both groups showed significant within-group improvement in the knee pain levels and stiffness as reflected by NPRS and WOMAC index. This was similar to the findings of Talbot *et al*[24] who compared

Table I. Within-group comparison for Numeric Pain Rating Scale (NPRS) at 95% confidence interval

Groups	Mean±SD
Group A (n=30)	
Pre-intervention (at baseline)	5.8±1.22
Post-intervention (after 8 wk)	2.7±1.11*
Group B (n=30)	
Pre-intervention (at baseline)	7.1±1.74
Post-intervention (after 8 wk)	4.1±1.31*

P *<0.05 compared to baseline value

Table II. Within-group comparison of Western Ontario and McMaster University Osteoarthritis Index (WOMAC) at 95% confidence interval

Groups	Mean±SD
Group A	
Pre-intervention (at baseline)	55.4±16.2
Post-intervention (after 8 wk)	32.7±14.4*
Group B	
Pre-intervention (at baseline)	65.8±12.6
Post-intervention (after 8 wk)	43.3±11.4*

P *<0.05 compared to baseline value

Table III. Between-group comparison of mean±standard deviation for Numeric Pain Rating Scale (NPRS) and Western Ontario and McMaster University Osteoarthritis Index (WOMAC) after eight weeks (at 95% confidence interval)

Outcome measure	Mean±SD	
	Group A (n=30)	Group B (n=30)
NPRS	2.7±1.11*	4.1±1.31
WOMAC	32.7±14.4*	43.3±11.4

P *<0.05 compared to group A

the effects of a 12 wk NMES intervention programme in patients with symptomatic knee OA, and found faster walking pace, quicker chair rise and decreased pain despite only modest (9%) improvements in leg extensor strength. The improvement in pain levels and WOMAC score could be due to strengthening of quadriceps muscle as reported by Selkowitz[25] who investigated the effects of muscle strength in the quadriceps femoris training isometrically with electrical stimulation and found a significant increase in the group training isometrically with electrical stimulation. Evidence shows that electrical stimulation of atrophied quadriceps muscles can improve its isometric strength with the combination of NMES and volitional exercise[26].

Robinson[27] indicated that NMES was 'significantly more effective at strengthening quadriceps than voluntary exercise'. However, the findings of our study were contradictory to those done by Paternostro-Sluga *et al*[28] who found that voluntary exercise and NMES showed no differences. In the present study, the pain levels were reduced in both groups, indicating that both mobilization and stimulation were effective. Mobilization produces a multitude of beneficial effects through stimulation of peripheral mechanoreceptors, inhibition of nociceptors and an increase in synovial nutrition, thus helping to reduce pain[29].

Several mechanisms have been proposed to explain how hypoalgesic effects of passive joint mobilization may be mediated. Sambajon *et al*[30] stated that local mechanical disturbance may modify the chemical environment and thereby alter the concentration of inflammatory mediators, which may lead to a reduction in the pain experienced. Melzack and Wall[31] in 1999 gave the theory that movement might trigger segmental inhibitory mechanisms relieving pain. Wright[32] and Souvlis *et al*[33] hypothesized that mobilization may activate descending pain inhibitory systems, mediated supraspinally. Improvement in outcome measure score may be explained due to improved circulation or pain gate mediated analgesia immediately following mobilization of the biomechanically impaired arthritic knee. Author study also reported that Maitland's technique was effective in reducing the symptoms of knee OA[34] and realigning collagen, when specific movements stress the specific parts of the capsule Mechanical force applied during Maitland's mobilization may lead to breaking up of adhesions. Maitland's mobilization mainly consists of rhythmic oscillatory movements which stimulate the Type II dynamic mechanoreceptors and by this way can inhibit the Type IV nociceptive receptors. Maitland's rhythmic oscillations have an effect on circulatory perfusion and fluid flow. This helps in facilitating fluid exchange and dispersing the chemical irritants resulting in reversal of ischaemia, oedema and inflammation cycle. Hence, the joint effusion and pain is relieved due to reduction of the pressure over nerve endings[35].

The findings of our study were consistent with Vaishnavi and Rajeeva[36] who showed a significant improvement in VAS and WOMAC score in patients with stage I and II OA of knee. Further, patients with

a more advanced stage of OA might obtain greater benefit from NMES[37]. Imoto *et al*[38] compared NMES plus conventional exercise programme with an exercise programme alone in reducing pain and improving physical function in patients with knee OA, and found that both were effective and no therapeutic benefit was observed with the use of NMES.

In conclusion, our result showed that although both the techniques were effective, Maitland's mobilization in combination with exercises was found to be more effective in improving pain levels and WOMAC scores in patients with knee OA.

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***Conflicts of Interest*:** None.

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