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RESEARCH ARTICLE
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TO FIND OUT THE EFFECTIVENESS OF NMES & EXERCISE ALONG WITH PATIENT EDUCATION IN OSTEOARTHRITIS

Shobha[1*], Dr. Monika Sharma[2]

[1*]Researcher, Department of Physiotherapy, Institute of Applied Medicines and Research (IAMR), [2]Professor and Head of Physiotherapy, Department, Institute of Applied Medicines and Research (IAMR), Atal Bihari Vajpayee Medical University, Lucknow, Uttar Pradesh.

ABSTRACT

Osteoarthritis (OA) of the knee is a prevalent musculoskeletal condition that causes pain, stiffness, and functional limitations, significantly affecting the quality of life of those impacted. This study aimed to evaluate the effectiveness of a combined rehabilitation approach involving Neuromuscular Electrical Stimulation (NMES), isometric knee exercises, and patient education in the management of chronic knee OA. A total of 100 participants were randomly assigned to two groups: Group A received NMES therapy, isometric knee exercises, and education, while Group B received conventional treatment with isometric knee exercises and education. The outcomes were assessed using the Visual Analog Scale (VAS) for pain and the WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) for functional disability at both pre-treatment and post-treatment stages. The results demonstrated significant improvements in both pain reduction and functional mobility in both groups, with Group A showing more pronounced improvements compared to Group B. NMES combined with isometric exercises and education was found to be an effective intervention in improving pain, muscle strength, and function in knee OA patients. These findings suggest that incorporating NMES into rehabilitation programs for knee OA can offer additional benefits in the management of this chronic condition. Further research is required to explore the long-term effects and optimal protocols for these interventions.

KEY WORDS: Osteoarthritis, Knee Osteoarthritis, NMES, Neuromuscular Electrical Stimulation, Isometric Exercises, Patient Education, Pain Relief, Functional Mobility, WOMAC, Visual Analog Scale (VAS), Rehabilitation, Chronic Knee Pain, Musculoskeletal Disorders, Quadriceps Strength, Physiotherapy, Osteoarthritis Treatment.

INTRODUCTION

Osteoarthritis (OA) is the most prevalent of the rheumatic diseases and is recognized as a leading cause of disability worldwide. It primarily affects weight-bearing joints, with knee osteoarthritis (KOA) being one of the most disabling forms. The condition is characterized by pain, stiffness, decreased range of motion, and muscle weakness. These symptoms can severely impair a person's ability to perform routine tasks such as climbing stairs, rising from a chair, and walking, ultimately leading to a loss of independence.

Osteoarthritis of the knee typically manifests as a degenerative process that involves cartilage deterioration, subchondral bone changes, and synovial inflammation. The condition progressively worsens over time, leading to functional impairments. In addition to the physical limitations it imposes, OA can result in psychological distress due to the chronic nature of the pain and functional restrictions. According to Nadine M. (1993), osteoarthritis presents not only as a personal challenge

for affected individuals but also as a significant societal burden, with its high prevalence placing a substantial strain on healthcare systems and the economy.

Self-management programs for OA have proven to be effective in improving patient outcomes. These programs typically include components like goal setting, optimizing activity levels, self-relaxation, problem-solving strategies, and the development of skills for monitoring and interpreting health status changes. However, despite the success of self-management approaches in reducing pain and improving quality of life, there remains a lack of clarity on which specific interventions benefit patients the most. Many of these programs require individuals to be motivated to change their habits and adopt new skills, making it essential to assess the readiness and willingness of patients to engage in these treatments effectively.

In this context, the combination of Neuromuscular Electrical Stimulation (NMES), exercise therapy, and patient education has the potential to offer a comprehensive approach to OA management. While each of these interventions has shown promise individually, the synergistic effects of combining them have yet to be fully explored. This study aims to evaluate the combined efficacy of NMES, exercise therapy, and patient education in managing chronic knee osteoarthritis, with a particular focus on pain relief, muscle strength, functional mobility, and overall quality of life.

AIM OF STUDY

The aim of this study is to evaluate the efficacy of a combined intervention consisting of Neuromuscular Electrical Stimulation (NMES), exercise therapy, and patient education in the management of osteoarthritis (OA), specifically focusing on the improvement of pain relief, muscle strength, functional mobility, and overall quality of life in OA patients.

OBJECTIVES

- To evaluate the efficacy of Neuromuscular Electrical Stimulation (NMES) in managing chronic knee osteoarthritis.
- To assess the effectiveness of exercise therapy and patient education in chronic knee osteoarthritis.
- To compare the combined efficacy of NMES, exercise therapy, and patient education versus exercise therapy and patient education alone in chronic knee osteoarthritis.

HYPOYHESIS

Null Hypothesis (H_0):

There will be no significant effect of Neuromuscular Electrical Stimulation (NMES) and exercise therapy combined with patient education on knee pain when compared to conventional treatment alone in patients with knee osteoarthritis (OA).

Experimental Hypothesis (H_1):

The combination of Neuromuscular Electrical Stimulation (NMES), exercise therapy, and patient education will be more efficacious in reducing knee pain and improving functional outcomes in patients with knee osteoarthritis (OA) compared to exercise therapy and patient education alone.

EXCLUSION CRITERIA

- **Age Group**: 40 to 60 years.
- **Gender**: Both male and female participants.
- **Knee Pain**: Non-traumatic history of knee pain in the dominant leg.
- **Pain Characteristics**: Presence of localized pain and tenderness on the anterior and posterior sides of the knee, with pain during bending and extension.
- **Pain Duration**: Pain duration between 10 days to 3 months.
- **Knee OA Severity**: Patients with Grade II and Grade III osteoarthritis (based on the Kellgren-Larence grading scale).

EXCLUSION CRITERIA

- Grade I and Grade IV Osteoarthritis (based on the Kellgren-Lawrence radiographic scale).
- Presence of neurogenic disorders affecting knee function.
- ·Rheumatoid arthritis or other systemic inflammatory conditions.
- History of hip or knee surgery.
- Knee pain minimized during active knee movement.
- History of fractures or dislocations involving the knee complex**.**

SAMPLE SIZE

The study included subjects who met the inclusion and exclusion criteria, and appropriate sampling was carried out using random allocation. The subjects were divided into two groups:
Group A: NMES, Isometric knee exercise, and education.
Group B: Isometric knee exercise, NMES, and education for knee pain treatment.

TOOL USED

Tools Used

NMES Unit

Device used to provide Neuromuscular Electrical Stimulation (NMES) to the quadriceps for muscle strengthening and pain reduction.

Cotton

Used for skin preparation and electrode placement.

Velcro Strap

Used to secure the electrode on the quadriceps to help reduce pain and improve muscle strength.

Visual Analog Scale (VAS)

Used to rate the relative magnitude of experimental chronic pain, commonly represented by a 10 cm horizontal line, with the left-hand anchor representing the minimum pain and the right-hand anchor representing the maximum pain.

WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index)

A functional index comprising 8 items that assess the ability to perform activities of daily living, with scores ranging from 0 (no difficulty) to 10 (inability to perform the activity).

DATA ANALYSIS AND INTERPRETATION

OBSERVATION AND DATA ANALYSIS

Statistics were performed using SPSS 11. Resu1ts were ca1cu1ated by using 0.05 significance 1eve1.

Using the statistica1 formu1ar for the mean, for a given number of subjects, the mean of different variab1es is ca1cu1ated follows:

$$X = \frac{\sum X}{N}$$

Where,

N= Number of subjects X= each subjects va1ue

STANDARD DEVIATION(σ)

$$S = \sqrt{\frac{\Sigma x^2}{N}}$$

x= deviation of score from mean N= Number of subject

t-test of dependent means$t = M_1 - M_2$

$$S_{DM}$$

$$S_{DM} = \sqrt{\left[\frac{(N_1 - 1)(s^2) - (N_2 - 1)(s^2)}{N_1 + N_2 - 21}\right]\left[\frac{N_1}{N_2} + \frac{1}{N_1} + \frac{1}{N_2}\right]}$$

$$s = \sqrt{\frac{Zx^2}{N}}$$

df= N_1+N_2-2

Where:

M = mean, SDM = Standard error of the differentiation between means
N = number of subjects in group,
S = standard deviation of group
DF = degrees of freedom

t-TEST OF INDEPENDENT MEANS

$$t = \frac{M_1 - M_2}{S_{DM}}$$

$$S_{DM} = \sqrt{\left[\frac{(N_1 - 1)(s^2) - (N_2 - 1)(s^2)}{N_1 + N_2 - 21}\right]\left[\frac{N_1}{N_2} + \frac{1}{N_1} + \frac{1}{N_2}\right]}$$

$$s = \sqrt{\frac{Zx^2}{N}}$$

df= N_1+N_2-2

M = mean, SDM = Standard error of the differentiation between means
N = number of subjects in group,
S = standard deviation of group
DF = degrees of freedom

RESULTS

Tab1e 7.1: Means or SD of Age of the subjects for Group A, B or Group C

	Group A Mean ± SD	Group B Mean ± SD	Group C Mean ± SD
Age	31.46 ± 2.85	31.80 ± 2.50	32.15± 2.48

Table 1 depict the mean or standard variance of age of the subjects of Group A and Group B, which appears to be 31.46 ± 2.50 from Group A or 31.80 ± 2.85 from Group B or Group C 30.15± 2.48 respectively.

Graph

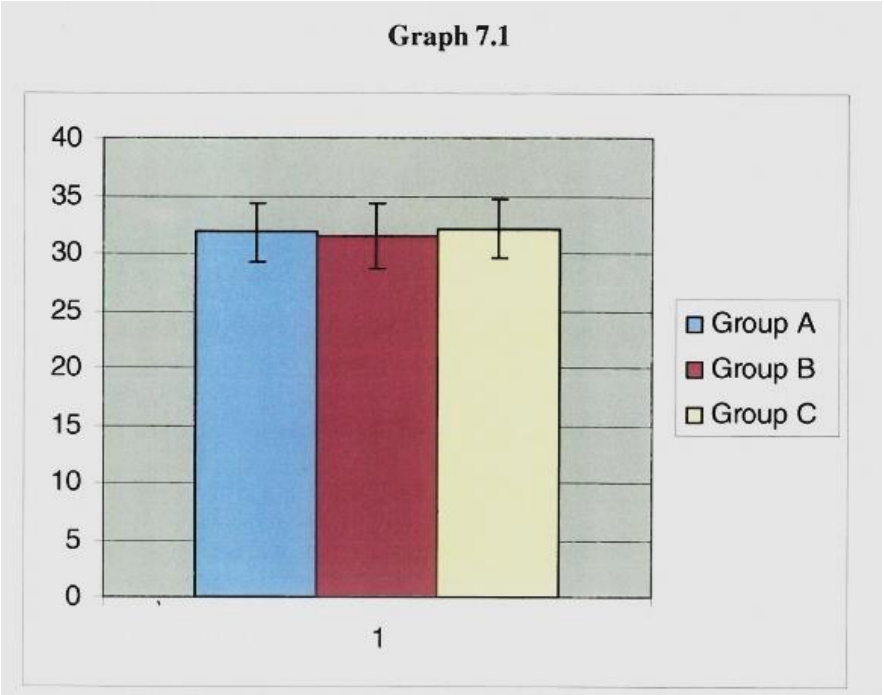
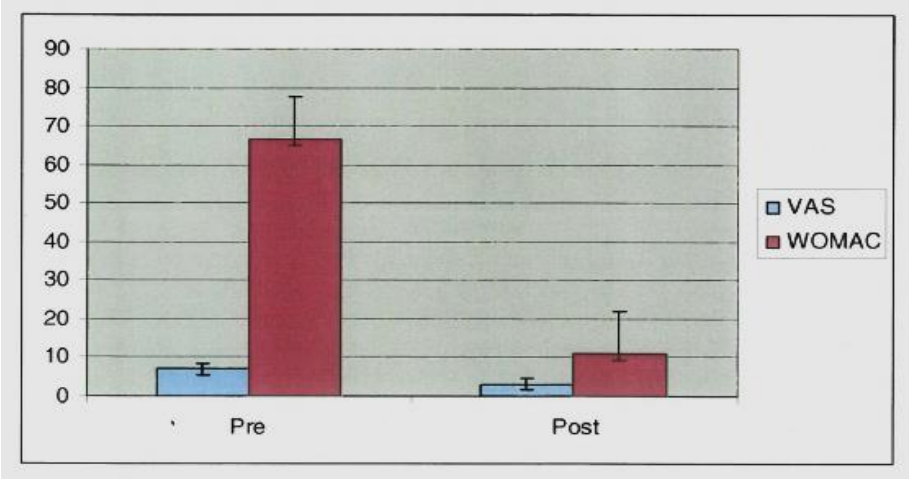


Table 7.2: Means or SD of Pre or Post value of VAS or WOMAC for subjects of Group A Group B or Group C

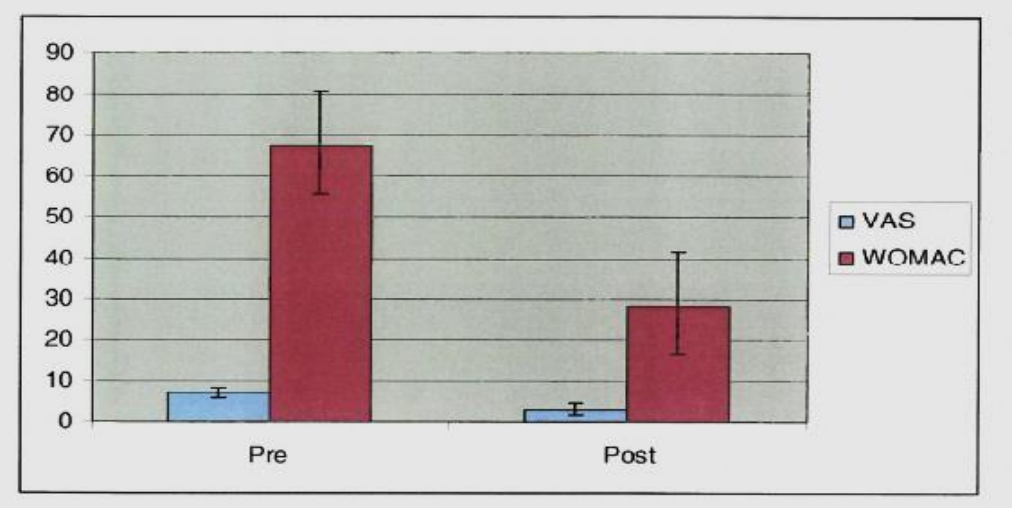
Session	Group A Mean ± SD		Group B Mean ± SD		Group C Mean ± SD	
	VAS	WOMAC	VAS	WOMAC	VAS	WOMAC
Pre	7.02±1.52	66.69±11.03	7.13±1.40	67.69±13.03	7±1.30	67.54±12.24
Post	3.11±1.30	28.62±1.75	3.13±1.24	28.51±11.90	5±1.41	51.02±13.34

Table 2 decribes the mean or standard variance of Pre and Post value of VAS or WOMAC of the subjects for Group A, which comes out to be 7.13±1.40, 667.69±13.03 and 3.13±1.24, 28.51±11.90. For Group B, which appears out to be 7±1.30, 67.54±12.24 or 5±1.41, 51.02±13.34 or Group C 7.16±1.52, 66.69±14.03, 3.13±1.30, 28.62±12.75 respectively.

Graph 7.2 Group A



Graph 7.3 Group B



Graph 7.4 Group C

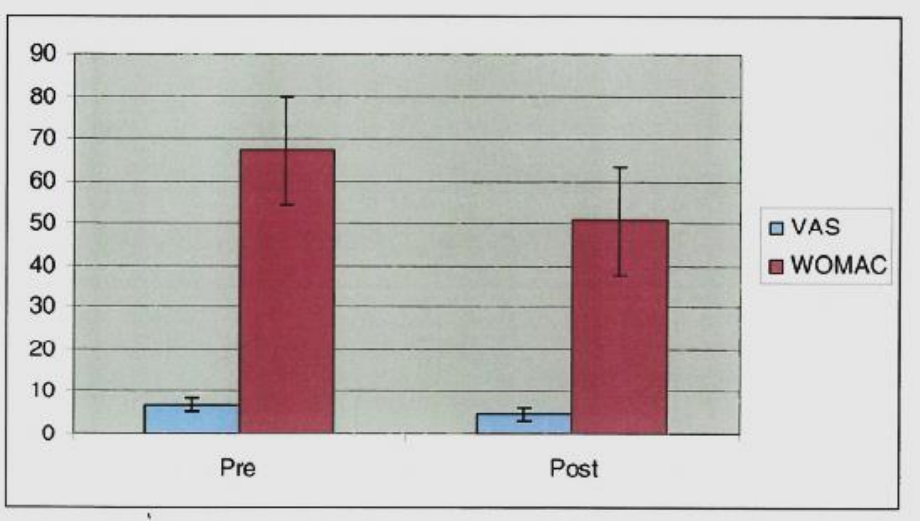


Table 7.3: Differentiation of mean value of VAS and WOMAC at Pre and Post sessions within Group A and Group B (intra group analysis)

Session	VAS		WOMAC	
	t-value	P value	t value	P value
Group A	20.49	P <0.05	14.49	P < 0.05
Group B	13.31	P < 0.05	19.48	P < 0.05

Table 3 describes the intra group analysis, the paired t-test finish to contrast the mean value of VAS or WOMAC at pre or Post session within Group A or Group B, the values for Group A VAS t value 20.49 (P<0.05) or WOMAC t value 14.49 (P < 0.05) or for Group B, VAS t value 13.31(P<0.05) or WOMAC t value 19.48 (P< 0.05) respectively.

Table 7.4 Mean differentiation (Post- Pre) or SD of VAS or WOMAC from Group A, Group B.

Session	Group A Mean ± SD		Group B Mean ± SD	
	VAS	WOMAC	VAS	WOMAC
Post-Pre	4.00±106	39.17±7.78	2.00±0.37	16.53±4.80

Table 4 describes the mean differentiation (Post-pre) or standard deviation of VAS or WOMAC for Group A were VAS 2.00±0.37 and WOMAC 16.53±4.80 or for Group B were VAS 4.00 ± 1.06 or WOMAC 39.17 ± 7.78 respectively.

Table 7.5: Differentiation of mean value at Pre-interval for VAS or WOMAC between Group A or Group B (intra group analysis)

Session	VAS		WOMAC	
	t-value	P value	t value	P value
Group A Vs Group B	-0.269	P > 0.05	-0.033	P < 0.05

Table 5 describes intra group analysis, the unpaired t-test finish to contrast the mean values at Pre-interval for VAS and WOMAC between Group A Group B were was t- value -0.269(P > 0.05) and WOMAC t-vale -0.033 (P > 0.05) respectively.

Table 7.6: Differentiation of mean value at Pre-interval for VAS and WOMAC between Group A or Group B (intra group analysis)

Session	VAS		WOMAC	
	t-value	P value	t value	P value
Group A Vs Group B Vs	3.83	P < 0.05	4.89	P < 0.05

Table 6 describes intra group analysis, the unpaired t-test finish to contrast the mean values at Pre-interval for VAS and WOMAC between Group A Group B were was t- value 3.83 (P < 0.05) and WOMAC t-vale 4.89 (P > 0.05) respectively.

Table 7.7: Differentiation of mean value at Pre-interval for VAS and WOMAC between Group A or Group B (intra group analysis)

Session	VAS		WOMAC	
	t-value	P value	T -value	P value
Group A Vs Group B Vs	-6.83	P <0.05	-9.58	P <0.05

Table 7 describes intra group analysis, the unpaired t-test finish to contrast the mean differentiation (post-pre) for VAS and WOMAC between Group A, Group B or were was t-value -6.83 (P<0.05) and WOMAC t-value -9.59(P<0.05) respectively.

DISCUSSION

This study aimed to evaluate the effectiveness of Neuromuscular Electrical Stimulation (NMES) and isometric exercises in the rehabilitation of chronic knee pain associated with osteoarthritis (OA). The results confirm that a rehabilitation approach incorporating NMES, isometric knee exercises, and patient education is effective in managing pain, improving knee strength, and enhancing overall functional mobility in patients with knee OA.

Both groups (Group A and Group B) demonstrated significant improvements in pain (VAS) and functional disability (WOMAC), as evidenced by the pre- and post-treatment scores. A paired t-test showed that both groups had clinically and statistically significant improvements in VAS and WOMAC scores, with Group A showing notable improvement, though not as pronounced as Group B. This indicates that NMES combined with isometric exercises and education contributes significantly to pain relief and improved knee function.

The efficacy of NMES and isometric knee exercises aligns with previous studies, including those by Kaufman et al., who demonstrated that isokinetic exercises minimize patellofemoral compression forces, leading to improved knee function. However, our study did not directly assess patellofemoral compressive power, though the reduction in knee pain may indirectly suggest a decrease in such compressive forces.

Baker et al. found no direct correlation between pain levels during testing and knee joint position errors, yet this does not rule out pain as a contributing factor to altered kinesthetic perception. While our study did not investigate this specific aspect, the reduction in pain following the intervention may have positively influenced the patient's proprioception and movement patterns.

In our sample, knee osteoarthritis was most commonly associated with the medial and lateral compartments, rather than isolated patellofemoral (PF) osteoarthritis. This is contrary to some prior studies that reported isolated PF OA more frequently. Our findings suggest that knee OA tends to involve more compartments with increasing age, which may explain the lower prevalence of isolated PF OA in our study sample.

Regarding the rehabilitation approach, isometric exercises and NMES significantly improved the strength and function of the quadriceps. Although the study did not measure gluteus medius strength or activation, improving these muscles could further enhance knee dynamics by improving patellar tracking and reducing pain caused by abnormal tracking. Future studies should investigate the impact of strengthening hip muscles, especially the gluteus medius, as it could play a crucial role in alleviating knee pain and improving function.

Recent literature has also emphasized the importance of aerobic and resistance training for patients with knee OA. Studies have shown that strengthening exercises and aerobic training can improve muscle strength, aerobic capacity, joint range of motion, and overall functional capacity. This is supported by findings from Kovar and colleagues, who reported improvements in timed walking distances and self-reported function in knee OA patients following an 8-week supervised walking program.

While both aerobic and resistance training have shown positive effects, it is still unclear which form of exercise is most beneficial for knee OA patients in the long term. It is possible that a combined approach, incorporating both types of exercise, may be most effective in improving physical function and preventing further disability. Future research should examine the optimal combination of these exercises to maximize outcomes for knee OA patients.

In conclusion, this study confirms that NMES, isometric exercises, and patient education are effective interventions for managing knee pain and improving function in chronic knee OA. However, further studies are needed to investigate the long-term effects of these interventions, especially when combined with hip muscle strengthening and aerobic training.

CONCLUSION

This study demonstrates the effectiveness of combining Neuromuscular Electrical Stimulation (NMES), isometric exercises, and patient education in the rehabilitation of knee pain associated with chronic osteoarthritis (OA). Both NMES and isometric exercises significantly improved pain, functional mobility, and strength in patients, with Group A (NMES + isometric exercises + education) showing substantial improvements in all measured parameters. These results highlight the importance of incorporating NMES and isometric exercises as part of a comprehensive rehabilitation program for knee OA. The findings align with existing literature that supports the role of exercise and NMES in improving knee strength and reducing pain. While the study confirms the benefits of these interventions, further research is needed to evaluate their long-term impact and to explore the potential benefits of combining these treatments with other forms of exercise, such as aerobic training, or strengthening of the gluteus medius. In conclusion, the combination of NMES, isometric exercises, and patient education provides an effective, non-invasive approach to managing knee osteoarthritis, improving pain relief, muscle strength, and functional outcomes. This approach can be a valuable addition to the conservative treatment options available for knee OA patients, with potential for broader application in clinical practice.

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