Advances in Bioresearch
Adv. Biores., Vol 16 (5) September 2025: 264-270

Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
DOI: 10.15515/abr.0976-4585.16.5.264270

Advances in Bioresearch

ORIGINAL ARTICLE

Evaluating Neuromuscular Training's Role On Balance, Proprioception and Functionality in Patients with Knee Osteoarthritis - An Experimental Study

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ABSTRACT
The Osteoarthritis is a commonest form of musculoskeletal disorder that affects the joint; it is caused by destructing articular cartilage. Knee osteoarthritis is the most common form of osteoarthritis. The overall prevalence of OA knee in India is 22-39%. It limits functional independence and impaired quality of life. Furthermore, poor balance and Proprioceptive defects are associated with the OA Knee. In this research we have used FITT protocol (frequency, intensity, time and type) that improve health of people. So, this study was done to check the role of neuromuscular training in patients with OA knee. To check role of neuromuscular training on Proprioception, Balance, Pain in patients with OA knee. Total 32 patients were taken between the ages of 45 to 65 diagnosed with OA knee. They were divided in two groups, Group A-Conventional exercises group and Group B-Experimental group, each group have 16 patients. The treatment was given 4 days per week for 4 weeks. SENSAMOVE, BOOMER & WOMAC used as outcome measures. There was statistically greater improvement in function and some components of balance in the experimental group when compared to conventional group. Hence it is beneficial to add neuromuscular training to conventional exercise program in patients with knee osteoarthritis.
Keywords*: Knee Osteoarthritis (OA Knee), Proprioception, Balance, Neuromuscular Training, Sensamove Miniboard, WOMAC, BOOMER.*

Received 23.04.2025 Revised 22.06.2025 Accepted 13.09.2025

How to cite this article:
Yash Khairekar, Vivek Kalwani, Yash Ghoghari and Payal Mehta. Evaluating Neuromuscular Training's Role On Balance, Proprioception and Functionality in Patients with Knee Osteoarthritis - An Experimental Study .Adv. Biores., Vol 16 (5) September 2025: 264-270.

INTRODUCTION

Arthritis is an inflammation of joints, common types of arthritis are rheumatic, rheumatoid, osteoarthritis, tubercular, gouty arthritis. Osteoarthritis is a normally a wear and tear process leading to degenerative joint disease of one or more joints. In India osteoarthritis of knee joint is most commonly occurs than the other joints. [1] Osteoarthritis represents the degenerative changes of the articular cartilage with ageing process. The pathogenesis of OA involves a degeneration of articular cartilage and remodeling of bone due to active response of chondrocytes and the inflammatory cells around articular cartilage of knee. Degenerative changes in the center resulting into Osteophytes formation at the edge of articular surface of the knee joint. [1] The development of OA in the knee joint is complex and is caused by modifiable and non- modifiable risk factors, Such as age, gender, obesity, ethnicity, genetic predisposition, hormonal factors and density of bone. Biomechanical factors - caused by sports, the workplace and workload, joint mal-alignment, and the obesity contributes to the joint injuries that leads to OA. [2] Knee pain, knee stiffness and reduce function are the three most common symptoms that are seen in OA knee patients. Pain is a leading cause of chronic disability in OA knee patients. Pain severity ranging from barely perceptible to immobilizing. Pain in OA knee typically increases by activity and relieves by rest. Short duration of stiffness less than 30 minutes may be seen in OA knee patients in the morning or after a period of inactivity. [3] It can be divided into non-surgical or surgical treatment. Non-surgical treatment includes non-pharmacological and pharmacological treatment. [4] Proprioceptive impairments may lead to pain or disability in patients with OA knee. According to recent studies articular mechanoreceptor

impairment, muscle weakness, inflammation and history of knee injuries such as ACL, PCL, or meniscus injury are the factors that causes impaired proprioception in OA knee patients. [5]It has been hypothesized that exercise can improve knee proprioception by the facilitation of dynamic joint stabilization to retrain altered afferent pathways thus improving proprioception and functionality in patients with OA knee. [6] A lot of studies have been conducted previously, but they primarily on qualitative outcomes. In contrast, fewer studies have utilized quantitative outcome measures. The purpose of this study is to evaluate the existing research using quantitative outcome measures. The Aim of study is to check effectiveness of neuromuscular training on Proprioception, Balance and Functionality in patients with OA knee.

MATERIAL AND METHODS

In this experimental study conducted at SPB Physiotherapy College OPD, Surat, in year of 2024.Patients who are clinically and radiologically diagnosed with osteoarthritis (OA) of the knee were included. The patients, aged between 45 and 65 years, were selected based on convenience sampling. The study duration was 4 weeks, with 4 sessions per week. The inclusion criteria required patients to be willing to participate, clinically and radiologically diagnosed with OA knee, and have osteoarthritic symptoms for at least the last 3 months. Patients with a history of knee injuries, surgeries, neurological or psychological disorders, bone diseases, or other diseases were excluded from the study. Written informed consent in Gujarati was obtained from all participants, and the exercise protocols were clearly explained and demonstrated to each patient. The sample size was calculated using Open Epi, Total 40 participants (18 male, 22 female) were enrolled and divided randomly into two groups of 20. Group A (Conventional Group) received only conventional exercises, while Group B (Experimental Group) received proprioceptive exercises in addition to conventional exercises. However, due to various reasons such as withdrawal of consent or loss to follow-up, 8 patients dropped out of the study. As a result, data from 32 patients were ultimately included in the analysis. Pre-test and post-test measurements were taken before and after the protocol implementation using Sensamove Miniboard, WOMAC scale, BOOMER test, measurements. The protocol was carried out for 4 days a week over 4 weeks. For Group A (Conventional Group), the treatment protocol included Ankle-Toe Movement, Isometric Quadriceps Exercise, Isometric Hamstring Exercise, Terminal Knee Extension, Straight Leg Raising, and High Sitting Knee Extension, each performed with a 5-second hold for 10 repetitions. Stretching exercises for the Hamstring and Calf muscles were performed with a 30-second hold for 3 repetitions, and Transcutaneous Electrical Nerve Stimulation (TENS) at 100-150 Hz frequency was applied for 10 minutes. In Group B (Experimental Group), in addition to the conventional exercises, neuromuscular exercises (proprioceptive exercises) were implemented. These exercises included Half Squats, Straight Lunges with a 5-second hold for 10 repetitions, One Leg Standing with a 30-second hold for 3 repetitions, and Wobble Board Balance exercises for 2 minutes.

Outcome Measures

Sensa move Miniboard: Sensamove is a basic measuring and recording software that have a cursor (Red dot) on the monitor screen of the connected PC/Laptop corresponds exactly to the tilting angle of the balance exercise system in use [7]. Sensamove Miniboard is a device which can be used in balance and proprioception testing, training and evaluating components of balance control mechanism. It is a wobble board with built-in sensors and anti-slip 10, 15, 20-degree tilting rubber pads [8]. Sensamove Miniboard is Valid and Responsive Tool to measure Balance and Proprioception.

Figure 1: Proprioception and Balance Testing Using Sensamove Mini board

WOMAC: WOMAC (Western Ontario and McMaster universities Arthritis Index) is multi-dimensional and self-administered and most of widely used for hip and knee OA. The WOMAC is a disease-specific measure of pain, stiffness, and physical function for individual knee OA. WOMAC questionnaire consisting of 24 items divided in three scales. 5 items related to pain, 2 items related to stiffness and 17 items related to physical functions. Each item is scored on a 5-point likert scale [9]. The test questions are scored on a scale of 0-4, which correspond to: None(0), Mild(1), Moderate (2), Severe (3), and Extreme (4).The scores for each subscale are summed up, with a possible score range of 0-20 for pain, 0-8 for stiffness, and 0-68 for physical function. Sum of the scores for all 3 subscales gives a total WOMAC score that is 96. Higher score on the WOMAC indicate Worse pain, stiffness, and functional limitations [10].

Reliability: The test-retest reliability was 0.74, 0.58 and 0.92 for Pain, Stiffness and Physical function subscales respectively [9].

Validity: Cronbach's alphas for likert scale format of the WOMAC were 0.86-0.89, 0.90-0.91, and 0.95 for Pain, Stiffness and Function subscale respectively [9].

Secondary Outcome Measures

BOOMER: BOOMER (Balance Outcome Measure for Elder Rehabilitation) assesses standing balance and functional mobility in elderly population. It measures static, dynamic and functional measure throughout all setting of elder rehabilitation [10]. It is used in older adults with deficiencies in standing balance [12]. Score range given between 0 – 16, each item (4 items) can score between 0 – 4, overall score is created by summing the score for each item. The scale ranges from 0 (unable to perform the test) to 4 (excellent) with a maximum score of 16 [13]. Concurrent validity of the BOOMER correlates with Functional Independence Measure and Modified Elderly Mobility Scale [14]. It has shown high correlation with the Berg Balance Scale at both admission (ρ=0.91; P<0.01) and on discharge (ρ=0.68; P<0.01) from geriatric rehabilitation units [12]. Construct validity of the study showed that BOOMER scores highly associated with BBS scores ($r = 0.93$, $p < 0.001$), as well as with raw scores on the de Morton Mobility Index ($r = 0.89$, $p < 0.001$). The same study showed only moderate associations with perceived confidence on the Activities-specific Balance Confidence scale ($r > 0.52$, $p < 0.001$) [15]. The Step Test involves repeatedly placing one foot on top of a 7.5 cm step and returning it back down to the ground as many times as possible within 15 seconds. The average between legs is then calculated for scoring. The Timed Up and Go test starts from a seated position, where the individual stands, walks 3 meters, turns 180°, walks 3 meters back to the chair, and sits down with their back resting against the backrest. In the Functional Reach test, the individual reaches as far forward as possible in a standing position without losing balance. Lastly, the Timed Static Stance requires the individual to stand with their feet together and eyes closed.

RESULT AND DISCUSSION

After the 4 weeks of treatment, statistical analysis was conducted using the SPSS (Statistical Package for Social Science) software (Version 27.0.1). A Test of Normality was performed using the Shapiro-Wilk test. The data was not distributed normally ($p<0.05$), so further analysis was conducted using non-parametric tests. Within-group analysis of Group A and B was conducted using the Wilcoxon Signed Rank Test. The results of the test are as follows:

BOOMER: Group A (Pre: 12.33 ± 1.54, Post: 13.26 ± 1.03, p = 0.032), Group B (Pre: 13.33 ± 1.39, Post: 14.13 ± 0.74, p = 0.026)

Sensamove (Balance Test): Group A (Pre: 82.8 ± 6.53, Post: 83.93 ± 5.87, p = 0.219), Group B (Pre: 84.73 ± 5.27, Post: 88.86 ± 4.08, p = 0.01)

Sensamove (Proprioception Test): Group A (Pre: 80.86 ± 6.70, Post: 76.33 ± 8.04, p = 0.014), Group B (Pre: 80.2 ± 7.99, Post: 83.86 ± 6.97, p = 0.036)

WOMAC: Group A (Pre: 30.53 ± 13.68, Post: 26 ± 12.81, p = 0.135), Group B (Pre: 22.93 ± 6.50, Post: 17.73 ± 9.03, p = 0.007)

Between-group analysis of Group A and B was done using the Mann-Whitney U Test. The results of the test are as follows:

BOOMER: Mean ± SD = 13.29 ± 2.43, p = 0.029

Sensamove (Balance Test): Mean ± SD = 83.80 ± 15.21, p = 0.026

Sensamove (Proprioception Test): Mean ± SD = 77.73 ± 15.06, p = 0.005

WOMAC: Mean ± SD = 21.71 ± 11.43, p = 0.045

Table 1: Wilcoxon Signed Rank Test (Within-Group Analysis)

Outcome Measure	Group	Pre Mean ± SD	Post Mean ± SD	p Value
Sensamove (Proprioception Test)	Group A	80.86 ± 6.70	76.33 ± 8.04	0.014
	Group B	80.2 ± 7.99	83.86 ± 6.97	0.036
Sensamove (Balance Test)	Group A	82.8 ± 6.53	83.93 ± 5.87	0.219
	Group B	84.73 ± 5.27	88.86 ± 4.08	0.01
WOMAC	Group A	30.53 ± 13.68	26 ± 12.81	0.135
	Group B	29.6 ± 5.80	17.73 ± 9.03	0.001
BOOMER	Group A	12.33 ± 1.54	13.26 ± 1.03	0.032
	Group B	13.33 ± 1.39	14.13 ± 0.74	0.026

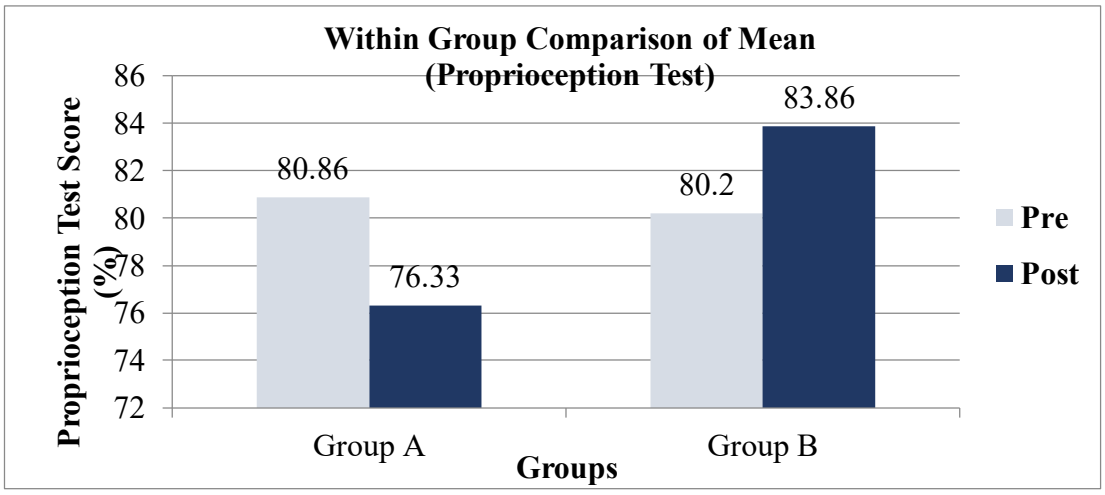

Figure 2: Within Group Comparison of Mean for Proprioception Test

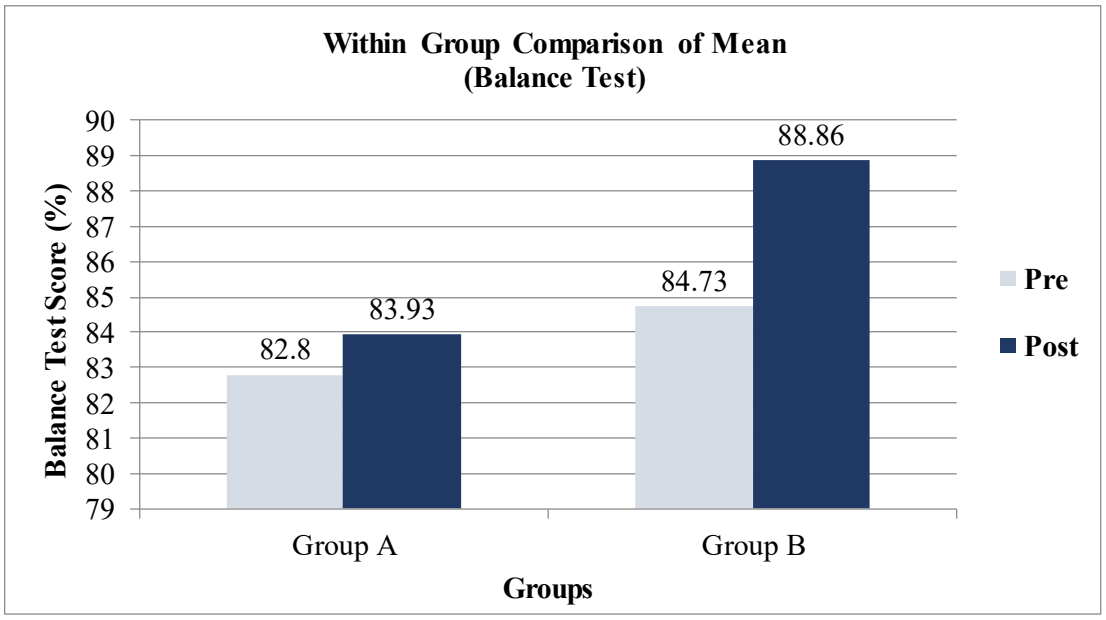

Figure 3: Within Group Comparison of Mean for Balance Test

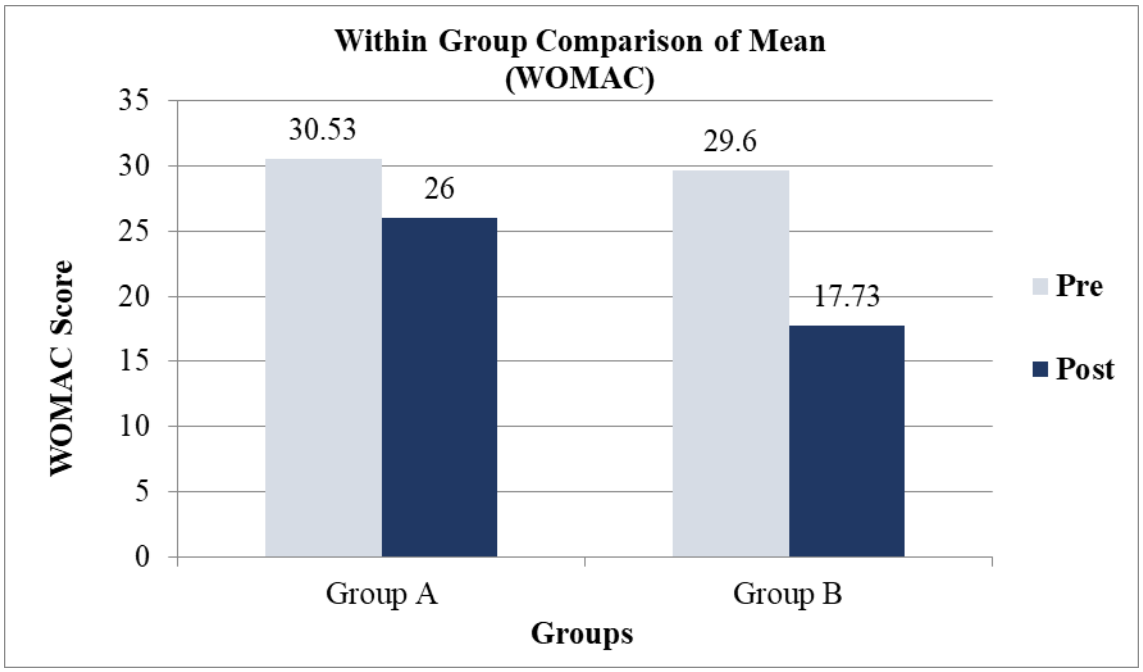

Figure 4: Within Group Comparison of Mean for WOMAC

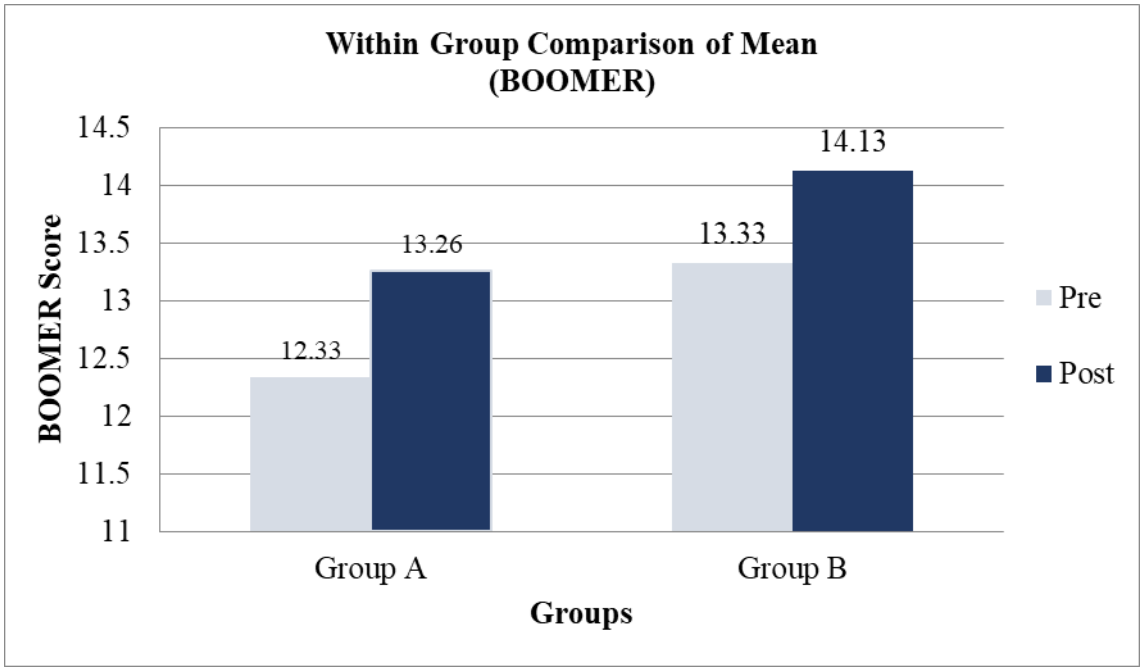

Figure 5: Within Group Comparison of Mean for BOOMER

Recent studies suggested a potential association between impaired knee proprioception and pathological changes occurs during the early stages of OA knee. Proprioception is provided by proprioceptors and mechanoreceptors in skeletal muscles, tendons, ligaments and fibrous capsules in knee joint. As a knee muscles, tendons, ligaments, and joint capsules in OA knee patients become weakened and damaged, proprioceptive sensation can also decrease and it leads to pain and disability in patients with OA knee. Proprioception is composed of several different components that include joint position sense, velocity, detection of movement and forces. Motion stimulates the Mechanoreceptors to provide proprioception that is essential for coordinated activities of daily living and other physically demanding tasks. [6] It has been hypothesized that exercise can improve knee proprioception by the facilitation of dynamic joint stabilization to retrain altered afferent pathways thus improving proprioception and functionality in patients with OA knee [6]. Proprioceptive training is a type of weight bearing training based on functional task that is responsible for restoration of proprioceptive responses. Proprioceptive process helps to facilitate muscle contraction in response to external force. Proprioceptive reaction permits changes in lengths of different muscles that pressures and position of the joints to improve movement, mobility and reduce pain. [1] Present study focuses on the Effectiveness of Neuromuscular training on balance, proprioception, functionality and pain in OA knee patients. It was conducted on 40 patients with osteoarthritis of knee. After taking the written consent (Gujarati), based on inclusion and exclusion criteria patients were divided into two groups by convenience Method. Each group contains 20 patients. The conventional training was implemented on group A, whereas conventional training along with neuromuscular training was implemented on group B. Here Group B taken 10 to 15 minutes more as compared to Group A. Both groups were received treatment for 4 sessions per week for 4 weeks. During our research duration there are total 10 dropouts due some reasons.All outcome measures were Sensamove for Balance and Proprioception, WOMAC for Functionality, BOOMER for balance and NPRS for pain were analyzed at baseline before (pre) and after (post) treatment. In our research we used Sensamove Miniboard as a diagnostic purpose for balance & proprioception testing. Furthermore, these testing were carried out Pre and Post intervention. In our testing we used rubber pad which allow maximum 10 degree tilting in each direction. In our research we used Neuromuscular Control test (NMC) test for measuring balance and proprioception. We performed two tests that are balance and proprioception test, each test was conducted for 60 seconds. For balance test, we asked the patient to stand on the Sensamove Miniboard for 60 seconds and try to maintain balance with help of visual feedback and for proprioception test the same test was performed without visual feedback. We used WOMAC for pain and physical function outcome. If there is increase in score which means there increased level of pain and functional disability. BOOMER is generally use for standing balance and functional mobility in Elderly population. BOOMER includes 4 tests that are Timed UP and Go Test, Functional Reach Test, Timed Static Stance Test, and Step Test. For measuring pain level we used NPRS scale in our

research process.In our study limitations are Sample Size was Limited, Long Term Follow up Not Taken, Population Area was Limited, the results cannot be generalized to all age people. The result of our study showed that both techniques are showing beneficial effect for the improvement in symptoms of OA Knee, but Neuromuscular training with conventional training demonstrate more significant improvement on Balance, Proprioception, and Functionality in OA Knee patients than the conventional training alone, whereas it is less effectiveness for reducing the pain.

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