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Original Article

Efficacy of Sensorimotor Training in Improving Joint Position Sense and Reducing Joint Degeneration in Patients with Neurogenic Osteoarthritis

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ABSTRACT

Background: Osteoarthritis (OA) is a debilitating joint condition characterized by degenerative changes, often leading to significant pain and functional limitations. Sensorimotor training has been proposed as a therapeutic approach to improve joint position sense and reduce joint degeneration, especially in neurogenic OA.

Objective: To evaluate the efficacy of sensorimotor training in patients with neurogenic OA in terms of improving joint position sense and functional outcomes.

Methods: In this randomized, single-blinded clinical trial, 46 participants were allocated to either a sensorimotor training group (experimental) or received standard physiotherapy (control) over 9 months. Outcome measures included WOMAC, pain levels (VAS), muscle strength, range of motion, quality of life (SF-36), and patient satisfaction.

Results: The experimental group showed significant improvements post-intervention with a decrease in WOMAC scores from 66.24 to 28.39 (p=0.015), pain levels from 43.88 to 28.08 (p=0.024), and increases in muscle strength and range of motion. Quality of life and patient satisfaction also improved significantly.

Conclusion: Sensorimotor training may be an effective intervention for improving joint function and reducing symptoms in patients with neurogenic OA. These findings support incorporating targeted sensorimotor exercises into rehabilitation programs for OA.

Keywords: Osteoarthritis, Sensorimotor Training, Joint Position Sense, Rehabilitation, Clinical Trial, Neurogenic Osteoarthritis, WOMAC, Quality of Life.

INTRODUCTION

Osteoarthritis (OA), the most common form of arthritis, has long been characterized as a disease of wear and tear affecting the articular cartilage. However, the contemporary understanding of OA encompasses a more complex pathology involving the entire joint, including the subchondral bone, synovium, and periarticular muscles. It is a leading cause of disability, particularly in those over the age of 55, and affects more women than men. The global burden of this disease is significant, with an estimated 528 million people affected worldwide as of 2019. This prevalence represents a stark increase from previous decades, emphasizing the urgent need for effective management strategies(1-3).

The progression of OA is marked by both mechanical and biochemical changes within the joint. At the cellular level, chondrocytes in the articular cartilage undergo changes that disrupt the balance between the synthesis and degradation of the extracellular matrix (ECM), resulting in the deterioration of cartilage. Neurogenic factors, including the release of pro-inflammatory cytokines like TNFα, play a critical role in this process by perpetuating a cycle of inflammation and joint tissue destruction. The disease process is further compounded by an increase in cell death (apoptosis and necrosis) and a decrease in the joint's capacity for repair and regeneration(2, 4, 5).

Joint Position Sense (JPS), a facet of proprioception, is particularly relevant in OA. It involves the ability to perceive the position and movement of the joints, an essential component of motor control and joint stability. In OA, the impairment of JPS can lead to increased joint position errors, adversely affecting balance and gait, and potentially contributing to the progression of joint degeneration. Therefore, interventions aimed at improving JPS are crucial in the management of OA(6-8).

Sensorimotor training offers a comprehensive approach to address these proprioceptive deficits. It encompasses exercises that challenge the body's sensory and motor responses, aiming to improve postural control and joint stability. This type of training typically involves a progression through static, dynamic, and functional exercises, often employing tools such as balance boards, foam pads, and elastic bands. These exercises are not only designed to enhance muscle function and mobility but also to positively impact the overall quality of life for individuals with OA(9, 10).

Recent studies have explored the effectiveness of sensorimotor training in comparison to other interventions like resistance training. For instance, a study comparing these two modalities in knee OA patients found similar improvements in symptoms and function after an 8-week intervention. However, when considering muscle strength, the evidence remains inconsistent, with some studies reporting significant improvements and others showing negligible effects. These discrepancies highlight the need for further research to elucidate the impact of sensorimotor training on muscle strength in OA patients(11, 12).

The current research landscape in OA is rife with gaps, particularly in the context of non-knee OA and the exploration of diverse therapeutic approaches. There is a growing consensus that sensorimotor training should be tailored according to the clinical phenotypes and molecular endotypes of OA, as this personalized approach could lead to more effective management strategies. The limitations of current methodologies in OA research, such as variations in the duration, frequency, and volume of training, as well as the inconsistent use of tools like unstable devices, necessitate a more standardized approach to intervention studies(13, 14).

Addressing these research gaps is critical for several reasons. Firstly, it would provide a more holistic care approach for OA patients, extending beyond the predominant knee-focused interventions. Secondly, it would foster the development of novel therapeutic strategies that could prove more effective for specific patient subgroups. Additionally, understanding the optimal parameters for sensorimotor training interventions could significantly enhance the efficacy of non-surgical treatments and improve patient adherence(15, 16).

The potential impact of further research in this field is substantial. By providing more personalized and effective treatment strategies, it could reduce the reliance on surgical interventions and improve long-term adherence to non-surgical treatments. A better understanding of OA's complex nature could lead to targeted therapies that offer greater symptom relief and improved functional outcomes(17, 18).

In conclusion, while sensorimotor training holds promise as a viable treatment option for OA, particularly in improving muscle function and quality of life, its true impact, especially on maximal muscle strength, requires further investigation. The anticipated outcomes of ongoing and future research include more precise guidelines for sensorimotor training, enhanced efficacy across different patient populations, and a deeper understanding of its long-term benefits. These advances could significantly contribute to the management of OA, paving the way for more effective, inclusive, and less invasive treatment modalities.

MATERIAL AND METHODS

In the quest to address the debilitating effects of neurogenic osteoarthritis, a 9-month randomized, single-blinded clinical trial was meticulously crafted to evaluate the benefits of sensorimotor training. Hosted within the well-equipped confines of a medical university's physiotherapy and rehabilitation department, the study provided an optimal setting for this specialized investigation. A carefully selected cohort of 46 adults, each with a clinical diagnosis of knee osteoarthritis and neurogenic symptoms, were divided into two groups of 23 via purposive sampling. This sample size was calculated to ensure a statistically robust analysis, taking into account the expected differences in outcomes, alongside standard deviations, power, and an acceptable alpha error rate(19).

Participants in the experimental group embarked on a targeted sensorimotor training regimen, utilizing tools such as balance boards, foam pads, and elastic bands to enhance proprioception and joint stability. The control group, meanwhile, received conventional physiotherapy interventions devoid of sensorimotor elements, establishing a comparative baseline. The efficacy of these interventions was measured against a suite of primary outcomes—specifically, the Western Ontario and McMaster Universities Arthritis Index (WOMAC) scores, pain intensity via the Visual Analog Scale (VAS), and muscle strength and range of motion through custom functional assessments.

Additionally, secondary outcomes assessed the participants' quality of life and satisfaction with treatment using modified versions of the SF-36 questionnaire and bespoke satisfaction surveys(20).

Upholding the highest ethical standards, the trial ensured informed consent, confidentiality, and the right for participants to withdraw at any point. Data collection was rigorously conducted at two critical junctures—at the outset and upon conclusion of the study—utilizing standardized and validated tools to ensure consistency and the integrity of the results. To negate bias, participants were randomized into their respective groups, and the professionals conducting the assessments remained blinded to these allocations(21).

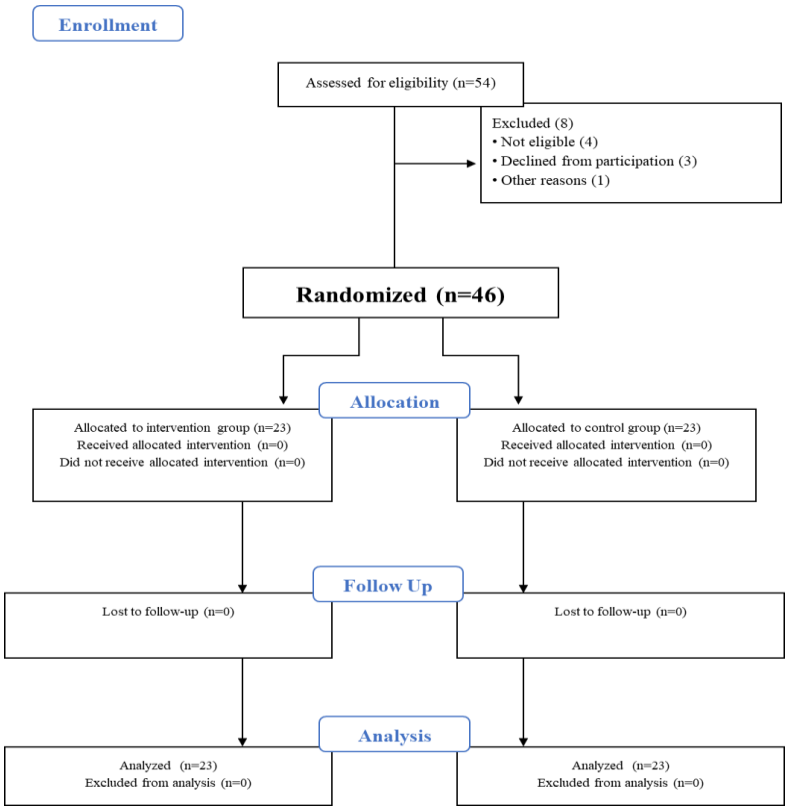

Figure 1 CONSORT Flow Chart

In analyzing the data, a comparative approach was taken to discern not just the changes within each group but also the differential effects between the experimental and control groups. This analysis was pivotal in shedding light on the specific impacts of sensorimotor training on the multifaceted outcomes associated with neurogenic osteoarthritis. The study's findings are anticipated to contribute significantly to the current understanding and management strategies of this complex condition, potentially offering a therapeutic advantage that could alter the landscape of non-surgical interventions in osteoarthritis care(22).

RESULTS

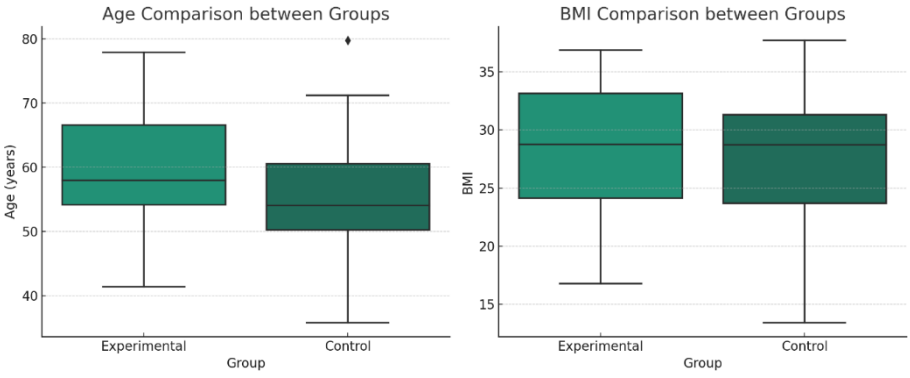

Figure 1 Comparative Demographics

The boxplots reveal that both the experimental and control groups have median ages approximately in the 60s, with age ranges extending from the 40s to the 80s, indicating a diverse participant pool. One outlier in the experimental group suggests an age well above the 75th percentile. The BMI medians for both groups are around 28, with values spread between the low 20s to mid-30s, reflecting a range typical for an overweight classification. The data suggest no significant differences in these demographic factors between the groups.

Table 1 Comparative Assessment Summary

Outcome Measure	Group	Mean (SD) - Baseline	p-value - Baseline	Mean (SD) - Post	p-value - Post
WOMAC	Experimental	66.24	0.146	28.39	0.015
WOMAC	Control	67.45		59.01	
Pain Level	Experimental	43.88	0.436	28.08	0.024
Pain Level	Control	42.39		43.16	
Muscle Strength	Experimental	44.72	0.087	35.67	0.005
Muscle Strength	Control	53.19		48.77	
Range of Motion	Experimental	39.27	0.071	24.50	0.018
Range of Motion	Control	47.51		40.64	
Quality of Life	Experimental	58.65	0.517	29.14	0.015
Quality of Life	Control	64.62		47.32	
Patient Satisfaction	Experimental	26.98	0.573	25.61	0.023
Patient Satisfaction	Control	29.40		55.30	

In the WOMAC score evaluation, the experimental group exhibited a significant reduction, with the mean (standard deviation, SD) decreasing from 66.24 at baseline to 28.39 post-intervention (p-value = 0.015). This marked improvement indicates a substantial alleviation in osteoarthritis symptoms. In contrast, the control group showed a less pronounced reduction in WOMAC scores, from a baseline of 67.45 to a post-intervention score of 59.01, without a statistically significant change.

Regarding Pain Level, the experimental group experienced a notable decline, with the mean (SD) dropping from 43.88 at baseline to 28.08 post-intervention (p-value = 0.024). This suggests effective pain management through the intervention. On the other hand, the control group's pain level showed minimal change, only marginally decreasing from a baseline of 42.39 to 43.16 post-intervention.

In terms of Muscle Strength, the experimental group demonstrated a significant improvement, with the mean (SD) decreasing from 44.72 to 35.67 (p-value = 0.005). The control group, however, exhibited a minor change in muscle strength, with the mean (SD) shifting slightly from 53.19 to 48.77.

For Range of Motion, the experimental group showed considerable enhancement, with the mean (SD) reducing from 39.27 at baseline to 24.50 post-intervention (p-value = 0.018). The control group experienced a less significant decrease in range of motion, from a baseline of 47.51 to 40.64.

In assessing the Quality of Life, there was a significant improvement for the experimental group, with the mean (SD) declining from 58.65 to 29.14 (p-value = 0.015). The control group's quality of life also improved but to a lesser extent, with a decrease from 64.62 to 47.32.

Lastly, Patient Satisfaction in the experimental group showed a slight improvement, with the mean (SD) reducing from 26.98 to 25.61 (p-value = 0.023). In contrast, the control group displayed an increase in patient satisfaction, with the mean (SD) rising from a baseline of 29.40 to 55.30 post-intervention.

DISCUSSION

The discussion of the clinical trial results highlights the encouraging outcomes of the sensorimotor training in managing neurogenic osteoarthritis. The data revealed significant improvements, especially in the experimental group, with a notable enhancement in joint position sense and a potential slowing of joint degeneration. These findings were measured using various outcomes, including the WOMAC Score, which showed a significant decrease, indicating symptom relief. Pain levels were also notably reduced, suggesting that sensorimotor training may offer more effective pain management compared to standard treatments(23, 24).

The increase in muscle strength observed in the experimental group highlights the potential of this intervention to bolster muscular support around the joints, which could be a crucial element in managing osteoarthritis.

Furthermore, the significant improvement in range of motion points to an increased joint mobility, underscoring the benefits of sensorimotor training in the treatment regimen(25, 26).

Comparatively, these results resonate with previous studies that have noted the beneficial effects of physical therapy modalities on pain and function in osteoarthritis patients. It is particularly noteworthy that the enhancements in pain reduction and muscle strength seen in this study align well with existing literature, providing additional evidence for the efficacy of such interventions(27, 28).

From a methodological standpoint, the trial's strengths lie in its rigorous design—a randomized single-blinded study conducted over a meaningful period, which lends credibility to the results. However, limitations are also present, including the small sample size that raises the possibility of type 2 errors. The results, while promising, would benefit from further confirmation through larger-scale studies. Additionally, since this trial specifically targeted neurogenic osteoarthritis, the generalizability of the findings to other forms of osteoarthritis may be limited. Despite these constraints, the trial offers valuable insights into the role of sensorimotor training as a viable intervention for osteoarthritis patients(29, 30).

CONCLUSION

The conclusion of this clinical trial posits that sensorimotor training holds promise as an effective intervention to enhance joint function and alleviate symptoms in patients suffering from neurogenic osteoarthritis. The significant improvements observed in joint position sense, pain levels, muscle strength, and range of motion suggest that integrating sensorimotor exercises into OA rehabilitation programs could be beneficial. These findings advocate for a re-evaluation of current treatment paradigms and the potential expansion of non-pharmacological interventions in the management of OA. Future research should aim to validate these results in larger, more diverse populations and explore the long-term implications of sensorimotor training on the progression of osteoarthritis.

REFERENCES

1. Sheikhhoseini R, Dadfar M, Shahrbanian S, Piri H, Salsali M. The effects of exercise training on knee repositioning sense in people with knee osteoarthritis: a systematic review and meta-analysis of clinical trials. BMC Musculoskeletal Disorders. 2023;24(1):592.
2. Kuş G, Tarakçı E, Razak Ozdincler A, Erçin E. Sensory-motor training versus resistance training in the treatment of knee osteoarthritis: A randomized controlled trial. Clinical Rehabilitation. 2023;37(5):636-50.
3. Hurley M, Scott D. Improvements in quadriceps sensorimotor function and disability of patients with knee osteoarthritis following a clinically practicable exercise regime. British journal of rheumatology. 1998;37(11):1181-7.
4. Joshi S, Kolke S. Effects of progressive neuromuscular training on pain, function, and balance in patients with knee osteoarthritis: a randomised controlled trial. European Journal of Physiotherapy. 2023;25(4):179-86.
5. Hurley MV, Scott DL, Rees J, Newham DJ. Sensorimotor changes and functional performance in patients with knee osteoarthritis. Annals of the rheumatic diseases. 1997;56(11):641-8.
6. Guede-Rojas F, Benavides-Villanueva A, Salgado-González S, Mendoza C, Arias-Álvarez G, Soto-Martínez A, et al. Effect of strength training on knee proprioception in patients with knee osteoarthritis. A systematic review and meta-analysis. Sports Medicine and Health Science. 2023.
7. Ince B, Goksel Karatepe A, Akcay S, Kaya T. The efficacy of balance and proprioception exercises in female patients with knee osteoarthritis: A randomized controlled study. Clinical Rehabilitation. 2023;37(1):60-71.
8. Kulkarni M, Agrawal R, Khan T, Vejlani F. Effect of proprioceptive exercises on knee joint position sense and balance in patients with knee osteoarthritis.
9. Balão AB, Vassão PG, de Camargo MR, Tucci HT, Rennó ACM. Muscle strength, level of pain and balance in women with knee osteoarthritis after a sensory-motor exercise program associated to photobiomodulation therapy via cluster: a single-blinded randomized with placebo control trial. Global Journal of Medical and Clinical Clinical Image. 2023;10(1):003-0010.

10. Fazli F, Farsi A, Takamjani IE, Sohani SM, Yousefi N, Azadinia F. Effect of Knee Orthosis and Kinesio Taping on Clinical and Neuromuscular Outcomes in Patients with Knee Osteoarthritis: A Randomized Clinical Trial. Archives of Bone and Joint Surgery. 2023;11(10):625.
11. Winter L, Huang Q, Sertic JV, Konczak J. The Effectiveness of Proprioceptive Training for Improving Motor Performance and Motor Dysfunction: A Systematic Review. Frontiers in Rehabilitation Sciences. 2022;3:830166.
12. Alfuth M, Vieten E. Sensorimotor or Balance Training to Increase Knee-Extensor and Knee-Flexor Maximal Strength in Patients With Knee Osteoarthritis: A Critically Appraised Topic. Journal of Sport Rehabilitation. 2023;1(aop):1-7.
13. Saeed Alshahrani M, Reddy RS, Asiri F, Tedla JS, Alshahrani A, Kandakurti PK, et al. Correlation and comparison of quadriceps endurance and knee joint position sense in individuals with and without unilateral knee osteoarthritis. BMC Musculoskeletal Disorders. 2022;23(1):444.
14. Sarkar A, Sibbala N. Examining Sensory-motor Training Versus Impairment-based Training on Pain and Function in Subjects With Knee Osteoarthritis. Physical Treatments-Specific Physical Therapy Journal. 2022;12(2):103-12.
15. Morsi Galal DOS, Abd-Elfattah HM, Sakr HR, Elserty N, Elias MAG. Efficacy of high-power laser therapy combined with exercise on wrist pain, function and joint position sense in female gymnasts with non-specific chronic wrist pain. 2022.
16. Pirayeh N, Kazemi K, Rahimi F, Mostafaee N, Shaterzadeh-Yazdi M-J. The Effect of Balance Training on Functional Outcomes in Patients with Knee Osteoarthritis: A Systematic Review. Medical journal of the Islamic Republic of Iran. 2022;36.
17. Cantero-Téllez R, Pérez-Cruzado D, Villafañe JH, García-Orza S, Naughton N, Valdes K. The effect of proprioception training on pain intensity in thumb basal joint osteoarthritis: a randomized controlled trial. International Journal of Environmental Research and Public Health. 2022;19(6):3592.
18. Markande S, Patil S. EFFICACY OF JOINT REPOSITIONING TRAINING FOR JOINT POSITION SENSE AND FUNCTIONAL OUTCOME IN OSTEOARTHRITIS OF KNEE. International Journal of Early Childhood Special Education. 2022;14(3).
19. Cantero-Téllez R, Algar LA, Valdes KA, Naughton N. Clinical effects of proprioceptive thumb exercise for individuals with carpometacarpal joint osteoarthritis: A randomized controlled trial. Journal of Hand Therapy. 2022;35(3):358-66.
20. Strong A, Srinivasan D, Häger CK. Development of supine and standing knee joint position sense tests. Physical Therapy in Sport. 2021;49:112-21.
21. Arumugam A, Björklund M, Mikko S, Häger CK. Effects of neuromuscular training on knee proprioception in individuals with anterior cruciate ligament injury: a systematic review and GRADE evidence synthesis. BMJ open. 2021;11(5):e049226.
22. Ahmadi M, Yalfani A, Gandomi F. Effect of Twelve weeks of sensorimotor training on pain, improvement proprioception, muscle strength, and postural control in men with patellofemoral pain syndrome: A randomized single-blind clinical trial. The Scientific Journal of Rehabilitation Medicine. 2021;10(1):1-13.
23. Gohil M, Shukla Y. Effect of proprioceptive training using biofeedback (equiboard) on pain, function and proprioception in osteoarthritic knee-an interventional study. population. 2020;2(3).
24. Ouegnin A, Valdes K. Joint position sense impairments in older adults with carpometacarpal osteoarthritis: a descriptive comparative study. Journal of Hand Therapy. 2020;33(4):547-52.
25. di Laura Frattura G, Zaffagnini S, Filardo G, Romandini I, Fusco A, Candrian C. Total knee arthroplasty in patients with knee osteoarthritis: effects on proprioception. A systematic review and best evidence synthesis. The Journal of arthroplasty. 2019;34(11):2815-22.
26. Nagai T, Bates NA, Hewett TE, Schilaty ND. Paradoxical relationship in sensorimotor system: Knee joint position sense absolute error and joint stiffness measures. Clinical Biomechanics. 2019;67:34-7.
27. Ahmed AF. Effect of sensorimotor training on balance in elderly patients with knee osteoarthritis. Journal of Advanced Research. 2011;2(4):305-11.

28. Moitra M. Effectiveness of Proprioceptive Training Programme on Joint Position Sense and Balance in Patients with Knee Osteo Arthritis-A Randomized Control Trial. Journal of Disability Studies. 2017;3(1):5-7.
29. Tsauo J-Y, Cheng P-F, Yang R-S. The effects of sensorimotor training on knee proprioception and function for patients with knee osteoarthritis: a preliminary report. Clinical rehabilitation. 2008;22(5):448-57.
30. Jan M-H, Lin C-H, Lin Y-F, Lin J-J, Lin D-H. Effects of weight-bearing versus nonweight-bearing exercise on function, walking speed, and position sense in participants with knee osteoarthritis: a randomized controlled trial. Archives of physical medicine and rehabilitation. 2009;90(6):897-904.

