

Effect of Sensorimotor Training on Pain, Balance and Functional Ability in Patients with Knee Osteoarthritis

Dr. Anjali¹, Dr. Mukesh Sharma²

¹Consultant Physiotherapist, Yamuna Nagar

²Assistant Professor in TDTR DAV IP & R, Yamuna Nagar

Corresponding Author: Dr. Anjali

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ABSTRACT

Background: Osteoarthritis (OA) is a chronic debilitating disease that causes several functional health status problems. Sensorimotor abilities such as proprioception, balance, and neuromuscular control are known to deteriorate as osteoarthritis progresses due to pain avoidance and progressive inactivity. Therefore, the aim of this study was to analyze the effect of sensorimotor training on pain and balance in patients with knee osteoarthritis and whether these changes were associated with impairment of functional performance.

Study Design: Experimental Design

Source of Data Collection: DAV Institute of Physiotherapy, Yamuna Nagar.

Methodology: 30 Subjects were included in the study on the basis of inclusion criteria and were randomly allocated into two groups. The experimental group received sensorimotor training in addition to the conventional OA knee exercises and the control group received the conventional OA knee exercise program. Treatment was given for 6 weeks. Pain, balance, and functional disability were measured as outcome measure on the 1st, 21st, and 42th day using the VAS scale, the berg balance test and the WOMAC scale, respectively.

Result: The result of the present study found that the sensorimotor group produced significantly better improvement in comparison to the conventional group in all the measured parameters.

Conclusion: The study provides evidence that the inclusion of sensorimotor training in the treatment of OA knee patients could produce a more positive effect on pain, balance, and functional activity levels. The association between pain, balance, and functional activity should be considered when treating knee OA.

KEY WORDS: Osteoarthritis knee, Sensorimotor training, Pain, Balance, Functional ability.

INTRODUCTION

Knee osteoarthritis is a form of degenerative and chronic disabling musculoskeletal disease among individuals older than 65 years, affects ability for standing, walking and climbing upstairs, resulting in pain, reduction in quality of life, and physical disability.¹ The prevalence of osteoarthritis among elderly is 56.6%.² The process appears to begin in the second decade of life, but degenerative changes are not

apparent until middle age, and by 55 to 65 years of age.³ Other causes include weight, and trauma to joint caused by repetitive movements, particularly, bending and kneeling.⁴ These patients usually confront difficulties while doing daily activities such as taking the stairs, walking and other actions involving the lower extremities.⁵

American College of Rheumatology has recommended a mixture of non-pharmacological and pharmacologic

treatments.⁶ Conservative treatment includes rest, external support, administration of salicylates, intra-articular injections of steroids, and exercise therapy.³ Physical therapy is one of the most widely used non-pharmacological interventions which includes various modes such as manual technique, massage, exercise, ultrasound, thermotherapy and so on.⁶ People may accommodate for (sub) conscious proprioceptive decline by adapting their behavior. Therefore, impaired proprioception may explain why people with symptomatic OA walk more slowly and with longer double limb stance to avoid risk of joint injury and prevent worsening of disease.⁷

The severity of Knee OA can be graded radiologically by Lawrence –Kellegren classification. A study was done to investigate agreement between radiographic OA using Lawrence – Kellegren classification and the clinical and self-reported diagnoses of OA knee which concluded that there was modest agreement between the radiographic, clinical and self-report methods of diagnosis of knee OA.⁸ Physical therapy management of OA knee is directed towards reducing joint pain and stiffness, maintaining and improving joint mobility, reducing physical disability, improving health-related quality of life, limiting the progression of joint damage. There are many emerging evidences showing that light to moderate intensity physical activities play a preventive and restorative role in the health and functional capacity caused by osteoarthritis.⁹ Sensorimotor training is a special form of proprioceptive and balance exercise that was designed for management of patients with chronic musculoskeletal pain syndromes. It is based on the concept that instead of emphasizing the isolated strength of a group of muscles around a joint, we should realize the importance of the central nervous system in regulating movement in order to reach proper firing patterns for maintaining joint stability.¹⁰

Balance training is often neglected during rehabilitation of patients with knee OA. The purposes of the current study is to investigate the effect of sensorimotor training in addition to Conventional OA knee exercises on pain, balance, and functional ability in elderly patients with knee OA.

METHODS

Participants

Study design was experimental and sampling technique was non-randomized convenient sampling technique. Total 30 subjects were included in the study on the basis of inclusion criteria and were randomly allocated into 2 groups as Group A and B using computer software program that generates random sequence.

Sampling Criteria:

Inclusion Criteria

- Age – group between 50 -70 years.
- Both Male & Female.
- Not participating in a regular program of physical activity at time of enrollment
- Average pain rating from 4 to 7 on Visual Analogue Scale.
- Subjects with chronic OA (symptoms for more than 3 months).
- Grade–2 or Grade–3 unilateral OA of the knee (Kellegren–Lawrence Classification of Osteoarthritis).

BMI: 18-30 kg/m²

Exclusion Criteria

- WOMAC subscale functional difficulty ≤ 16 .
- Patient having any cardiovascular, respiratory or musculoskeletal conditions that precludes participation in exercise program.
- Were unable to walk or exercise without the use of an assistive device.
- History of severe knee trauma, surgical interventions in last six months.
- Patient having polyarthritis, RA or other systemic inflammatory arthropathies.

- Patient with unilateral or bilateral Total knee replacement (TKR).

Outcome Measures

Pain, balance, and functional disability were measured as outcome measure on the 1st, 21st, and 42th day using the VAS scale, the berg balance test and the WOMAC scale, respectively.

Protocol

Study Protocol

Subjects in Group A performed sensorimotor exercises along with conventional exercise and Group B performed conventional OA knee exercises. Both the groups received hot pack for 10 minutes before commencement of exercises and TENS for 10 minutes after the completion of exercises.

GROUP A (Experimental Group)

Patients in Experimental group were given sensorimotor exercise program for lower limb along with Conventional OA knee exercises.

Sensorimotor training programme¹⁰:

Patients were trained through three stages: static, dynamic and functional. The exercises were graduated from easy to more difficult.

1st and 2nd week: Static Phase

- Standing upright position (30 seconds)
 - On a firm surface,
 - On a soft surface (a mat).
- Single leg stance with closed eyes (10 sec.) first on a firm surface then on soft surface
 - On the affected limb,
 - On the non-affected limb.
 - Half-step position for 10 seconds.

3rd and 4th week: Dynamic Phase, (in addition):

- Forward stepping lunge.
- T-band kicks exercise.

5th and 6th weeks: Functional Phase, (in addition):

- Walking (50 meters):
 - on a firm surface
 - on a foam surface
- Mini Squat:
 - Against a wall
 - Away from the wall with hand support.
- Balance exercise on wobble board:
 - Multidirectional rolling movement from sitting.
 - Multidirectional rolling movement from standing on both legs between parallel bars with eyes open, then eyes closed.
 - Multidirectional rolling movement from standing on one leg between parallel bars with eyes open, then eyes closed.
 - Balance with two legs, eyes open, multidirectional, then eyes closed.
 - Balance with one leg, eyes open, multidirectional, then eyes closed.

3 Sets of 5 repetitions was performed for each exercise. There was a pause of 3 seconds between repetitions and 3 minutes rest between the consecutive sets.

GROUP B (Conventional group)

Patients in Control group were given with Conventional exercises of OA knee

Conventional OA Knee Exercises¹⁰

The conventional exercise program included isometric and isotonic exercises. The exercise program was carried out according to the following protocol:

For 1st and 2nd weeks:

- Range of motion of Knee
- Stretching of hamstring muscle
- Stretching of calf muscle,
- Quadriceps isometrics
- Hamstring isometrics
- Isometric exercises were applied for 6 seconds hold time and a rest period of 4 seconds.

For 3rd and 4th weeks (in addition):

- Straight leg raising exercise,
- Short-arc terminal extension exercise for the knee joint, and

- Isometric exercises for the abductor and adductor muscles of the hip.

For 5th and 6th weeks (in addition):

- Short-arc terminal extension exercise with resistance for the knee joint,
- Isotonic resistance exercise for hamstring muscles.
- Isotonic resistance exercise for hamstring muscles.
- For Isotonic resisted exercises, the maximum weight that could be lifted up to 10 times was determined. Isotonic exercises were started as first set of 8

repetitions with half of weight of 10 RM, next set of 8 repetition with three fourth of this weight and last set of 8 repetitions with whole 10 RM. 10 RM was determined again sixth week.¹¹

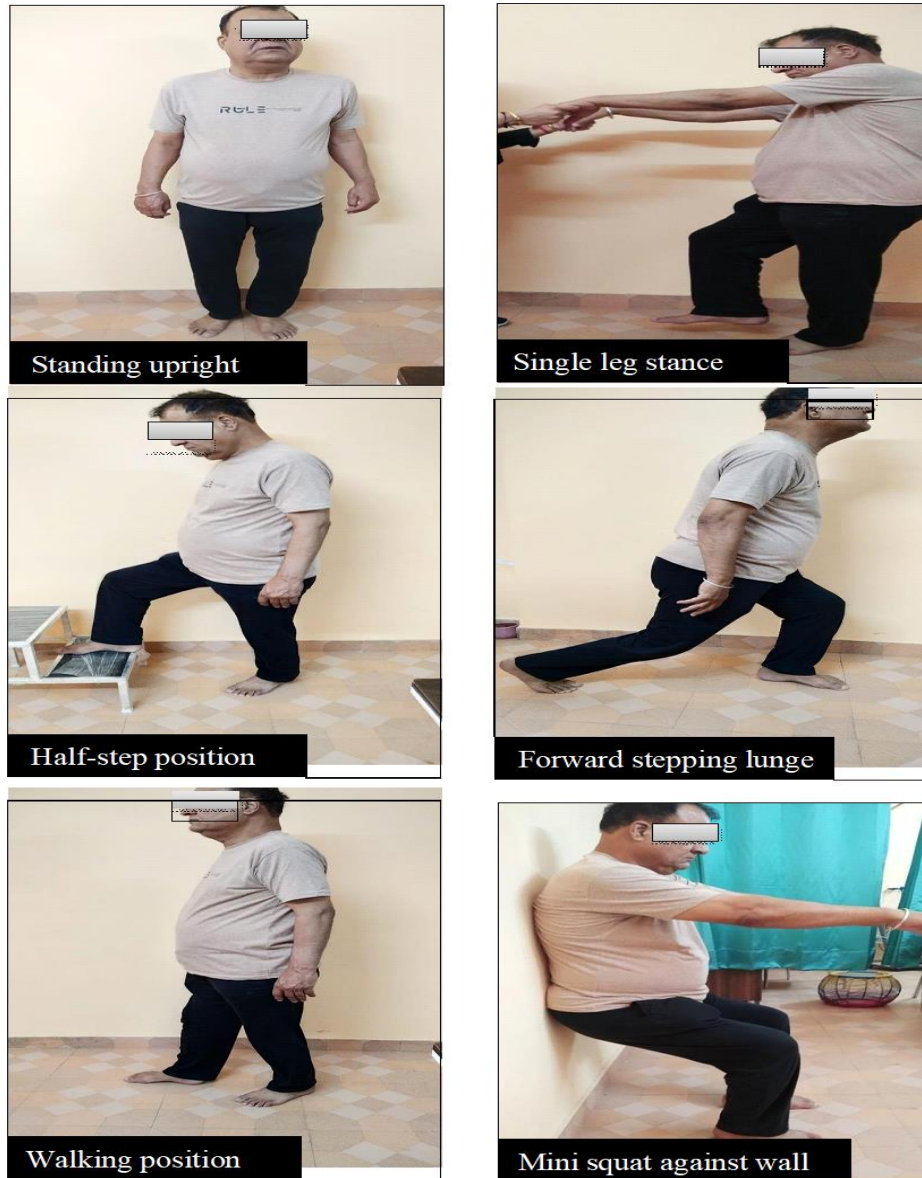
3 Sets of 5 repetitions was performed for each exercise and 3 minutes rest between the consecutive sets.

The exercises were done under clinical supervision daily for first two weeks and then on alternate day in the rest of the 4 weeks, for the total duration of 6 weeks.¹²

Figure: 1 Conventional OA knee exercises



Figure: 2 Subject performing sensorimotor exercises



DATA ANALYSIS

The data analysis was done with the help of SPSS v-20. Unpaired t- test used for between group comparisons. Repeated

ANOVA and Tukey's method for pairwise comparison was used within the group comparison. The results were found to be non- significant at $p > 0.05$.

Unpaired T Test	VAS SCORE					
	1st Day		21st Day		42nd Day	
	Group A	Group B	Group A	Group B	Group A	Group B
Mean	5.40	5.87	3.73	4.67	1.87	2.87
S.D.	0.986	0.990	0.961	0.724	0.834	0.834
Number	15	15	15	15	15	15
Maximum	7	7	5	6	3	4
Minimum	4	4	2	4	0	1
Range	3	3	3	2	3	3
Mean Difference	0.47		0.93		1.00	
Unpaired T Test	1.294		3.004		3.284	
P value	0.2064		0.0056		0.0027	
Table Value at 0.05	2.05		2.05		2.05	
Result	Not-Significant		Significant		Significant	

Table no. 1: Comparison of VAS Score between the groups.

Unpaired T Test	WOMAC SCORE					
	1st Day		21st Day		42nd Day	
	Group A	Group B	Group A	Group B	Group A	Group B
Mean	46.53	46.93	50.40	48.80	58.27	50.67
S.D.	7.249	6.713	6.162	6.201	5.994	5.740
Number	15	15	15	15	15	15
Maximum	56	59	60	61	70	62
Minimum	32	36	40	39	49	41
Range	24	23	20	22	21	21
Mean Difference	0.40		1.60		7.60	
Unpaired T Test	0.157		0.709		3.547	
P value	0.8765		0.4843		0.0014	
Table Value at 0.05	2.05		2.05		2.05	
Result	Not-Significant		Not-Significant		Significant	

Table no. 2: Comparison of WOMAC Score between the groups.

Unpaired T Test	BERG BALANCE SCORE					
	1st Day		21st Day		42nd Day	
	Group A	Group B	Group A	Group B	Group A	Group B
Mean	36.07	35.00	45.80	37.20	53.67	39.93
S.D.	2.815	3.295	3.005	2.783	1.952	2.963
Number	15	15	15	15	15	15
Maximum	40	41	50	42	56	44
Minimum	31	31	39	33	50	35
Range	9	10	11	9	6	9
Mean Difference	1.07		8.60		13.73	
Unpaired T Test	0.953		8.133		14.990	
P value	0.3486		<0.0010		<0.0010	
Table Value at 0.05	2.05		2.05		2.05	
Result	Not-Significant		Significant		Significant	

Table no. 3: Comparison of Berg Balance Score between the groups.

DISCUSSION

Present study was intended to find the effect of sensorimotor exercises on pain, balance and functional ability in patient with Osteoarthritis of knee. The result of the present study found that inclusion of sensorimotor training with conventional knee exercises results in better outcomes in treatment of OA knee.

Effects of sensorimotor training on pain:

Present study found significant improvement on pain performing sensorimotor exercises is well supported by Ali Yalfani et al, 2020 who stated that pain relief could be related to two mechanisms: The first mechanism is due to muscle balance created after sensorimotor exercises in the vastus medialis and lateralis muscles. Accordingly, it leads to the normal position of the patella inside the condylar groove of the femur; thus, relieving pain and improving neuromuscular control. The second mechanism is due to the increase in the strength and proper activation of the gluteus medius; it overcomes the

compensatory function of the iliotibial band and external retinaculum and prevents external patella traction.¹³

Effect of sensorimotor training on balance:

The result of the present study showed significant improvement in balance in sensorimotor group that support the study performed by Amal F et.al. (2011); that analyzed the effect of sensorimotor training on balance in elderly patients with knee osteoarthritis and concluded that the addition of sensorimotor training to traditional strengthening and stretching exercises could provide more motor control and help neuromuscular restoration of balance and subsequently improve the functional level of OA patients. The study stated that the decline in sensory output from the knee joint affects sensorimotor function and may result in balance impairment. It was suggested that the sensorimotor training increased coordination between muscle groups and improved the response to sensorial information. In

sensorimotor training, the patient progresses through exercises in different postures, base of support, and challenges to their center of gravity. So, each exercise elicits automatic and reflexive muscular stabilization demanding the patient to maintain postural control under a variety of situations.

Increasing muscle force-generating capability can be achieved by two means. The first is by central nervous system adaptation, whereby greater maximum voluntary contraction is produced by CNS learning and adaptation of the pattern of excitation. The force gains are achieved by greater and more effective recruitment of muscle fibers. The second means is by building the physical bulk of the muscle to produce a greater force output for the same neural input. Also, the increase in muscle force can be explained by the decrease in pain. Because pain leads to decreased activation level of the muscle. The anticipation of pain causes the patient to guard his physical activities and this in turn aggravates the disability and muscle weakness.¹⁰

Effects of sensorimotor training on functional ability:

The sensorimotor exercise prescription in this study was successful to enhance functional ability which is in accordance with the result of the study performed by Michael V Hurley et al. (1997) reported sensorimotor changes and functional performance in patients with knee osteoarthritis. According to the study patients with knee OA have quadriceps sensorimotor deficits, some of which were associated with decreased postural stability and deterioration in functional performance and disability. Arthritic damage to articular mechanoreceptors may evoke abnormal afferent discharge that decreases α and $\bar{\alpha}$ -motor neurons excitability, impairing motor control, and proprioceptive acuity. These sensorimotor deficits reduce the patient's stability, undermine their confidence, and lead to a deterioration in function. Moreover, the impairment of

neuromuscular protective mechanisms may be involved in the pathogenesis of knee OA and accelerate joint damage.

The effectiveness mechanism of the treatment protocol on muscle strength could be attributed to several factors, as explained in the following: The first factor could be due to the effect of adaptation created in the CNS; during the exercises, learning and adapting the stimulation pattern were increased. Ultimately, it enhanced maximal voluntary contraction. The second factor included is by increasing sensory input about joint position and changes in muscle length and tension in the CNS. In turn, it improves the nervous system's ability to generate a pattern of rapid and optimal muscle utilization and increases the number of active motor units. Moreover, increased intragroup and intergroup muscle coordination leads to improved force generation ability and thus increasing functional abilities.¹⁴

CONCLUSION

The result of the present study suggests that sensorimotor exercises along with conventional Exercises is more effective than conventional exercises alone and resulting in speedy and early recovery in patient with OA knee.

Declaration by Authors

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