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Effectiveness of Multidirectional Wobble Board Lateral Step Up Exercise and Unidirectional Wobble Board Lateral Step Up Exercise on Joint Position Sense in OA Knee

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ABSTRACT

Background: Osteoarthrosis (OA) is defined as a degenerative condition of the synovial joints. OA of the knee is ranked as one of the most significant causes of disability among the elders. It is a common disorder of cartilage degradation, synovial inflammation, osteophyte formation, thinning of joint space and subchondral sclerosis.

Methods: 219 participants were allocated into three groups multidirectional wobble board lateral step-up exercise group (MD), unidirectional wobble board lateral step-up exercise group (UD) and control group. All the participants' basic subjective data, clinical measurements including the age, gender, body mass index (BMI) and joint position sense were measured. Data were analyzed with a paired t-test, unpaired t-test and ANOVA.

Results: This study shows both the unidirectional wobble board exercise group(UD) and multidirectional wobble board exercise group(MD) showed a better reduction in mean test angle of joint position sense in OA knee participants than the control group but multidirectional wobble board exercise group(MD) was better than unidirectional wobble board exercise group (UD). The longer 4 weeks duration was more beneficial than the shorter 2 weeks of weight-bearing wobble board protocol.

Conclusion: This study proved that the multidirectional wobble board lateral step-up exercise is more beneficial than unidirectional wobble board lateral step-up exercise in OA Knee.

Key Words: Osteoarthrosis, BMI, Multidirectional wobble board, Unidirectional wobble board, Lateral step-up, Proprioception

INTRODUCTION

Osteoarthrosis (OA) is defined as a degenerative condition of the synovial joints. OA of the knee is ranked as one of the most significant causes of disability among the elders.[1,2] Osteoarthrosis is a heterogeneous condition that will cause symptoms in the joint and are involved in damaging the integrity of the articular cartilage and bone at the margins of the joint.[3] OA in the knee and hip is now ranked as the 11th leading cause for disability as per the global burden of disease study.[4] OA is diagnosed as per the clinical symptom which exhibits eburnation, more wear and tear due to repeated loading leading to restrict ROM and pain of knee joint [5]. The second risk factor for OA knee is the BMI of the individual.[6] This is because of the joint overloading and inflammation-induced due to adiposity.[7] It is a common disorder of cartilage degradation, synovial inflammation, osteophyte formation, thinning of joint space and subchondral sclerosis.[8,9]

Worldwide estimation reported that more than 100 million people suffer from OA, and it was clinically one of the leading causes of disability.[10] The prevalence rate for symptomatic OA worldwide is estimated to be 9.6% in male and double in the female which is around 18%.[11] In India due to reduced physical activity majority of the population will increase the risk of early occurrence of OA knee. The prevalence of osteoarthrosis of the knee was 21.6% among women in the age group between 30-60 years. Prevalence was higher in menopausal women due to hormonal changes. So clinically men had a lower risk of OA knee than women. In India, the prevalence rate is estimated to be 17–60.6 %.[12]

The knee undergoes many alterations of force pattern in the muscle biomechanics during the daily event.[13] Biomechanically increased obesity and inactive physical activity are the risk factors for the prevalence of OA knee.[14] OA knee creates a burden on future health problems among the Indian

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population in modern health scenario. The female population other than their age and obesity are susceptible to high risk due to other factors like menopause, genetics, poor diet, joint overuse and muscle weakness.[15]

The management for OA includes Ultrasound therapy,[16] interferential therapy, [17] Neuromuscular electrical stimulation (NMES),[18] Laser and acupuncture[19], Deep heat (microwave diathermy)[20], static stretching.[21] The recent research has found open kinematic chain exercise and closed kinematic chain exercise is best for improving the muscle strength of the quadriceps muscle.[22] The Population who does not have any kind of injury to the joint should do exercise regularly to prevent degeneration of weight-bearing joints,[23] aerobic exercises,[24] isometric exercises,[25] Resistance strength training,[26] Wobble boards,[27,28] Manual therapy, exercise and electrical dry needling techniques,[29] massage therapy.[30] Non-steroidal anti-inflammatory drugs, hyaluronic acid, Total knee replacement.[31]

Electrogoniometer (EGM) is a flexible lightweight tool that is reliable for measuring static knee joint angles in supine, sitting and standing positions. Electrogoniometer is an easy non-invasive and cheap method to assess and is considered as a precise way to assess movement capability. It is also proved that the reliability of this instrument is high.[32] The advantages of Electrogoniometer are stable, precise, accurate and repeatable in performance. The universal goniometer is easy to be employed, it can be used in the clinical evaluation of patients. still, the electro-goniometer is more accurate and hence it is used in laboratory studies.

The National Institute for Clinical Excellence (NICE) report, in the 2014 guidelines, state that treatment for osteoarthrosis should take a holistic approach. The use of MD and UD wobble board is hypothesized that improves balance and proprioception. So pain, lower extremity muscle power and proprioception are clinically important for the participants' balance control. Hence there is a need to study that the weight-bearing exercise to hip abductor in various balance strategies which may need to achieve joint position sense.

MATERIALS AND METHODS

Ethical clearance

The present study was approved by the Institutional Ethics Committee (IEC), Saveetha Medical College and Hospital(IEC No. 016/02/2017/IEC/SU dated 28th February 2017). The procedure was informed to all the members and higher authorities. The intervention procedure and benefits of the study were well explained to the participants before enrolling on the study. The clinical parameters and other details from the participants were collected after getting informed consent and the information was maintained confidential throughout the study.

Procedure

The participants were taken from the Physiotherapy Outpatient Department, Saveetha Medical College Hospital, Saveetha Institute of Medical and Technical Sciences, Thandalam, Chennai 602 105, Tamil Nadu, India. The Randomised Controlled Trial with three arms (random allocation with sealed envelopes) was used. The sample size estimation was done by using N Master software with the power of 90% and alpha error 5% and arrive the sample size 219 (it includes 10% of dropout), 73 of each group for three groups. The inclusion criteria of OA knee was diagnosed by clinical history and physical examination, each participant met the American College of Rheumatology criteria for OA knee and age of 50 years and above and chronic knee pain for 6 months or more and unilateral knee osteoarthrosis subjects. The exclusion criteria were a history of any recent injury in the lower limbs. Any recent fracture in the lower limb, any neurological weakness in the lower limb, feel difficult in single-limb standing on wobble board, limb length discrepancy and established deformities in the affected knee.

Totally 253 participants diagnosed with unilateral knee osteoarthritis were screened for this study and 219 participants who satisfied the inclusion and exclusion criteria were enrolled. The aim and purpose of the study, hip abductor strengthening procedures on multidirectional and unidirectional wobble board were explained to all the participants and informed consent was taken before enrolling them for the study.

The basic subjective data and clinical measurements were collected for all participants before allotting them into the groups randomly. The basic subjective data and clinical measurements include the age of the patient, gender, body mass index (BMI) after enrolling these data, the participants were randomly allotted into three groups as multidirectional wobble board lateral step-up exercise group (MD EXERCISE GROUP), unidirectional wobble board lateral step-up exercise group (UD EXERCISE GROUP) and control group.

The sensitivity and acuity of peripheral proprioceptors have been investigated by assessing JPS using electrogoniometer by test angle measurement. In a quiet environment, the participants were blindfolded and seated on a high couch with back support and their hips and knees flexed to approximately 90° and their lower leg hanging independently. An electrogoniometer was attached to the lateral aspect of the subject's knee using doubled sided sticky tape. The proximal electrogoniometer block was placed just above the lateral femoral condyle in line with the greater trochanter, and the distal block just below the head of the fibula, in line with the lateral malleolus. In this 'resting position' the electrogoniometer display unit was set to 0. The subjects were instructed to slowly straighten their knee and told to stop at a random angle. This 'test angle' indicated on the display was noted.

For approximately 5 secs the subjects were asked to visualize their knee position. The subjects were then told to relax, allowing their leg to hang freely and return to the resting position, and after 3 secs the subjects were asked to reproduce the test angle. The 'reproduced angle' on the display was recorded. The procedure was performed for 10 test angles chosen randomly by the researcher throughout the range of 90° flexion and full knee extension. The mean error between the 10 test and reproduced angles were calculated and tabulated.[33]JPS was measured by the physiotherapist who was blinded to the group allotment. These testers were qualified and expertise in making use of the above outcome measures.

The participant's baseline values for JPS were recorded and analyzed with the help of the parametric test, one way ANOVA was used to analyse the baseline homogeneity. Before starting the exercise program the pretest measurements was taken and post-test measurements were measured and tabulated during the 2nd week of the intervention period and 4thof the intervention period for statistical analysis to obtained results. Joint position sense in OA knee was measured and statistically analysed by Electrogoniometer. One way repeated measures of ANOVA (Student Newman Keuls Method) was used to compare within-group significance and the second section deals with one way ANOVA test.

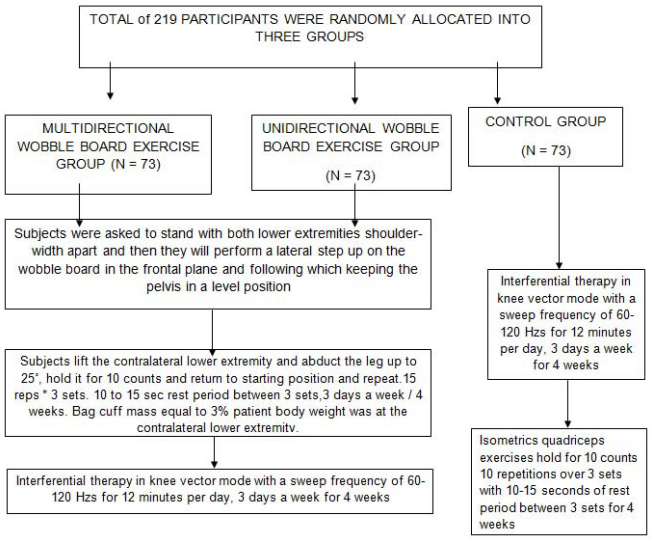

Figure 1: Flowchart depicting the methodology.

RESULTS

The participants' demographic factors like age, gender, body mass index (BMI) analysis done for the following subgroups (Table 1).

The participants' age, gender, body mass index were recorded in this study and was analyzed with the help of a non-parametric Chi-square test.The$\chi 2$ value of 0.346 and $p<0.001$ was observed in gender analysis. The age means 55.60± 3.72, 56.41± 4.47, 56.61±4.22 for Control, UD, MD respectively with the $\chi 2$ value of 1.038 and $p<0.001$ and BMI mean 28.44 ± 3.84, 28.92 ± 4.07, 27.48 ± 3.93 for Control, UD, MD respectively with the $\chi 2$ value of 1.303 and $p<0.001$proves the baseline homogeneity of demographic variables for the participants of all three groups. The sigma plot software was used for all data analysis (Table 2).

The participant's baseline values for JPS were recorded and analyzed with the help of the parametric test, one way ANOVA was used to analyse the baseline homogeneity. The JPS mean 12.44 ± 0.61, 12.20± 0.714, 12.38 ± 0.60 for Control, UD, MD respectively with the F value of 2.895 and $p<0.00$ proves the baseline parameter homogeneity for the participants of all three groups (Figure 2).

Joint position sense in OA knee was measured by Electrogoniometer and was statistically analyzed before and after the intervention. This was analyzed with the parametric test. One way repeated measures of ANOVA (Student Newman Keuls Method) was used to compare within-group significance and the second section deals with one way ANOVA test[34]. The results of paired and unpaired t-test of JPS were presented in (Table 3)

This study shows both UD and MD with a better reduction in mean test angle of JPS in OA knee participants than control and MD was better than UD. The longer 4 weeks duration was more beneficial than the shorter 2 weeks of weight-bearing wobble board protocol. This study showed that in response to 4 weeks of proprioceptive training in participants with degenerative OA knee exhibited a better increase in proprioception sense used wobble board lateral step up than unilateral wobble board lateral step up with help of hip abductor strength in the frontal plane.

DISCUSSION

Proprioceptive exercises will increase attention by giving proprioceptive cues to the brain. The first stage at the conscious level early in training, second stage later level, more training, at last, autonomous level.[35] Joint pain may have harmful effects on muscle spindle function (muscle strength and activation) and joint position sense (proprioception and balance).[36] So, the wobble board weight-bearing exercise program was designed to strengthen the thigh muscles, enhance proprioception, and reduce pain in individuals with OA. Clinically in OA knee proprioception deficits act as a risk factor for symptoms progression.[37] Proprioceptive accuracy of the knee seems to be impaired inOA the knee. Eleven studies showed a significant impairment in position sense or motion sense in a total of 387 OA knee participants, when compared to age and gender-matched healthy controls.[38]

Exercises in specific weight-bearing seem to improve proprioceptive accuracy (both position and motion sensing in joint movement), as well as pain and functional activity limitation. Proprioceptive exercises (both non-weight bearing and weight-bearing) weight-bearing muscle strengthening exercises seem to be the most effective in improving proprioceptive accuracy. Non-weight bearing muscle strengthening exercises, however, do not result in improvement in proprioceptive accuracy.[39,40,41]

The general exercise program shows less clinical significance than the program that targets a specific system (e.g. visual, vestibular, and somatosensory) that functions to maintain balance.[42] The present study proves that 4 weeks proprioceptive balance training program improves balance and proprioception in OA participants.

In our participants it was 12.39± 0.6º, 12.21 ± 0.7º and 12.45 ± 0.6ºat the angles of 20º and 60º of knee flexion, respectively, before training and improved to 3.14 ± 0.4º, 9.26 ± 0.3º and 11.25 ± 0.2º respectively, after 4 weeks of training. Therefore in the wobble board lateral step up training knee position sense was improved in the OA knee (Table 4, Figure 3).

CONCLUSION

In summary, this study proved that the multidirectional wobble board lateral step-up exercise is more beneficial than unidirectional wobble board lateral step-up exercise in OA Knee. Considering the higher prevalence rate of OA knee in India there is huge evidence available for the management of symptoms like pain and reduced muscle power. Another symptom that tends to affect the patients ADL and QOL is diminished joint proprioception and balance. Multidirectional wobble board training protocol may be beneficial as proved with joint position sense for the participant with OA knee. Results of this study conclude that changes in improved intermuscular coordination and co-activation and selective muscle recruitment, hip knee and ankle strategy were the key factors for adaptations to balance training and these adaptations influenced joint mechanics and contribute to the safer performance of challenging landing activities in degenerative conditions. This study strongly recommends using weight-bearing exercise to hip abductor in various balance strategies for managing osteoarthritis of the knee joint.

Conflict of Interest: There was no conflict of interest in the study

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Authors Contribution:

Authors Contribution	All Authors Involved in This Study Contribute Following Areas
Research concept and design	✓
Collection of samples	✓
Data analysis and interpretation	✓
Writing the article	✓
Critical revision of the article	✓
Final approval of the article	✓

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Table 1: Demographic Data analysis for all three groups (n=225)

S. No.	Variable	Groups			χ^2 value	p value
		Control	UD	MD		
	Gender (m/f)	19/56	16/59	18/57	0.346	0.841
	Age (Mean and SD)	55.60 and 3.72	56.41 and 4.47	56.61 and 4.22	1.038	0.595
	BMI (Mean and SD)	28.44 and 3.84	28.92 and 4.07	27.48 and 3.93	1.303	0.521

Table 2: Baseline Data analysis for all three groups (n=225)

S. No.	Variable	Groups			F value	p value
		Control	UD	MD		
	JPS Mean and SD	12.44 and 0.61	12.20 and 0.714	12.38 and 0.60	2.895	0.057

Table 3: Effectiveness multidirectional wobble board lateral stepup exercise and unidirectional wobble board lateral stepup exercise on joint position sense in OA knee measured by electrogoniometer in degreeo (n=225)

S. No	Parameter	Group	Mean ± SD ino	One way repeated Measures Analysis of Variance (q value)			One way Anova (F value)		
				4 - 0 week	4 - 2 week	2 - 0 week	0 week	2nd week	4th week
	EGM	Control Group 0 Week	12.449 ± 0.617	44.665 p<0.001	17.925 p<0.001	26.740 p<0.001	2.895 p 0.057 CU- NS CM-NS UM-NS	6519.306 p<0.001 CU- S CM-S UM-S	11915.988 p<0.001 CU- S CM-S UM-S
		Control Group 2nd week	11.248 ± 0.206						
		Control Group 4th Week	10.443 ± 0.194						
		UD Group 0 Week	12.205 ± 0.714	93.132 p<0.001	37.318 p<0.001	55.814 p<0.001			
		UD Group 2nd week	9.256 ± 0.266						
		UD Group 4th Week	7.284 ± 0.145						
		MD Group 0 Week	12.389 ± 0.605	170.154 p<0.001	65.731 p<0.001	104.423 p<0.001			
		MD Group 2nd week	6.715 ± 0.255						
		MD Group 4th Week	3.143 ± 0.441						

Figure 2: Measurement of test angle using electrogoniometer..

APPENDIX-1

INFORMED CONSENT

Informed Consent to Participate in a Research Study

Outpatient Department of Physiotherapy, Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Chennai, Tamilnadu.

Title of the Study: Effectiveness of multidirectional wobble board lateral step-up exercise and unidirectional wobble board lateral step-up exercise on joint position sense in OA knee.	**Name of the Principal Investigator :** Dr. Kotteeswaran. K Professor, Saveetha College of Physiotherapy, SIMATS, Thandalam, Chennai-602015 Phone: 9894286700 Email: k.kotteeswaran@gmail.com
Purpose & Background : To study the weight-bearing exercise to hip abductor in various balance strategies to achieve joint position sense among OA knee subjects.	**Address :** Outpatient Department of Physiotherapy, SCPT, SIMATS.

If I participate in this study: I will be required to share my demographic details and I will be assessed on my balance and proprioception. The assessment timings will range up to maximum 30 minutes.

Risks: There are no foreseeable risks or discomforts involved in participating in this study.

Confidentiality: The records from this study will be kept as confidential as possible. No individual identities will be revealed in any reports or publications resulting from the study. Research information will be kept in locked files at all times at the Department of Physiotherapy. Only the research personal will have access to the files and only those with essential need to see names will have access to that particular file.

Costs: There will be no costs to me as a result of participating in the study.

Consent

I'm giving my full consent to participate in this study. I am free to decline to participate in this research study, or I may withdraw my participation at any point without penalty.

I have spoken with _____ about this study and have my questions and doubts answered. If I have any doubts I can contact Dr. K. Kotteeswaran 9894286700 or write to him at the outpatient Department of Physiotherapy, Saveetha College of physiotherapy, SMCH, SIMATS, Thandalam.

Signature: _____ (Research Participant) Date: _____

Signature: _____ (Researcher) Date: _____