**Research article**

# Effect of multidirectional and unidirectional wobble board lateral step-up exercise in pain, symptom and ADL among unilateral medial compartmental osteoarthrosis of knee

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## ABSTRACT

**Introduction and Aim:** Osteoarthrosis is defined as degenerative condition of the synovial joints. Weak thigh muscle will cause impaired walking and balance and leads to risk of fall during activities of daily living. Use of MD and UD wobble board is hypothesized to improve balance and proprioception. So, pain, muscle power and proprioception are clinically important for balance control. Hence there is a need to study weight bearing exercise to hip abductor in various balance strategies to achieve muscle strength, joint position sense, balance, and activity of daily living.

**Methodology**: Knee osteoarthrosis subjects(n=219) were selected according to selection criteria and were randomly allocated into 3 groups as multidirectional wobble board lateral step-up exercise group, unidirectional wobble board lateral step-up exercise group and control group. The pre-test KOOS pain, symptoms and ADL measurements were taken before the intervention and another measurement during the 2nd week of intervention and at the end of the intervention period during 4thweek post-test measurements were measured and statistically analysed.

**Results**: At the end of 4th week control, UD and MD was found to be statistically significant with H=200.192 with p<0.001. KOOS symptoms between 3 groups was found to be statistically significant with H=200.288 and p <0.001. KOOS ADL values was found to be statistically significant between 3 groups with H=193.640 and p<0.001.

**Conclusion**: This study concludes that both unidirectional and multidirectional wobble board lateral step-up exercise showed improvement with KOOS pain, symptom and ADL scores compared to control group.

**Keywords**: Osteoarthrosis; KOOS; wobble board; knee pain; balance; hip abductor strength.

## INTRODUCTION

Osteoarthrosis (OA) is a common disorder of cartilage degradation, synovial inflammation, osteophyte formation, thinning of joint space and sub-chondral sclerosis (1) most commonly targeting the weight bearing joints. The cartilage is the structure which is present between the bones to prevent the rubbing of the bone to each other. The synovial fluid which is secreted by the synovial membrane will reduce the friction between the joint. The OA knee will cause pain and restrict the range of motions (2). Primary cause for OA knee is obesity, repeated strain to weight bearing structures.

Prevalence of osteoarthrosis of knee was 21.6% among women in the age group was 30-60 years. The prevalence rate of the OA knee increases with the age. Prevalence was higher in menopausal women due to hormonal changes. Sedentary lifestyle and higher BMI also emerged as the common factor which cause OA knee. In India, OA knee affects all the age groups, but after the age of fifty years the prevalence increases dramatically (3). OA ranks fourth among medical problems in women. So clinically men have a lower risk of OA knee than the women. In India, the prevalence rate is estimated to be 17–60.6 % (4).

Medical management of osteoarthrosis includes non-steroidal anti-inflammatory drugs which are commonly used as primary medical intervention for osteoarthrosis of knee. In chronic conditions hyaluronic acid will make it particularly suitable in elderly patients for whom NSAIDs are contraindicated. Total knee replacement is a surgical treatment which is available for severe OA knee (5). Soft tissue abnormalities will be excised by using arthroscopic surgery and clinically it does not show any improvement in pain and knee dysfunction in early stage of OA knee (6).

Physiotherapeutic interventions include pulsed mode Ultrasound therapy at low intensity has shown effect on pain and pain is reduced due to the thermal effect produced by the ultrasound therapy (7). The interferential therapy for short duration of time has shown to reduce the pain and improve the physical function in OA knee. This result shows that interferential therapy treatment can be given along with the drugs for management of pain (8). Neuro muscular electrical stimulation (NMES) will be given

to the participants of OA knee to improve the functional performance to prevent moderate to severe OA knee. This is the most accepted mode of treatment for OA knee. Stretching as add on to an isokinetic exercise, in that proprioceptive neuromuscular facilitation stretching is better and effective than the stretching in the static (9). Home based stretching exercise regimen was effective even in participants with severe OA knee before and after total knee replacement (10). The recent research has found open kinematic chain exercise and closed kinematic chain exercise are best for improving the muscle strength of the quadriceps muscle (11). The low intensity cycling, a type of closed kinematic chain exercise will improve the function and gait in participant with OA knee.

Wobble boards are most simple portable and low-cost devices widely used to assess and the same provide training to improve balance and postural control (12). These devices can provide fast improvement in balance performance with a long-term retention (13). The different balance and agility activities for cognitive level stimuli are incorporated in clinical protocol. This includes side stepping, cross over stepping, backward walking. Significant difference was found in the functional improvement after wobble board weight bearing and normal weight bearing exercise. The weight bearing exercise will have the physiological effect on co-activation of the adductor and abductor of the hip. Clinically this exercise can be used to treat joint position and balance impairment in OA knee (14).

The KOOS (Knee injury and osteoarthritis outcome score) is a useful, reliable, valid, and responsive instrument for assessment of patient relevant outcomes in elderly subjects with advanced osteoarthrosis. Compared to the WOMAC, the KOOS could be advantageous when assessing younger groups, groups with high expectations of physical activity, interventions with smaller effects or interventions where physical function is the primary outcome, and when assessing long term outcome, it was used to assess pain, remained unchanged in knee biomechanics. Functional performance and activities of daily living measured by KOOS and an advantage of the KOOS was the inclusion of two different subscales of pain and physical function relating to daily life, and sport and recreation. KOOS consists of 5 subscales: Pain, Other Symptoms, Activities of Daily Living (ADL), Sport and Recreation Function (Sport/Rec) and knee-related Quality of Life (QOL). The previous week is the time period considered when answering the questions. Standardized answer options are given and each question is assigned a score from 0 to 4. A normalized score (100 indicating no symptoms and 0 indicating extreme symptoms) was calculated for each subscale.

Hip joint muscle strength has a critical role in balancing the lower extremity in single limb stance. During heel strike, gluteus medius contract and create lateral tilt on opposite side pelvis to maintain center of gravity in a level position. Clinically gluteal medius weakness causes pelvic drop in opposite side leads to change in a weight bearing axis of knee joint and it creates abnormal weight bearing on the medial and lateral tibiofemoral condyles respectively and also have impairment in proprioception. Weak thigh muscle will cause impaired walking and balance and leads to risk of fall during activities of daily living. Use of MD and UD wobble board is hypothesized that improve balance and proprioception. So pain, lower extremity muscle power and proprioception are clinically important for participants balance control. Hence there is a need to study weight bearing exercise to hip abductor in various balance strategies to achieve muscle strength, joint position sense, balance, and activity of daily living.

## MATERIALS AND METHODS

The present study is a three-arm randomized controlled trial. 219 diagnosed unilateral knee osteoarthrosis subjects were selected according to selection criteria which were subjects Diagnosed of unilateral knee OA by clinical history and physical examination, subjects with chronic knee pain for 6 months or more and participants who met the American College of Rheumatology criteria for OA knee and age of 50 years and above from the Physiotherapy Outpatient Department, Saveetha Medical College Hospital, Saveetha Institute of Medical and Technical Sciences were recruited. History of any recent injury in lower limbs. Subjects with Any recent fracture in the lower limb or Any neurological weakness in lower limb or with any established deformities in the affected knee. Subjects who Feel difficult in single limb standing on wobble board and showing Limb length discrepancy were excluded. Interested participants were enrolled in the study after duly signing the institutionally approved consent form. Sample size calculation was done using N Master software with 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. Samples were randomly allocated to each groups using sealed envelopes. 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 includes age of the patient, gender, body mass index (BMI). The participants were randomly allotted into three groups as multidirectional wobble board lateral step-up exercise group, unidirectional wobble board lateral step-up exercise group and control group. The outcome measure used were pain, symptom and quality of life from KOOS.

The strengthening exercise intervention program was conducted one session per day 3 days a week for 4 weeks duration for multidirectional and unidirectional wobble board lateral step-up exercise group. KOOS were measured by a physiotherapist who is blinded to the group allotment. Before starting the exercise program, the pre-test measurements were taken and another measurement during the 2nd week of intervention period and end of the intervention period at the 4thweek post-test measurements were measured and tabulated for statistical analysis and the results were obtained. The present study was approved by 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 study was well explained to the participants before enrolling to the study.

*Multidirectional wobble board lateral step-up exercise group*

Subjects will stand with both lower extremities shoulder width apart then they perform a lateral step up on the multidirectional wobble board in frontal plane following which keeping the pelvis in level position the subjects lift the contra lateral lower extremity from the ground and abduct the leg up to 25˚, hold it for 10 counts and then the subjects return back to starting position and repeat the exercise for 15 repetitions over 3 sets. 10 to 15 sec rest period was allowed in between 3 sets. During this procedure sand bag cuff mass equal to 3% patient body weight was placed around the ankle level (long lever resistance) at the contra lateral lower extremity for enhancing ipsilateral hip abductor moment arm and sarcomere recruitment. After completion of exercise program in each session the participants received the interferential therapy treatment for 10 minutes.

*Unidirectional wobble board lateral step-up exercise group*

Subjects will stand with both lower extremities shoulder width apart then they performs a lateral step-up on the unidirectional wobble board (UD group) in a frontal plane (tilt board placed on frontal plane direction) following which keeping the pelvic a level position the subjects lifts the contra lateral lower extremity from the ground and abduct the leg up to 25˚, hold it for 10 counts and then the subjects return back to starting position and repeat the exercise for 15 repetitions over 3 sets. 10 to 15 sec rest period was allowed in between 3 sets. During this procedure sand bag cuff mass equal to 3% patient body weight was placed around the ankle level (long lever resistance) at the contra lateral lower extremity for enhancing ipsilateral hip abductor moment arm and sarcomere recruitment. After completion of exercise program in each session the participants received the interferential therapy treatment for 10 minutes.

*Control group*

The control group received interferential therapy four electrode placement around the knee joint vector mode with sweep frequency between 60 and 120 Hz for 12 minutes per session for 3 days a week for 4 weeks duration, and isometric quadriceps exercise (hold for 10 counts, 10 repetitions over 3 sets. 10 to 15 sec rest period was allowed in between 3 sets) for 4 weeks.

## RESULTS

Pain, symptom, and ADL were statistically analyzed before and after the intervention. Friedman Repeated Measures Analysis of Variance on Ranks (Student Newman Keuls Method) was used to compare within group significance and the second section deals with comparison between the groups by Kruskal Wallis test. The results of non-parametric test were tabulated and presented in table 1.

**Table 1:** Effectiveness multidirectional wobble board lateral step-up exercise and unidirectional wobble board lateral step-up exercise on KOOS in OA knee (n=225)

| Parameter KOOS Subscale | Group | Median (25 – 75th percentile) | Friedman Repeated Measures Analysis of Variance on Ranks (q value) | | | Kruskal Wallis Test (H value) | | |
|---|---|---|---|---|---|---|---|---|
| | | | 4 - 0 week | 4 – 2 weeks | 2 - 0 week | 0 week | 2nd week | 4th week |
| Pain | Control Group 0 Week | 20.000 18-22 | 17.321 p<0.001 | 12.247 p<0.001 | 12.247 p<0.001 | 11.107 p 0.004 CU- S CM-NS UM-S | 200.113 p<0.001 CU- S CM-S UM-S | 200.192 p<0.001 CU- S CM-S UM-S |
| | Control Group 2nd week | 38.000 36-39 | | | | | | |
| | Control Group 4th Week | 49.000 47-59 | | | | | | |
| | UD Group 0 Week | 21.000 19-23 | 17.321 p<0.001 | 12.247 p<0.001 | 12.247 p<0.001 | | | |
| | UD Group 2nd week | 56.000 54-58 | | | | | | |
| | UD Group 4th Week | 62.000 61-64 | | | | | | |
| | MD Group 0 | 20.000 | 17.321 | 12.247 | 12.247 | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Week | 18-22 | p<0.001 | p<0.001 | p<0.001 | | | |
| | MD Group 2nd week | 68.000 65-68 | | | | | | |
| | MD Group 4th Week | 74.000 72-75 | | | | | | |
| Symptoms | Control Group 0 Week | 20.000 18-22 | 17.321 p<0.001 | 12.247 p<0.001 | 12.247 p<0.001 | 0.163 p 0.922 CU-NS CM-NS UM-NS | 200.037 p<0.001 CU- S CM-S UM-S | 200.288 p<0.001 CU- S CM-S UM-S |
| | Control Group 2nd week | 38.000 36-39 | | | | | | |
| | Control Group 4th Week | 49.000 47-51 | | | | | | |
| | UD Group 0 Week | 20.000 18-22 | 17.321 p<0.001 | 12.247 p<0.001 | 12.247 p<0.001 | | | |
| | UD Group 2nd week | 56.000 54-58 | | | | | | |
| | UD Group 4th Week | 62.000 62-64 | | | | | | |
| | MD Group 0 Week | 20.000 18-22 | 17.205 p<0.001 | 11.921 p<0.001 | 12.411 p<0.001 | | | |
| | MD Group 2nd week | 68.000 66-69 | | | | | | |
| | MD Group 4th Week | 74.000 71-74 | | | | | | |
| ADL | Control Group 0 Week | 19.000 19-22 | 17.321 p<0.001 | 12.247 p<0.001 | 12.247 p<0.001 | 0 p 1 CU-NS CM-NS UM-NS | 200.350 p<0.001 CU- S CM-S UM-S | 193.640 p<0.001 CU- S CM-S UM-S |
| | Control Group 2nd week | 37.000 36-38 | | | | | | |
| | Control Group 4th Week | 49.000 46-51 | | | | | | |
| | UD Group 0 Week | 19.000 19-22 | 17.321 p<0.001 | 12.247 p<0.001 | 12.247 p<0.001 | | | |
| | UD Group 2nd week | 47.000 46-48 | | | | | | |
| | UD Group 4th Week | 56.000 53-57 | | | | | | |
| | MD Group 0 Week | 19.000 19-22 | 17.321 p<0.001 | 12.247 p<0.001 | 12.247 p<0.001 | | | |
| | MD Group 2nd week | 58.000 57-58 | | | | | | |
| | MD Group 4th Week | 68.000 66-69 | | | | | | |

*KOOS pain*

In UD group, the median KOOS pain score in the pretest was 21.000 and was reduced to 56.000 in the 2nd week and in 4th week the score was 62.000. It was found to be statistically significant with p<0.001 compared to the 0-week, 2nd week as well as 4th week. In MD (multidirectional wobble board) group the median KOOS pain score in the pretest was 20.000 and was reduced to 68.000 in the 2nd week and in 4th week of post-test KOOS pain score was 74.000. It was found to be statistically significant with p<0.001 compared to the 0-week, 2nd and 4th week. The median KOOS pain score for the control group during the pretest was 20.000 and was reduced to 38.000 in the 2nd week and 49.000 in the 4th week of post-test. It was found to be statistically significant with p<0.001 compared to the 0-week, 2nd week as well as 4th week. Comparison of KOOS pain scores for the control, UD and MD group. In the 0 week was found to be statistically significant difference with H=11.107 with p=0.004. In the 2nd week control, UD and MD was found to be statistically significant difference with H=200.113 with p<0.001. In the 4th week control, UD and MD was found to be statistically significant with H=200.192 with p<0.001 and between UD and MD also showed statistically significant difference (represented in Fig. 1). This study shows both UD and MD were better in reducing KOOS pain score 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.

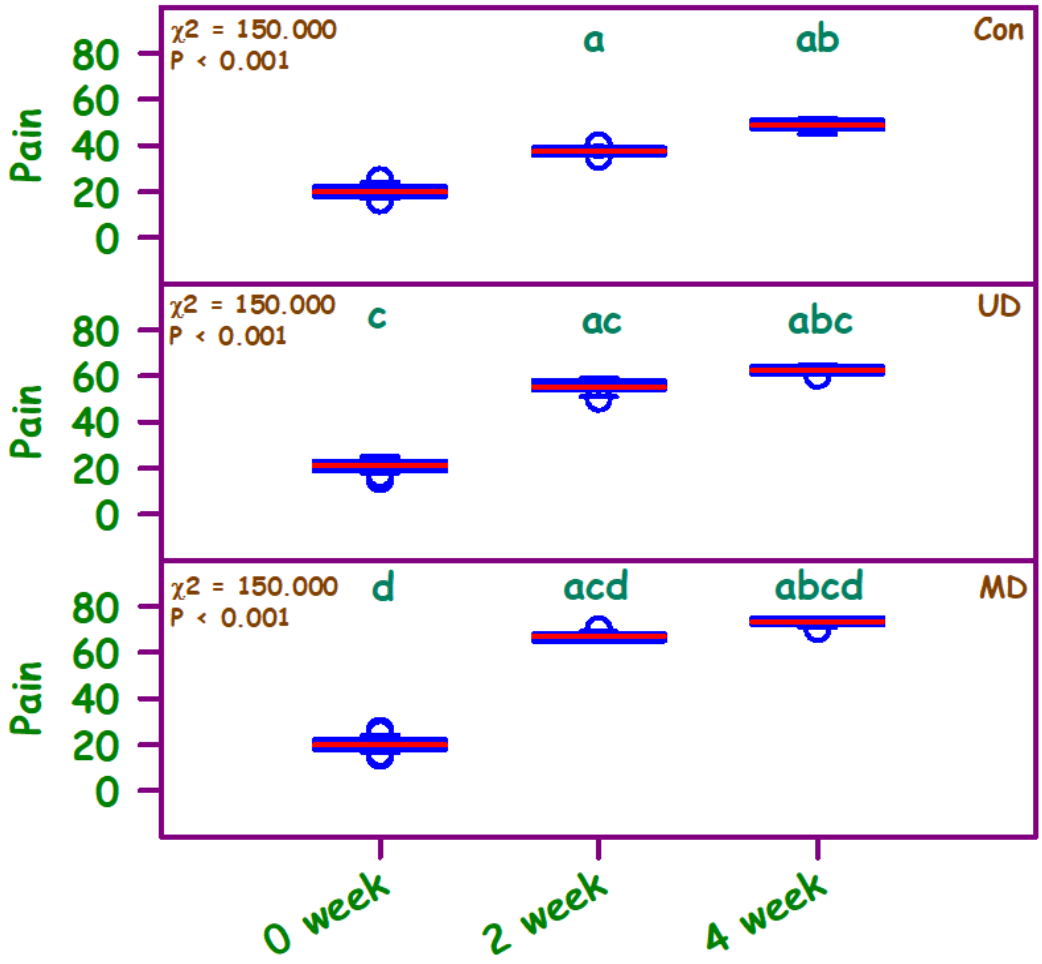


**Fig. 1:** Effectiveness of conventional (Con), unidirectional (UD) and multidirectional (MD) wobble board lateral step-up exercise on KOOS-pain (score) of OA knee.

The middle blue line is the median and the red line is the mean (n = 75 each)

The 'χ2' and 'P' values are by Friedman RM ANOVA on ranks with Student Newman Keul's multiple comparison test.

a Significantly different from the respective 0 week.

b Significantly different from the respective 2 week.

The respective 0-week, 2 week and 4 weeks of conventional, UD and MD are compared by Kruskal Wallis ANOVA on ranks

The 'H' and 'P' values for 0 week are 11.107 and 0.004 respectively.

The 'H' and 'P' values for 2 weeks are 200.113 and < 0.001 respectively.

The 'H' and 'P' values for 4 weeks are 200.192 and < 0.001 respectively.

c Significantly different from the respective conventional group.

d Significantly different from the respective 2-week group.

*KOOS symptoms*

In the UD group, the median KOOS symptoms score in the pretest was 20.000 and was reduced to 56.000 in the 2nd week and was 62.000 in 4th week of post-test. It was found to be statistically significant difference with p<0.001 compared to the 0, 2nd as well as 4th week. In the MD group the median KOOS symptoms score in the pretest was 20.000 and was reduced to 68.000 in the 2nd and was 74.000 in 4th week. It was found to be statistically significant difference with p<0.001 compared to the 0-week, 2nd as well as 4th week. The median KOOS symptoms score for the control group during the pretest was 20.000 and was reduced to 38.000 in the 2nd week and was 49.000 in 4th week of post-test It was found to be statistically significant difference with p<0.001. Comparison of KOOS symptoms score for the control, UD and MD was found to be statistically not significant with H=0.163 and p=0.922. In the 2nd week control, UD and MD was found to be statistically significant with H=200.037 and p<0.001. In the 4th week control, UD and MD was found to be statistically significant with H=200.288 and p <0.001 (represented in Fig. 2). This study shows both UD and MD were better reducing KOOS symptoms score in OA knee participants than control and MD was more superior than UD.

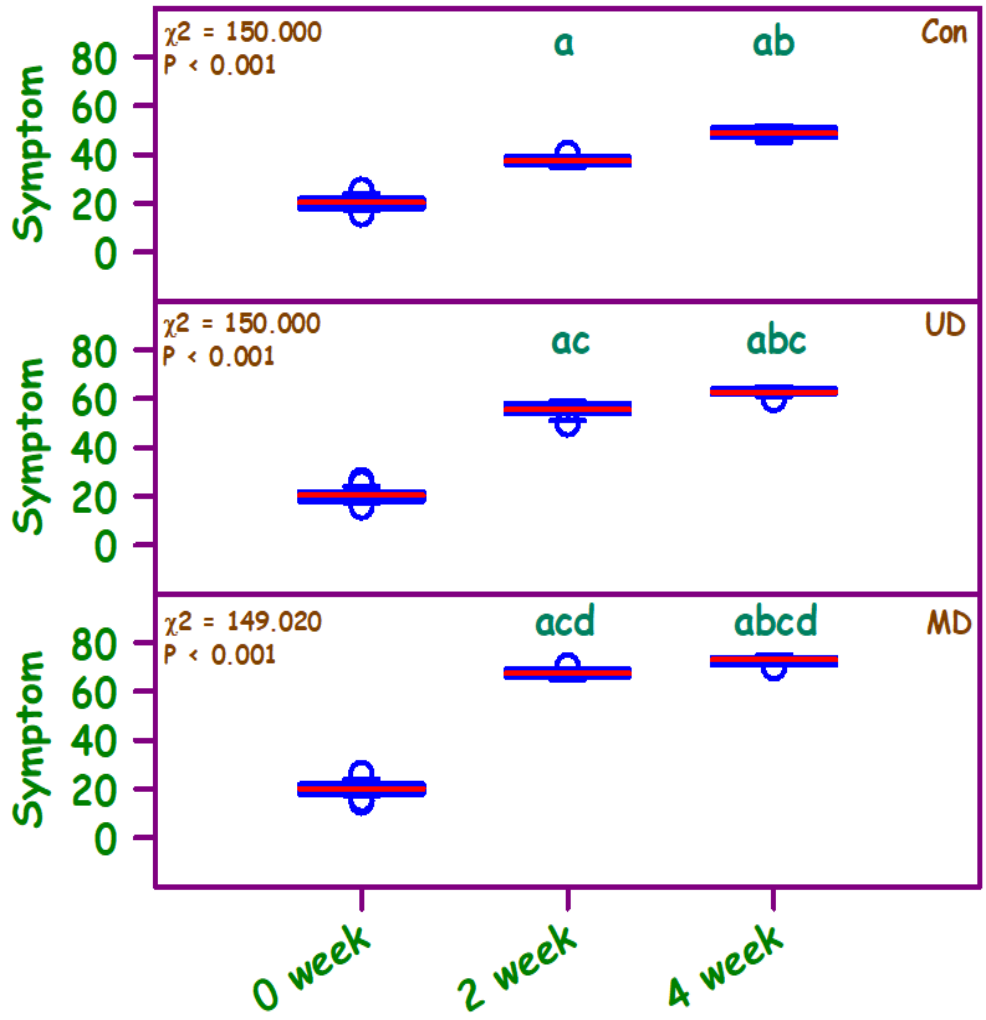


**Fig. 2:** Effectiveness of conventional (Con), unidirectional (UD) and multidirectional (MD) wobble board lateral step-up exercise on KOOS-Symptom (score) of OA knee.

The middle blue line is the median and the red line is the mean (n = 75 each)

The 'χ2' and 'P' values are by Friedman RM ANOVA on ranks with Student Newman Keul's multiple comparison test.

a Significantly different from the respective 0 week.

b Significantly different from the respective 2 week.

The respective 0-week, 2 week and 4 weeks of conventional, UD and MD are compared by Kruskal Wallis ANOVA on ranks

The 'H' and 'P' values for 0 week are 0.163 and 0.922 respectively.

The 'H' and 'P' values for 2 weeks are 200.037 and < 0.001 respectively.

The 'H' and 'P' values for 4 weeks are 200.288 and < 0.001 respectively.

c Significantly different from the respective conventional group.

d Significantly different from the respective 2-week group.

*KOOS activity of daily living*

In the UD group median KOOS ADL score in the pretest was 19.000 and was improved to 47.000 in the 2nd week. In 4th week of post-test, the score was 56.000. It was found to be statistically significant difference with $p<0.001$ compared to the 0-week, 2nd week as well as 4th week. In MD group median KOOS ADL score in the pretest was 19.000 and increased to 58.000 in the 2nd week of post-test and 68.000 In 4th week of post-test. It was found to be statistically significant difference with $p<0.001$ compared to the 0-week, 2nd week as well as 4th week. Also, the 4th week showed better KOOS ADL score improvement than 2nd week. Comparison of KOOS ADL scores for the control, UD and MD group in the 2nd week control, UD and MD was found to be statistically significant difference with $H=200.350$ and $p<0.001$. In the 4th week control, UD and MD was found to be statistically significant with $H=193.640$ and $p<0.001$(represented in Fig. 3). This study shows both UD and MD were better in increasing KOOS ADL score in OA knee participants than control and MD was better than UD.

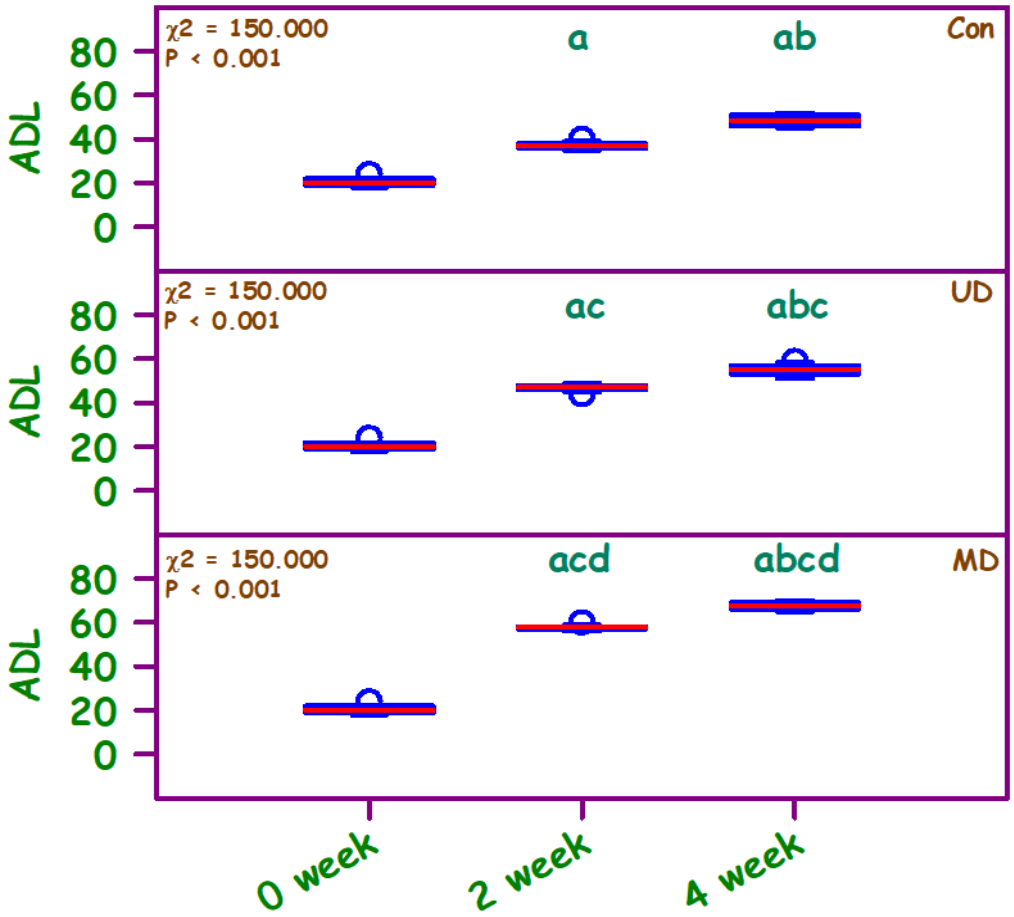


**Fig. 3:** Effectiveness of conventional (Con), unidirectional (UD) and multidirectional (MD) wobble board lateral step-up exercise on KOOS-ADL (score) of OA knee.

The middle blue line is the median and the red line is the mean (n = 75 each)

The 'χ2' and 'P' values are by Friedman RM ANOVA on ranks with Student Newman Keul's multiple comparison test.

a Significantly different from the respective 0 week.

b Significantly different from the respective 2 week.

The respective 0-week, 2 week and 4 weeks of conventional, UD and MD are compared by Kruskal Wallis ANOVA on ranks

The 'H' and 'P' values for 0 week are 0 and 1 respectively.

The 'H' and 'P' values for 2 weeks are 200.350 and < 0.001 respectively.

The 'H' and 'P' values for 4 weeks are 193.640 and < 0.001 respectively.

c Significantly different from the respective conventional group.

d Significantly different from the respective 2-week group.

## DISCUSSION

The intention of this study was to encourage and gain more selected responses from lower extremity muscles to a destabilizing load rather strong co-contraction responses to keep the knee stable. Physiologically this wobble board lateral step-up training protocol was to expose participant to activities such that challenge knee stability and balance in a controlled manner during balance rehabilitation. Some evidence suggests that the balance training rehabilitation protocol for people with knee ligament injuries will return to higher levels of physical activity without recurrent episodes of knee instability (15).

Balance and knee stability was challenged by wobble board lateral step up. The intensity of an agility and wobble board training program for OA knee participants reduced by decreasing the time used for each training technique and by providing frequent rest periods between techniques during training sessions (16). The participants instructed to keep a multidirectional balance board in horizontal plane and this particular activity was required to stimulate and activate cognitive, all the sensory and motor pathways and to maintain the upright standing performance which counter act with HAT load. This approach was including simple reactive tasks, such as to respond to single wobble board frontal plane strategy generated by platform to initiate controlled or to master a unidirectional wobble board. The multidirectional rotation at hip joint may perturb the body along both the directions, anyway, as the posture passes from quiet, side by side standing, to

more perturbed conditions, the ankle and hip strategies concurrently activated, producing a less discrete postural changes (17).

In previous studies, some authors deemed that ankle and hip strategies were inadequate in representing a general model of upright standing, and they suggested that the control variable for the posture adaptations was the level of coordination dynamics between weight bearing joints and not the motion of a single joint (18) during weight bearing activity other joints, such as the knee, showed a significant contribution for both quiet and wobble board lateral step up (19). Faster reaction time has been achieved to recruit muscles at forward perturbations to standing after 6 weeks of wobble board balance training as well as reduced loading of the knee joint while performing side step activities after 12 weeks of balance training using wobble boards, tilt boards, mini trampolines, dura disks, and Swiss balls (20).

Nociceptors were located maximum in the joint capsule, ligaments, periosteum, menisci, subchondral bone, and synovium (21). In OA knee clinical complaints of pain may suggests that these structures were in contact with each other and that stimulate Nociceptors the intra articular environment and initiate the afferent stimuli sensory action potentials that causes pain perception. Pain was the one of the major causes for reducing functional ability in knee osteoarthrosis. Knee injury and osteoarthritis outcome score (KOOS) pain was the most reliable valid structured functional outcome score used to measure the pain in OA (22). So, this study used KOOS to measure pain level, other symptoms, and activity of daily living. The questionnaire has a good internal consistency, and that the questionnaire items are relevant for elderly patients who suffered from OA. Training is not necessary, as the components of the KOOS and the scoring instructions were self-explanatory (23).

KOOS score in wobble board lateral step-up training was improved in OA. In this study many participants complaint of pain and stiffness on rising from the bed in the morning after long sleep and after long periods of immobility and increased intensity of pain during stair climbing activities and not placed the single limb and they found impaired balance before the protocol started, and at the end the 3 to 4th week participant reported reduced KOOS pain score and better balance in single limb stance activity in multidirectional wobble board and unidirectional wobble board lateral step up than the control group. In this study participants received the interferential current stimulation to OA knee and the possible mechanism of action was inhibition of nociceptive transmission by activation of Aα and Aβ fibres, block the pain by induce endogenous opioid secretion increase in neurotransmitter levels, including serotonin, which is important in endogenous and modulate ascending pain control pathways and not transmit to cephalic. Another possible action was increased blood flow leads to better tissue perfusion, increased metabolic activity, and muscle relaxation (24).

## CONCLUSION

This study concludes that lateral step-up exercise in multi directional and unidirectional wobble board strength training for 4 weeks to hip abductor in OA knee participants showed EMG activity for hip abductor better in multidirectional wobble board lateral step up and unidirectional wobble board lateral step than control in OA knee. This study concludes that changes in improved muscle strength may be the activity of agonist and antagonist coordination and co activation, and specific muscle recruitment in lateral step up and hip knee and ankle postural strategy. Result of this study concludes that both unidirectional and multidirectional wobble board lateral step-up exercise showed improvement with KOOS pain, symptom and ADL scores compared to control group. Result of this study also states that decrease in pain and symptoms directly improves the ADL. Multidirectional wobble board training protocol showed to be superior than UD as proved with KOOS score, joint position sense and balance for participant with OA knee. Results of this study conclude that changes in improved muscle strength, speed of timed up and go test, inter muscular coordination and co activation, and selective muscle recruitment, hip knee and ankle strategy were key factors for adaptations to balance training and these adaptations influenced joint mechanics and contribute to safer performance of challenging landing activities in degenerative conditions.

## CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

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