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EFFECTS OF SINGLE AND DUAL TASK TRAINING ON STATIC, DYNAMIC BALANCE PERFORMANCE AND GAIT IN PATIENTS WITH GRADE II KNEE OSTEOARTHRITIS

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ABSTRACT

Background: Degenerative osteoarthritis advances with age and is characterized by muscular weakening, discomfort, and functional restrictions, such as stiff joints. shortened exercise time. Balance and gait are greatly influenced by cognitive thinking while walking, and this connection can be explained by the fact that higher order cognitive functions like executive functions are involved in knee osteoarthritis.

Objectives: To determine effect of single task and dual task exercise on static, dynamic balance and gait in patient with grade II knee OA.

Material and Methods: A Randomized clinical trial was conducted between December 2022 to June 2023. 44 patients were participate. Patients were allocated into 2 groups. Single task and dual task using random Allocation software. The patients were get 2 treatment sessions per week. Assessment was done at baseline and after12 sessions. For analyzed the data 27 version of Statistical Package for Social Sciences (SPSS-27 version) was used.

Results: Age of patients in both groups was shown mean and std. deviation (60.772±5.778). 63.6% male and 36.4% female patients were participated Between groups analysis shows statistically

significant on dynamic balance (p=0.024), static balance (p=.009), Berg Balance Scale (p=0.003) and dynamic gait index (p=0.018) from baseline to 6 weeks between both groups.

Conclusion: This study concluded that both single and dual task training was effective on improving static and dynamic balance and gait in patients with knee osteoarthritis. But single task training show better improvement in static and dynamic balance and gait as compared dual task training group.

Key Words: Knee Osteoarthritis, Static balance, Dynamic Balance, Gait.

INTRODUCTION

The most frequent source of knee discomfort and osteoarthritic changes that affect ligaments, tendons, muscles, and structures inside the articular cavity is knee osteoarthritis (KOA). Proprioceptive accuracy and decreased quadriceps muscle power are two key neuromuscular variants associated with KOA (1). Additionally, people with KOA reported having less equilibrium, more accidents, and more pelvic sway (2). Symptomatic knee OA occurs 10% more frequently in men than in women, at 13%. OA is the second most typical reason for impairment in elderly people. Over 50% of senior people with OA experienced more falls than healthy elderly people, which is significant (3). Balance and gait are greatly influenced by cognitive thinking while walking, and this connection can be explained by the fact that higher order cognitive functions like executive functions are involved (4). The loss of equilibrium control can cause severe physical, psychological, and social losses due to accident injuries. Before treating knee OA patients, a thorough assessment of equilibrium control is required (5). There is a growing corpus of research documenting kinematic gait changes in individuals with KOA, such as slower walking rates, less knee flexion during weight bearing, and less knee joint range of motion overall (6). Since many everyday tasks combine motor and cognitive components, performing a motor task while also performing another task under typical neurological circumstances may provide a more accurate measure of one's functional ability. Exercises for balance that focus on quick muscle stimulation help people with knee OA avoid accidents by maintaining acceptable muscle function. Exercises that focus primarily on balance have been successful in lowering the risk of accidents in individuals with KOA (7, 8). The symptoms include stiffness, pain, substantial impairment, and poor performance in social and physical activities, all of which have an impact on the person's general health and make walking, crouching, and ascending stairs difficult (9). Many everyday tasks combine motor and cognitive components, performing a motor task while also performing another task under typical neurological circumstances may provide a more accurate measure of one's functional ability (10). Gait dysfunctions are a serious public health issue More than 32% of people 60 years and older have gait impairment, which includes slower walking, shorter strides, and an increased double support phase. Their frequency rises with age (11).

Aslihan examined effect of single and dual task exercise on balance in older individuals with knee osteoarthritis (OA) in 2020. At the conclusion of the therapy, both groups' BBS and TUG test results for the single- and dual-task ABC scale revealed statistically significant gains (p0.05), but there had been no statistically significant difference in any other parameter between the groups (p>0.05). In older individuals with knee OA, both single task and dual task workouts were shown to be effective in improving balance function under single task and dual task conditions. Therefore, they came to the conclusion that dual task exercise was not better than single task exercise for improving balance in knee OA patients. (12) The therapeutic effectiveness of a three-dimensional communicative augmented reality system (3D-ARS) for balance and mobility therapy was evaluated by Ku et al. in 2019. With a realistic 3D interactive balance exercise and measurements of movement parameters and joint angles made possible by a dynamic sensor system, this device aids in participant training. To regain balance function, it is important to encourage physical activity

and enhance proprioceptive capabilities with targeted therapies. This may be the case because 3D-ARS motivates participants to plan their actions around the topics presented on the screen while they are looking at it. It can more effectively support both the unconscious automatic system and the conscious motor learning process (13). Joohee Hahn et al conducted a study and demonstrated the use of dynamic gait index using trampoline training in improving balance among patients with balance dysfunction. The study recruited 28 participants who had the ability to walk at least 2 minutes with or without walking assistance. A randomised pre- and post-test, two group design was used in this research. Randomly chosen participants were divided into a control group (CG; n=14) or a trampoline exercise group (TG; n=14). The intervention was finished by all 24 subjects. The results of this study demonstrated that the dynamic gait index increased considerably in the TG ($p<0.05$), and this disparity was also significantly larger than it was in the CG (14). A study conducted by Adriano Zanardi da Silva in 2018 on the effects of dual task training on balance, gait and functional mobility. It was a single-blind, randomized study. 28 people who fulfilled the requirements for admission were randomly assigned to the Experimental Group (EG) and Control Group. (CG). For ten weeks, EG underwent a twice-weekly dual-task water training program. It took 40 minutes for each practice. The people were evaluated at the start (AS1), following a fitness program (AS2), and three months later. (AS3). BBS and DGI were used to verify balance and gait. The results of the study demonstrated an increase in gait and balance using Dynamic gait index and Berg balance scale (15). So the objective of study is to determine effect of single task and dual task exercise on static dynamic balance and Gait in patient with grade II knee OA.

MATERIAL AND METHODS:

Randomized Clinical Trail collected from Allied Hospital and Safi Teaching Hospital Faisalabad in duration of December 2022 to June 2023. Sample size was calculated by using Giga calculator using confidence interval 95%, margon of error 5% power of study 80% with mean under H0 34.5 SD 6.3 so sample size is 40, by adding 10% attrition rate sample size was 44, 22 in each group (5). Participants were selected using inclusion & exclusion criteria. both males and Females with age above 50 years with unilateral Knee OA (16). Berg Balance Scale (BBS) 30-45 points (17). American College of Rheumatology (ACR) standards classifying KOA and rate of distress in knee joint and some 3 of 6 factors listed below (18). (1) Patient's age >50 (2). Crepitus sound on active movement of knee (3) < 30 minutes Morning stiffness (4) Bony soreness (5) Bone Overgrowth (6) Warmness of synovium not palpable were included and patient those using intra-articular injections of Knee Joint. Any stroke history during the previous 12 months (Ischemic/ Hemorrhage), cardiovascular disease (Myocardial Infarction), incidence of fractures or lesions in lower limb from last six months were excluded (19).

For data collection procedure Berg Balance Scale (BBS) have show great reliability (ICC - 0.98) and Intra-class Coefficient (ICC = 0.97 - 0.98) (17, 20). Dynamic Gait Index (DGI) were used and patient were divided into Group A: Single task training and Group B: Dual task training using non-Probability purposive sampling technique was used to collect the data.

Intervention Protocols

Conventional Physical Therapy

- Patient were received treatment like heat therapy by infrared lamp which was placed about 1ft away from the knee joint for atleast 10-15 minutes and isometric and dynamic strengthening of quads muscles (21).

Group A: Single Task Training

Static Balance:	Static/Dynamic/Postural Control:
1) Romberg with eye open 30 sec &eye close30 sec repeat 3 times.	1) Sit to stand: 5 repetition
2) Tandem standing with eye Open 10 sec, then with eye close 10 sec right foot front first , then left foot front repeat 3 times	2) Functional reach test: forward, sideways & cross reach ,practice 1 min for each
3) Single leg stance 5 repetition with 30 sec	3) TUG test: with distance of 10 feet &time 10 sec. practice 2 min

Group B: Dual Task Training

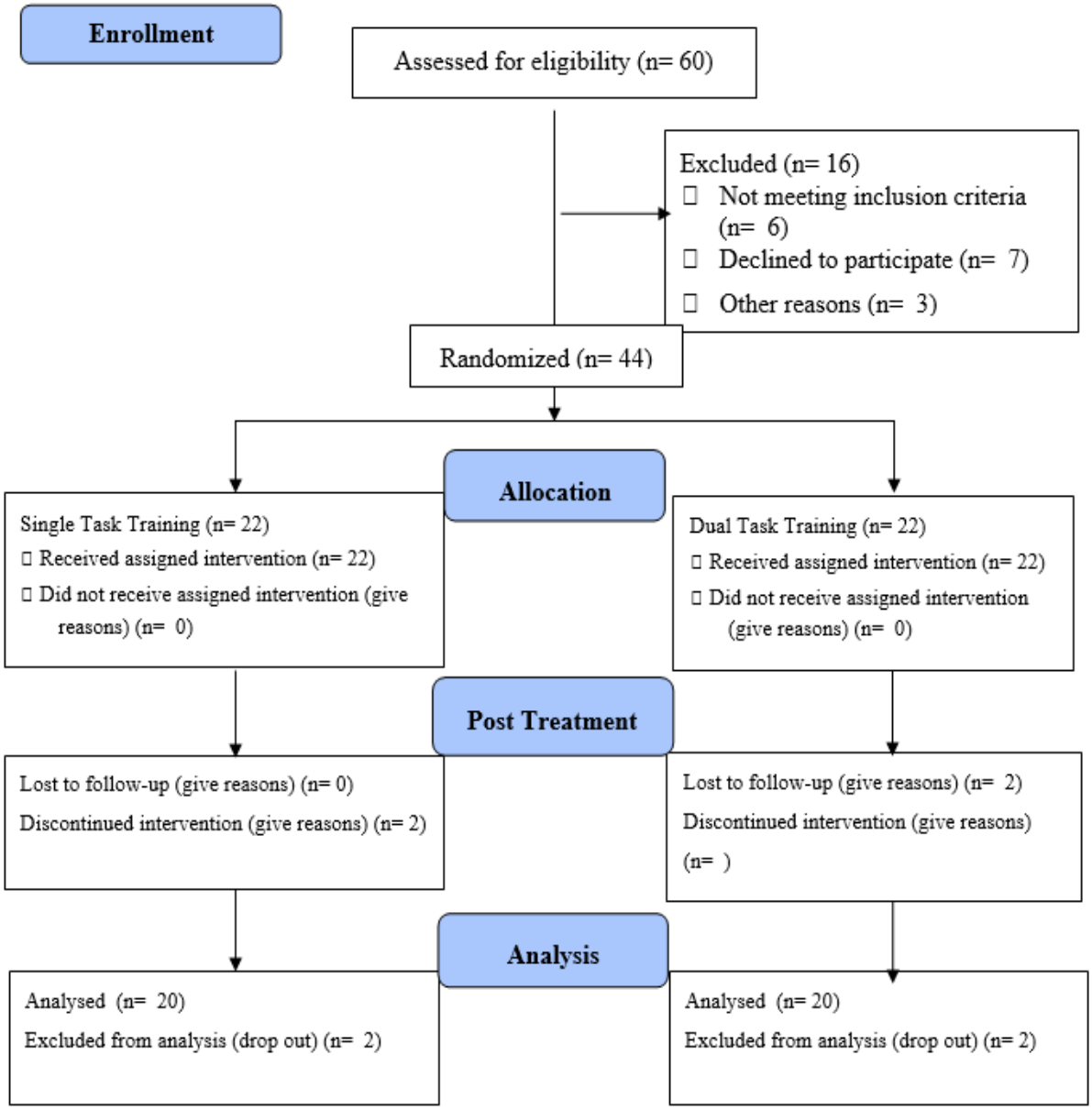
Static Balance	Static/Dynamic/Postural Control:
1) Romberg with eye open 30 sec &eye close30 sec repeat 3 times. 2) (Count from 20, Remember 5 words/name of animals)	1) Sit to stand: 5 repetition (Reverse count from 20, Remember 5 words/name of animals)
2) Tandem standing with eye Open 10 sec, then with eye close 10 sec right foot front first , then left foot front repeat 3 times (Count from 20, Remember 5 words/name of animals)	2) Functional reach test: forward, sideways & cross reach ,practice 1 min for each (Reverse count from 20, Remember 5 words/name of animals)
3) Single leg stance 5 repetition with 30 sec (Count from 20 Remember 5 words/name of animals)	3) TUG test: with distance of 10 feet &time 10 sec. practice 2 min (Reverse count from 20, Remember 5 words/name of animals)

Data Collection Procedure:

Consent form was signed from patient and for data collection standardized Questionnaire were used. Single and dual task exercises were given 2 times/week for 6 weeks. Assessment was done at baseline and after 6 weeks. Subjects was randomly allocated to intervention groups and a random list prepared before starting data collection using Random allocation software version 2 (22).

Data was analyzed through SPSS 27. Descriptive Statistics show the frequency distribution of tables, bar and pie charts was use for summarize the groups measurements which was measured over time. Shapiro Wilk test used to see the data was normally distributed or not normally distributed. Which indicate that Dynamic BBS, Static BBS, Total BBS and Dynamic gait index at baseline show p value more than 0.05 which indicate data was normally distributed and parametric test (Independent sample T test and Paired Sample T test) was applied.

Consort Flow Chart



RESULTS

Table 1 show 28 (63.6%) male and 16(36.4%) female were patient were enrolled in this trail, 34.1% patient normal in weight, 65.9% were overweight, 24 (54.5%) patient were suffering right knee osteoarthritis and 20(45.5%) suffering left knee OA. And descriptive statistics of age, height, weight which mean ±SD of age (60.772 ±5.778), height (65.205±3.331) and weight (75.205 ±12.354).

Table 1 Baseline characteristics

	N	%
Gender		
Male	28	63.6
Female	16	36.4
Body Mass Index		
Normal in weight	15	34.1
Overweight	28	65.9

Knee OA		
Right Knee	24	54.5
Left Knee	20	45.5
	N	Mean ±SD
Age of Patient	44	60.772±5.778
Height of Patient	44	65.205±3.331
Weight of Patient	44	75.205±12.354

Table 2 show Independent sample t test was applied for between groups comparison. There were non-significant differences (p=0.078) between groups in dynamic balance at baseline with mean ±SD of single task training (11.409 ±2.085), dual tasks training (11.818± 1.468). There were significant differences (p=0.024) between groups in dynamic balance after 6th weeks of treatment with mean ±SD of single task training (16.000 ±2.772), dual tasks training (13.350± 1.565). There were non-significant differences (p=0.404) between groups in static balance at baseline with mean ±SD of single task training (21.818±2.442), dual tasks training (20.727±2.979). There were significant differences (p=0.009) between groups in static balance after 6th weeks of treatment with mean ±SD of single task training (26.650 ±4.602), dual tasks training (23.000± 2.695). There were non-significant differences (p=0.571) between groups in berg balance scale at baseline with mean ±SD of single task training (33.227±3.053), dual tasks training (32.409±3.431). There were significant differences (p=0.003) between groups in berg balance scale after 6th weeks of treatment with mean ±SD of single task training (42.650 ±5.760), dual tasks training (36.082± 3.082). There were non-significant differences (p=0.939) between groups in dynamic gait index at baseline with mean ±SD of single task training (13.363±1.915) and dual tasks training (13.136±1.983). There were significant differences (p=0.018) between groups in dynamic gait index after 6th weeks of treatment with mean ±SD of single task training (17.650 ±3.265), dual tasks training (15.800± 1.962).

Table 2 Between Groups difference of Dynamic, Static balance and Gait Index

Outcome Measure	**Treatment Groups**						**T**	**P value**
	Single Task			**Dual Tasks**				
	N	**Mean**	**SD**	**N**	**Mean**	**SD**		
Dynamic Balance at Baseline	22	11.409	2.085	22	11.818	1.468	-0.752	0.078
Dynamic Balance After Treatment	20	16.000	2.772	20	13.350	1.565	3.723	0.024
Static Balance at Baseline	22	21.818	2.442	22	20.727	2.979	1.328	0.404
Static Balance After Treatment	20	26.650	4.602	20	23.000	2.695	3.060	0.009
BBS at Baseline	22	33.227	3.053	22	32.409	3.431	0.835	0.571
BBS After Treatment	20	42.650	5.760	20	36.350	3.082	4.312	0.003
DGI at Baseline	22	13.363	1.915	22	13.136	1.983	0.387	.939
DGI After Treatment	20	17.650	3.265	20	15.800	1.962	0.018	.018

Within group difference Paired sample t test was applied. Paired difference of dynamic balance in single task Group was (4.850 ±2.777) with significant p value (.001) and paired difference in dual task group was (1.750 ±1.019) with significant p value (.001). Paired difference of static balance in single task Group was (4.700 ±3.213) with significant p value (.001) and paired difference in dual task group was (2.100 ±1.774) with significant p value (.001). Paired difference of berg balance scale in single task Group was (9.550 ±4.122) with significant p value (.001) and paired difference in dual task group was (3.800 ±1.935) with significant p value (.001). Paired difference of dynamic balance scale in single task Group was (4.550 ±3.170) with significant p value (.001) and paired difference in dual task group was (2.650 ±1.225) with significant p value (.001).

Table 3 Within group difference of dynamic, static balance and dynamic gait at baseline and after Treatment

Assessments	Treatment Groups					
	Single Task			Dual Task		
	N	Mean	SD	N	Mean	SD
Dynamic balance at Baseline	20	11.150±1.980		20	11.600±1.313	
Dynamic balance after Treatment	20	16.000±2.772		20	13.350±1.565	
Paired Differences		4.850±2.777			1.750±1.019	
P value		.001			.001	
Static balance at Baseline	20	21.950±2.523		20	20.900±3.076	
Static balance after Treatment	20	26.650±4.602		20	23.000±2.695	
Paired Differences		4.700±3.213			2.100±1.774	
P value		.001			.001	
BBS at Baseline	20	33.100±3.177		20	32.550±3.561	
BBS after Treatment	20	42.650±5.760		20	36.350±3.082	
Paired Differences		9.550±4.122			3.800±1.935	
P value		.001			.001	
DGI at Baseline	20	13.100±1.774		20	13.150±1.980	
DGI after Treatment	20	17.650±3.265		20	15.800±1.962	
Paired Differences		4.550±3.170			2.650±1.225	
P value		.001			.001	

DISCUSSION

This Randomized clinical trial aimed to compare the effects of single and dual task training on static and dynamic balance performance and gait in patients with grade II knee OA. The results of the study demonstrated a significant improvement between groups in terms of static, dynamic balance, Berg balance scale and dynamic gait index. The within group differences also shown a significant improvement in terms of static dynamic balance, Berg balance scale and dynamic gait index signifying the effectiveness of these interventions. The present study used berg balance scale and dynamic gait index to determine the effect of single and dual task training on balance in patients with grade II knee osteoarthritis. The results of the study indicated that there was significant difference between groups in terms of dynamic balance (0.024) with mean difference between both groups (2.65) shown that single task training improve more dynamic balance as compared with dual task training. Present study indicated that there was significant difference between groups in terms of static balance (0.009) with mean difference between both groups (3.65) shown that single task training improve more static balance as compared dual task training.

Current study also specified that there was significant difference between groups in terms of Berg balance scale (0.003) with mean difference between both groups (6.30) shown that single task training improve more balance as compared dual task training. The results of the study shown that there was significant difference between groups in terms of dynamic gait index (0.018) with mean difference between both groups (1.85) shown that single task training improve more dynamic gait index as compared with dual task training. Konak et al., in 2016 shown that 4 week single task and dual task balance exercises significantly improved score of Berg balance scale, gait speed and ABC-6 in all patients ($p< 0.05$) BBS and gait speeds under single and dual-task conditions showed significantly greater improvement in the single task balance training group than in the dual task balance training group ($p< 0.05$) (23).

Results of current study also supported by Silsupadol et al., in 2019 provide evidence than 4th week balance training program significantly improve performance on single task gait speed and berg balance scale the overall BBS score was improve 5.75 point (46.85-52.60) (24).

The primary outcomes in the present study were balance and gait as measured by berg balance scale and dynamic gait index to determine the effects of single and dual task training in patients with grade II knee OA. Both single and dual task training improved gait in the present study as a significant difference was found between groups ($p<0.05$). These findings were supported by a

study conducted by CY Baek in 2021, the study reported that both the single-task condition and the dual-task condition showed significant changes between preintervention and postintervention in the experimental group (P<0.01 and P<0.001, respectively). Both the single-task condition and the dual-task condition showed significant changes between preintervention and postintervention in the control group (P<.01 in each case). In the dual-task condition, there were noticeable speed differences between the groups (P<0.05) (25).

The present study reported that both single and dual task training improved balance and gait in patients with knee OA. The results reported a statistically significant difference between groups in terms of balance and gait as indicated by BBS (P<0.001) and DGI (P<0.01). MSM Saleh in 2019 reported similar results, indicating that comparison between pre and post treatment in each group revealed that there was a significant improvement ($p < 0.01$) post treatment compared with pre-treatment in both groups. Thus the study concluded that dual task training is an effective intervention in improving gait and balance (26). The results reported that balance and mobility improved in both single and dual task training groups. Dual-task balance performance, functional mobility, and gait speed improved more in the dual-task training group after training (*P*<.05). The study concluded that Dual-task training was more effective than single-task training in the improvement of balance and gait (27).

Limitations of current study include the study recruited small number of participants. There was homogeneity of the study population making it difficult to generalize the results. The sample was recruited from a single institution and it may not be suitable for extrapolation to other populations. The long-term efficacy of the both trainings was not measured. Recommendations of this study is Clinical application of this study recommends that dual task training can beneficial method to enhance balance and mobility gait of a purposeful rehabilitation exercise. Long period development due to effect of both training could require further research.

This study concluded that both single and dual task training was effective on improving static and dynamic balance and gait in patients with knee osteoarthritis. But single task training show better improvement in static and dynamic balance and gait as compared dual task training group.

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