

ORIGINAL RESEARCH

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TO STUDY THE EFFECT OF AGILITY AND PERTURBATION EXERCISES VERSUS DYNAMIC RESISTANCE EXERCISES TO IMPROVE KNEE FUNCTION IN KNEE OSTEOARTHRITIS – A COMPARATIVE STUDY

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ABSTRACT

Background: Primary osteoarthritis is more commonly found in post menopausal women; Secondary osteoarthritis had an underlying cause such as trauma, obesity or inflammatory arthritis. It is characterized by a progressive degeneration of the articular cartilage with subsequent remodeling and hypertrophy of the bone at the joint margins. Muscle weakness is associated with increased functional limitation, disability. Muscle strengthening through resistance exercises increases physical function; decreases pain due to osteoarthritis and reduces self reported disability. Agility is the ability to change direction and maintain stability and is more often important in changing direction and speed; In order to train muscle to react quickly neuromuscular training is essential; Perturbation enhances the ability of the proprioceptor signals to the muscle and prevent injuries and enhances performance. The aim of this study is to compare the effectiveness of agility training and dynamic resistance training in patients with primary osteoarthritis.

Methods: 50 subjects were assigned in two groups 25 each group and subjects were selected by convenient sampling method. Group A with agility training and Group B with dynamic resistance training. The treatment session was performed 3 days a week for 3 weeks lasting for 45minutes. Day 0 is the starting day of the session and Day-21 last day of the session. Each subject performed all the measurement with knee function assessed by Timed up and Go test (TUG) and Lower extremity function Scale (LEFS). Both outcomes were tested at starting day and at the end of 21st day.

Results: All the analysis was carried out in PASW version 21.0. An alpha level of 0.05 was used to determine statistical significance. The between group analysis of agility training and dynamic strengthening for LEFS and TUG in evaluation of knee function was done using independent 't' test showed statistically very significant (P=0.000).

Conclusions: The effectiveness of Agility and Perturbation exercises improvement was considerably more than Dynamic resistance exercises. Therefore it is concluded that Agility and perturbation exercises is a better treatment approach than Dynamic resistance exercises.

Keywords: Osteoarthritis, agility training, dynamic strengthening exercises, TUG test

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INTRODUCTION

Knee Osteoarthritis (OA) is one of the most common musculoskeletal disorders in the world, affecting 2,693 of every 100,000 women and 1,770 of every 100,000 men.¹ In India, the prevalence of OA knee is relatively more as compared to western population.² Osteoarthritis is the most frequent joint disease encountered in the clinical practice with prevalence rate of 22 % to 39 % in India and is the most common cause of locomotor disability in the elderly.³ The World health organization (WHO) has reported that knee OA is the fourth most important global cause of disability in women and the eighth most important disability in men. Knee Osteoarthritis is the most common form of degenerative joint disease which affects both men and women and has increasing prevalence with advancing age.⁴ Primary OA which can be localized or generalized, the later is more commonly found in post menopausal women; Secondary OA had an underlying cause such as trauma, obesity or inflammatory arthritis It is characterized by a progressive degeneration of the articular cartilage with subsequent remodeling and hypertrophy of the bone at the joint margins(osteophytes).⁵

Thus Knee OA is characterized by pain, articular cartilage deterioration, joint space narrowing and reduced muscle strength.⁶ Osteophytes develop at the joint margins and bone cysts develop adjacent to the articular cartilage with progression of hyaline cartilage degradation, the arthokinematics of joint become altered , which cause abnormal loading pattern and contact pressures on joint surfaces. Muscle weakness is associated with increased functional limitation and disability and decreased muscle atrophy among persons with osteoarthritis⁷ Individuals with knee OA must often overcome a variety of problems such as joint pain, tenderness, limitation of movement, crepitus, occasional effusion, swelling and local inflammation⁸ Pain, perceived instability and functional limitations are the common downstream effects of the degenerative process.

Muscle weakness is associated with increased functional limitation, disability. Muscle strengthening through resistance exercises increases physical function; decreases pain due to OA and reduces self reported disability. Resistance exercise has been shown to increase α (alpha) motor discharge or tone of the muscles trained, This α -motoneuron activity is reciprocally influenced by muscle spindles and Golgi complexes within the muscle, thus regular resistance training may attenuate the impact and impulsive loads through the knee joint, not only by

increasing the strength of the muscles surrounding the knee but also by increasing the sensitivity and coordination of the proprioceptors within the quadriceps muscles during walking and other weight bearing activities.⁹

Agility is the ability to change direction and maintain stability and is more often important in changing direction and speed; In order to train muscle to react quickly – neuromuscular training is essential; Perturbation enhances the ability of the proprioceptor signals to the muscle and prevent injuries and enhances performance.¹⁰ Since, Knee Osteoarthritis contributes significantly limitations and disability in elderly; Quadriceps weakness and arthrogenic quadriceps inhibition can directly influence joint stability, alter the coordination of neuromuscular reflexes and cause early fatigue in lower limb muscles.¹¹ The intent of agility and perturbation training activities is to expose people to activities that challenge knee stability and balance in a controlled manner during rehabilitation, a strategy that may allow them to develop motor skills adequate to protect the knee from potentially harmful loads during functional activities.¹² Decreasing the proprioceptive deficit would increase dynamic knee stability and improve activities of daily living function. Poor knee joint proprioception is related to limitations in functional ability and poor proprioception aggravates the impact of muscle weakness on limitations in functional ability in osteoarthritis of the knee.

In knee Osteoarthritis, functional disability has been investigated in patients. Several studies were done on both the techniques (Agility and Perturbation, Dynamic resistance exercises), but significantly no comparative studies were done. The present study is focused on the effectiveness of Agility and Perturbation exercises versus Dynamic resistance exercises to improve knee function in knee OA patients.

METHODOLOGY

Based on inclusion criteria and exclusion criteria 50 subjects diagnosed as osteoarthritis of knee referred by orthopedic doctor or physician were included in to this study. A convenient sampling technique was used to enroll the subjects. Subjects with bilateral Primary OA between 40 to 55 years of age were included into the study. All the subjects belong to grade 2 and 3 according to Kellgren and Lawrence scale. Subjects with history of knee surgeries, steroid injection and spinal surgeries were excluded. Subjects with deformity on knee, hip, back and subjects with any physical / medical problems for which exercises would be

contraindicated were also excluded from this study.

PROCEDURE

50 subjects were assigned in two groups A & B 25 each group and subjects were selected by convenient sampling method on the basis of inclusion criteria.

A hot pack is applied to the knee prior to the exercises. These exercise wear taught and advised from the day one of the treatment. The contraction was first taught on the therapist itself on herself, and was felt by the patient along with the therapist, The participant was placed in a long sitting position; a towel was placed underneath the popliteal fossa and participant was asked to press the rolled towel by isometrically contracting the quadriceps with the hold of 5 seconds and repeated for 10 times with 10 seconds rest between each repetition.

Group A: Agility training group:

Agility training techniques were modified from running based activities to walking based activities. These activities emphasize quick starting, stopping movements, twisting movements and sudden change in direction. The techniques were side stepping, braiding (lateral stepping combined with forward and backward crossover steps), front cross over steps during backward walking, back cross over steps during backward walking, shuttle walking (forward and backward walking to and from designated markers and a multiple change in direction drill, in which therapist provided hand signals at random to promote the participants to change the directions during walking (forward - backward, right left lateral steps, diagonally backward- forward) Perturbation training: Participant stood on a foam surface with single leg support while the therapist attempted to perturb the participant's balance in various directions. Participant stood on the wobble board with double limb support and therapist applied perturbation of wobble board in a random fashion. After 10 to 30 seconds of perturbations on each leg, the patient switched feet and the technique is repeated.

Group B: Dynamic Resistance Exercises:

Each exercise 3 days per week and 2-3sets of 10 repetitions with 5-10 seconds hold as instructed by the therapist

1. Knee extension in sitting with knee – Patient in high sitting position on a tool with knee at 90° flexion, fully extend knee using resistance of ankle weights

2. Knee extension with hold at 30° knee flexion – Patient In high Sitting position with knee at 90° flexion , extend to 30° using resistance of ankle weights
3. Straight leg raise – Patient in Supine position, raise leg to 30° hip flexion using resistance of ankle weights.
4. Outer range knee extension- Patient in high Sitting with knee at 90° extends to 60° against resistance.

The treatment session was performed 3 days a week for 3 weeks lasting for 45minutes. Day 0 is the starting day of the session and Day-21 last day of the session. Each subject performed all the measurement with knee function assessed by Timed up and Go test (TUG) and Lower extremity function Scale (LEFS). Both outcomes were tested at starting day and at the end of 21st day.



Figure 1: Patient on wobble board



Figure 2: Single limb support on foam surface



Figure 3: Agility training, running to walking based change in directions.



Figure 4: Dynamic resistance exercise.



Figure 5: Straight leg raise using weight cuffs.



Figure 6: Isometric quadriceps exercise

STATISTICAL ANALYSIS AND RESULTS:

All the analysis was carried out in PASW version 21.0. An alpha level of 0.05 was used to determine statistical significance. Paired t-test was performed to find effectiveness of agility and perturbation exercises and Dynamic Resistance exercises. Independent sample t-test was carried out to compare Agility and Perturbation exercises and Dynamic Resistance exercises.

In this study 50 subjects were conveniently selected, and then were allocated in group A and B. In group A the mean age is 48.84 ± 2.838 and in group B mean age is 48.96 ± 2.406

Graph 1: Mean age of subjects of group A and group B.

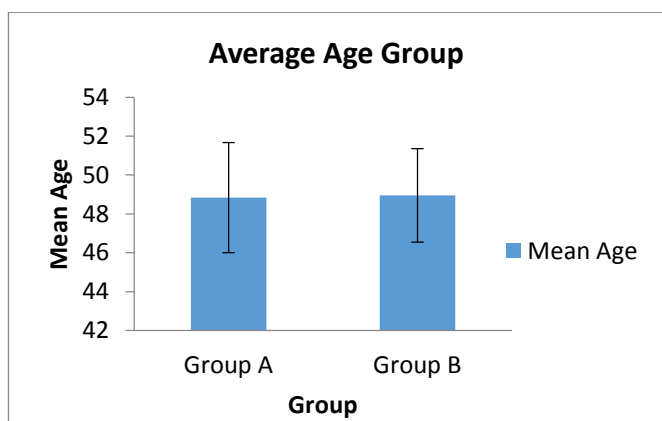


Table 1: Group analysis within Groups A and B for LEFS and TUG

Outcome measure	Group	Day	Mean \pm SD	P	t	Comment
LEFS	Group A	0	25.60 \pm 1.732	0.000	-47.083	Null hypothesis rejected
		21	44.76 \pm 1.332			
	Group B	0	25.92 \pm 1.998	0.000	-27.758	
		21	42.08 \pm 2.272			
TUG	Group A	0	19.532 \pm 1.1636	0.000	18.587	Null hypothesis rejected
		21	17.028 \pm 1.3164			
	Group B	0	19.784 \pm 0.9724	0.000	12.704	
		21	18.228 \pm 0.8498			

In Group A, LEFS increased after application of Agility and Perturbation exercises. Paired t-test was performed to see the significance difference in LEFS from Day 0 to Day 21. It was found that in Group A, $t = -47.083$ which is highly significant ($p = 0.000$). We can say that there has been remarkable increase in LEFS after applying Agility and Perturbation exercises.

In group B, LEFS increased after application of Dynamic Resistance exercises. Paired t-test was performed to see the significance difference in LEFS from Day 0 to Day 21. It was found that in Group A, $t = -27.758$ which is highly significant

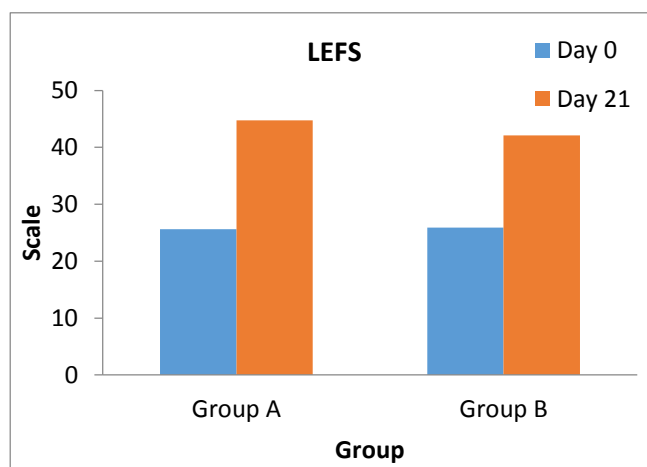
($p = 0.000$). We can say that there has been remarkable increase in LEFS after applying Dynamic Resistance exercises.

In Group A, TUG decreased after application of Agility and Perturbation exercises. Paired t-test was performed to see the significance difference in TUG from Day 0 to Day 21. It was found that in Group A, $t = 18.587$ which is highly significant ($p = 0.000$). We can say that there has been remarkable decreased in TUG after applying Agility and Perturbation exercises.

In group B, TUG decreased after application of Dynamic Resistance exercises. Paired t-test was performed to see the significance difference in TUG from Day 0 to Day 21. It was found that in Group A, $t = 12.704$ which is highly significant ($p = 0.000$). We can say that there has been remarkable decreased in TUG after applying Dynamic Resistance exercises.

The above table is constructed to see the significance difference within the Group A and B between day 0 and day 21.

Graph 2: Bar graph showing the differences of mean within the groups by LEFS



Graph 3: Bar graph showing mean differences within the group by TUG

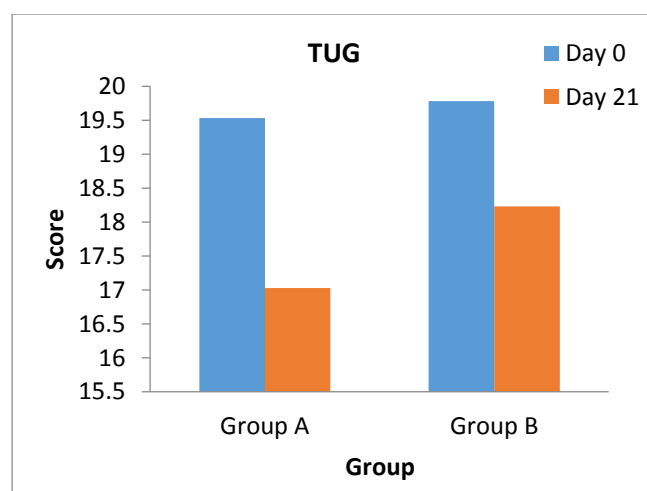
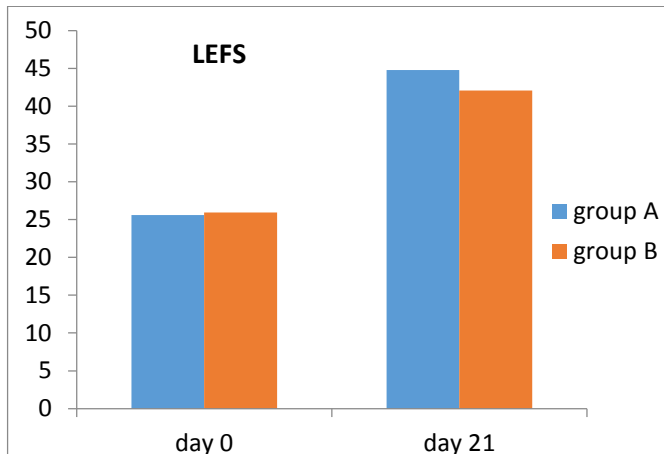


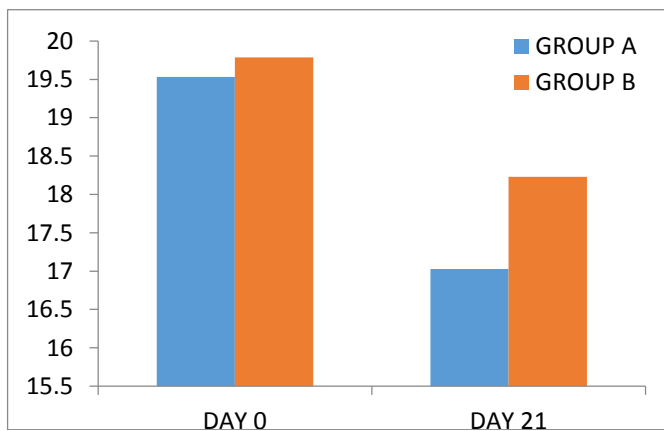
Table 2: Between group analysis of group A and Group B for LEFS and TUG

Outcome measure	Group	N	Mean \pm SD	t	Independent 't' test	Comment
LEFS	Group A	25	44.76 \pm 1.332	5.089	0.000	Significant difference between the groups after treatment
	Group B	25	42.08 \pm 2.272	5.089	0.000	
TUG	Group A	25	17.028 \pm 1.3164	3.829	0.000	Significant difference between the groups after treatment.
	Group B	25	18.228 \pm .8498	3.829	0.000	

Graph 4: Bar graph showing mean differences between the groups by LEFS



Graph 5: Bar graph showing mean differences between the groups by TUG



The between group analysis for LEFS and TUG in evaluation of knee function was done using independent 't' test showed statistically very significant ($P=0.000$)

DISCUSSION

The present study was undertaken to determine the comparative effect of Agility and perturbation exercises and Dynamic resistance exercises to improve knee function in knee osteoarthritis. The mean values of LEFS questionnaire are 25.60 ± 1.732 and 25.92 ± 1.998 for group A and B respectively in day 0 which increased to 44.76 ± 1.332 and 42.08 ± 2.272 for group A and B respectively in Day 21. TUG test are 19.532 ± 1.1636 and 19.784 ± 0.9724 for group A and B respectively for day 0 which decreased to 17.028 ± 1.3164 and

18.228 ± 0.8498 for group A and B respectively in Day 21. The calculated statistical value obtained through focus on Kolmogorov- Smirnov test.

From the results it is evident that patients who received treatment of Agility and perturbation exercises (Group A) showed more improvement in knee functions for patients with knee osteoarthritis when compared to patients who received treatment of Dynamic resistance exercises (Group B). Thus it can be said that Agility and Perturbation exercises is more beneficial in improving knee function for patients with knee osteoarthritis.

Several studies stated that quadriceps muscle weakness is a well established clinical feature of knee Osteoarthritis; muscle weakness is also associated with increased functional limitation and disability and decreased balance among persons with Osteoarthritis.^{13,14} Quadriceps strengthening is globally accepted physical therapy technique to reduce pain and to improve knee joint functions. A study on 13 men and 29 women with knee osteoarthritis aged 40-65 years and concluded that the maximum isometric quadriceps strength, reduction in pain intensity and improvement in function in the isometric exercise group were significantly greater than those of the control group ($P < 0.05$).¹⁵

Patients with O.A knee use to face several associated problems like balance problems, instability of knee and loss of overall functional ability. G. Kelley Fitzgerald and Carol Oatis, stated that Individuals with knee OA may have a variety of impairments and functional limitations that prevent them from participating in regular exercise and physical activity, physical therapists can offer a variety of supplemental treatment approaches that may help patients overcome these barriers and enhance the overall effectiveness of exercise therapy programs.¹⁶

Due to the prevalence of quadriceps weakness in persons with knee OA, leg strength training is commonly used in intervention programs. Kinesthesia, Balance and Agility exercise training is designed to decrease proprioceptive impairment by using Agility and balance exercises to activate, challenge and adapt the nervous system's proprioceptors. Decreasing proprioceptive deficit would thereby increase dynamic knee stability and improves activities of daily living function.¹⁷ Daniel Rhon et al. conducted a study on "Manual physical therapy and perturbation exercises in knee Osteoarthritis" in which 15 patients were taken and stated that WOMAC score significantly improved ($P=0.001$), the manual physical therapy that also included perturbation exercises resulted

in improved outcome scores in patients with knee OA .Outcome measures- WOMAC, Numeric Pain Rating scale^{18,19}.

CONCLUSIONS

In this study, it has been found that the use of Agility and Perturbation exercises and Dynamic Resistance exercises produces improvement in knee function in patients with osteoarthritis. However the effectiveness of Agility and Perturbation exercises improvement was considerably more than Dynamic resistance exercises. Therefore it is concluded that Agility and perturbation exercises is a better treatment approach than Dynamic resistance exercises.

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