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EFFICACY OF PERTURBATION TRAINING IN IMPROVING BALANCE AND FUNCTION IN THE MANAGEMENT OF KNEE OSTEOARTHRITIS

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ABSTRACT

Background: Subjects who are suffering from osteoarthritis of the knee will have problems including progressive loss of function, depending on walking, climbing stairs, and it may affect lower extremity functions. Balance is a major component required for the activities of daily living and functions. The objective of the study was to compare the effectiveness of perturbation training and conventional physiotherapy in improving balance and function in the rehabilitation of knee osteoarthritis.

Method: Study design was an experimental study. Thirty subjects (16 males and 14 females) suffering from knee osteoarthritis were randomized into a control group and experimental group. Fifteen subjects in the control group were treated with traditional methods like ultrasound, stretching and strengthening, and fifteen subjects in the experimental group were given perturbation training along with the conventional method. Outcome measures used were Timed get up and go test score (TUG) and Functional reach test score (FRT) scales, pre-assessed on Day 1. Each group received 14 sessions of treatment, after which post-assessment of outcome measures was done.

Results: Timed get up and go test score was reduced in both groups after training, which was statistically significant ($p < .05$). Functional reach test score was increased after training in both groups, which was statistically significant ($p < .05$). However, comparing between groups, the experimental group showed more reduction in TUG score and improvement in the FRT score, which was statistically significant ($p < .05$).

Conclusion: Perturbation training given with conventional treatment was found to have a significantly better effect in improving the function of the lower extremity in OA knee subjects. However, a well-designed trial, including a larger sample size with repeated measurements is needed to find out the effectiveness of training with perturbation in management of knee osteoarthritis and generalize it in a larger population.

Keywords: Knee osteoarthritis, Perturbation training, Balance training, Timed get up and go test, Physiotherapy management, Functional reach test.

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INTRODUCTION

Degenerative changes of the knee joint area is most affected orthopedic condition, and the prevalence is 30–40% of the population and results in structural and functional limitation in old age population [1]. In knee osteoarthritis, changes seen are increased smoothing and disruption of articular cartilage and fibrosis of capsule. Subjects suffering from osteoarthritis are likely to face problems like reduced mobility and activities of daily living [2,3].

Individuals suffering from OA knee may vary in demographics; severity and type of arthritic mechanism. The goal is to improve physical fitness by performing a unique exercise programme with them. An individualized exercise prescription is recommended participating in a rehabilitation programme for OA subjects. Along with that, constant support and motivation are required to actively involved in the exercise. All the subjects are not suitable for vigorous exercise, so by proper education, they can adapt to a suitable life changes to balance function and health, and bring down their chance of inactivity-related disorders. When initiating a new exercise programme, the patients must be given positive reinforcement throughout the exercise [4,5].

OA subjects experience loss of range of motion, increasing their need towards tasks that were performed with ease before the condition. Balance is a function that requires an integrated approach of vestibular, visual and somatosensory input is an integral component in performing day-to-day tasks [6,7]. Pain in osteoarthritis knee may lead to a reduction in balance. Pain may hamper the tissues like muscles and soft tissues, which could lead to compromised active and timely motor responses needed for postural integrity which affects person's ability to maintain his center of mass within the base of support. Studies have found that pain is a significant cause of sway in osteoarthritis subjects; however, pain scores were not related to observed balance deficits in any of the study [8,9].

Potter P J et al. (1990) [10] and Minor M A et al. (1999) [11] have shown that combined agility and balance training to exercise programme can be proven effective in rehabilitation in subjects with instabilities of joint. To fully understand the mechanisms behind balance impairments, further research needs to be done to determine the find out how osteoarthritis affects postural control. In the present study, the researcher is trying to assess if perturbation training helps to improve balance and functional activities in the subjects with OA knee. In case the positive result is obtained, the same protocol can be included in the conventional rehabilitation of knee osteoarthritis in the near future.

Objectives of the study were to find out whether traditional physiotherapy improves balance and function, to find out the effectiveness of conventional physiotherapy given with perturbation training in improving balance and function in the management of knee osteoarthritis; and to compare the efficacy of both perturbation training and traditional physiotherapy in improving balance and function in the management of knee osteoarthritis.

METHODS

Subjects with knee osteoarthritis satisfying the inclusion criteria were referred to the physiotherapy department of KIMS, Trivandrum. The inclusion criteria were as follows: subjects who were diagnosed with bilateral knee osteoarthritis and confirmed by an orthopaedician; Grade 3 osteoarthritis patient according to Kellageren and Lawrence [12] radiographic grading. Exclusion criteria were Recent fractures and injuries to lower limb, Limb length discrepancy, Acute knee joint effusion, Fixed flexion contracture, Genu valgum ($>6^\circ$), Genu varum ($>15^\circ$), Hip and ankle joint pathology, Ligament, meniscal and other soft tissue injury, Arthroscopy and surgical procedures on knee, Neurological conditions, Visual and auditory problems, Uncontrolled diabetics, Uncontrolled blood pressure, Severe obesity (BMI > 30) and Uncooperative patient [12].

Subjects of either gender between the age group (ranges 50-65 years) were included in the study. Detailed information about the study was given to the subjects. Informed consent was taken from the ones who were willing to participate. Sampling design used was purposive sampling. Thirty subjects were recruited for the study and were randomly allocated to one of the two groups. The control group (sample size of 15) was treated with conventional methods like ultrasound, stretching, and strengthening. The experimental groups (sample size of 15) were treated with perturbation training regimen along with traditional therapy. The treatment was given for fourteen sessions on alternate days. The effectiveness of the treatment program was measured using the TUG and FRT scales post-intervention.

PROCEDURE

CONTROL GROUP

Ultrasound therapy

The ultrasound therapy unit (Pulsonic; Elecrocare Ltd India) was used for the treatment. The frequency of 1 MHz was given in continuous mode. The Ultrasound probe was applied for 10 minutes to each treated region: over the medial side, lateral side, and anserine bursa. The patient was positioned in supine lying with bilateral knee flexion of 90° for medial side and anserine bursa [13].

Active, relaxed free exercises

- In high sitting – knee extension and knee flexion within the pain-free range: 2 sets, each of 10 repetitions
- In prone lying – knee extension and flexion within the pain-free range: 2 sets, each of 10 repetitions [14].

Strengthening exercises

- Static quadriceps exercises [14] subject in the supine position with a folded towel placed under the knee joint, the leg kept as straight as possible. The subject was then instructed to press his knee against the towel and hold for ten seconds: 2 sets of 10 repetitions each
- Static hamstring exercises [14] Patient in supine lying with a knee in slight flexion (10- 20 degree) and heel on the mat. The patient was instructed to press heel on the mat without any movement and pull oneself towards the buttock and hold the contraction for 10sec-

onds: 2 sets of 10 repetitions each

- Straight leg raise [14] Subject in the supine position with the opposite leg flexed to 90 degrees flexion. The subject was asked to extend the knee joint to 45 degrees, but no higher than the thigh of the opposite leg. The subject was then instructed to hold the position for at least five seconds and relax for two seconds and repeat the exercise: 2 sets of 10 repetitions each.

Stretching exercise

- Hamstring stretching exercises [14] Patient in a sitting position with one leg off the quadriceps table. The patient was told to reach forward slowly and hold the position for a count of 10. Total of 5 minutes stretching was given per day. The patient was warned not to bounce when stretching.
- Calf stretching exercises [14] Patient was made to stand with heels on the floor and the toes slightly pointing inwards. The knees were kept straight. The patient was then advised to lean forward and hold the stretch for a count of 10; performed for 5 mins.

EXPERIMENTAL GROUP

Experiment group received both conventional and perturbation training as described below.

Conventional exercise: Same as the control group

Perturbation Training: In this study, training consists of 3 techniques of perturbation training as described by Teresa et al. [12].

Outcome measures

Outcome measures used were TUG and FRT scales, pre-assessed on Day 1. Each group received 14 sessions of treatment, after which post-assessment of outcome measures was done.

Data analysis: Analysis was performed by a statistical package of social sciences (seventeenth) for windows. P-value was kept as 0.05. Independent T-test was used to analyze difference demographic variables such as age & duration and to compare scores between groups for FRT & TUG at baseline and post measurement. The paired t-test was used to find out the significant difference within-group for FRT & TUG. Microsoft excel, the word was used to generate graph and tables.

RESULTS

Demographic variables taken into consideration in the present study were age, gender, and duration. In the group A, the mean age was 55.87 with the standard deviation of 2.10, and in the group B, the mean age was 55.53 with the standard deviation of 2.59 which were not statistically significant (p-value >0.701). In both groups, there were eight males and seven females. In the group A, the mean duration was 3.33 with the standard deviation of 0.82, and in the group B, the mean age was 3.47 with the standard deviation of 0.64 which were not statistically significant (p-value >0.623). In the group A, the mean TUG was 15.40 with the standard deviation of 1.68, and in the group B, the mean TUG was 15.33 with the standard deviation of 1.63

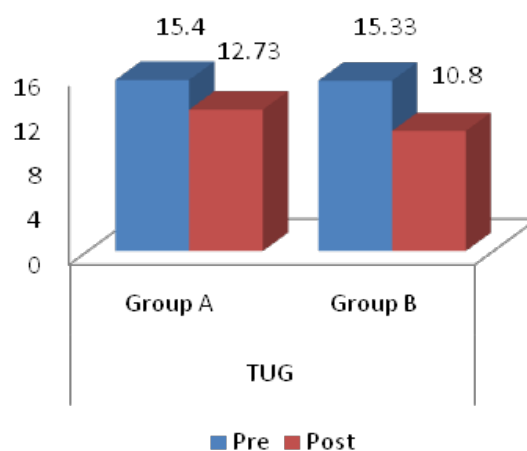
which were not statistically significant (p-value >0.913). In the group A, the mean FRT was 4.53 with the standard deviation of 1.31 and in the group B; the mean FRT was 4.25 with the standard deviation of 1.35 which were not statistically significant (p-value >0.569). In summary, baseline data of demographic and outcome variable were homogeneous among both groups before intervention.

Pre-post comparison for both groups was statistically significant (p <.05) for both TUG and FRT (Graph I, II). However, comparing between groups, both TUG and FRT were better in group B compared to group A (p <.05) (Table I).

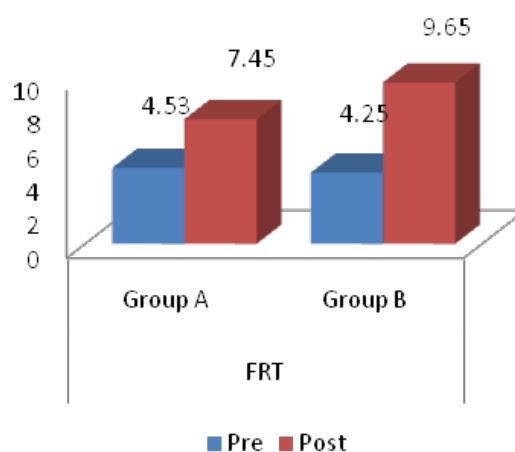
Table I: Difference between groups

Sl.No:	Variables	Group A	Group B	p-value
1	TUG	12.73±1.58	10.80±1.52	<0.002
2	FRT	7.45±1.19	9.65±1.55	<0.0001

The graph I: Pre-post data within TUG



Graph II: Pre-post data within FRT



DISCUSSION

The results proved that the balance and function of knee osteoarthritis subject were improved significantly when perturbation training was given, thereby supporting the alternate hypothesis.

Perturbation training showed improvement in the timing of spinal reflex of the extensor muscle with the response to anteromedial movement. Also, the cortical response time of the gastrocnemius, medial hamstring and lateral quadriceps muscle got improved. These factors might have

contributed to better knee function, consequently leading to dynamic joint stability and better functioning. Mechanoreceptors are stimulated; muscle spindle sensitivity is increased due to increased gamma motor activity. Perturbation training could re-enforce the muscle spindle, GTO, and proprioceptors activity [15,16].

In this study, the pre and post test mean of TUG of Group A were found to be 15.4 and 12.73, respectively. The pre and post test mean of TUG of Group B were 15.33 and 10.8, respectively. Similarly, the pre and post test mean of FRT of Group A were 4.53 and 7.45 respectively whereas the pre and post test FRT mean of Group B were 4.25 and 9.65, respectively. This analysis showed significant improvement in balance and function in both groups.

The result shows that all the treatment protocols were effective in improving balance and function of OA knee patients. However, the comparison of post test values of FRT and TUG test between the control and the experimental group clearly shows that the experimental group had better improvement than the control group. Subjects can return to a higher level of activity if perturbation and agility are given as mentioned by G Kelley Fitzgerald, John D Childs et al. (2000) [16]. According to Hall M.C and Brody LT (1999). The functional improvement seen in the control group could be contributed to isometric exercises, strengthening the exercise of Quadriceps and Hamstring, Straight leg raise exercise and Stretching of calf and hamstring. These exercises are thought to stimulate the mechanoreceptors present in the joint capsules and ligaments — the movement of joint relay proprioception to the higher center. Weight-bearing exercises stimulate Type I (Ruffini) and Type III (Golgi type) receptors to generate an impulse. Type I receptors are responsible for the detection of joint pressure applied, and Type IV (free nerve endings) detect rapid joint movement as well as deep pressure, perpendicular compression of a joint capsule like the one performed during the weight-bearing posture. In a closed kinetic chain exercise, the indirect forces are transferred and received from the muscles of adjacent segments [17].

Sullivan OS (2001) has stated that, during isometric contraction, the muscle produces force without causing any change in the muscle length, which leads to the production of measurable tension in the muscle. The isometric exercises thus help in improving muscle tone, static endurance while in turn prepares the joint for vigorous activities. Davis MA, Ettinger WH, (1995) has stated that OA subjects suffer from progressive loss of function, which leads to increased dependency while lower limb activities and ADL. Incorporating agility and balance training techniques to the regular rehabilitation protocol can enhance the effectiveness of treatment in subjects with instabilities of joint [18,19]. The significant improvement in the functional performance of the experimental group over the control group could be due to the effect of perturbation training. With perturbation training, there is pivoting, faster changes in direction which tackle their balance function. These extra training developed motor skills for knee joints when there

are knee stabilizing forces [12].

The sensitivity to muscle spindle also increased, which further improve joint stability, as explained by Terese et al. [12]. This prevents the knee joint from the overload while doing their increased physical performance. The altered muscle activity may also improve their stability of the joint and bringing the subject back to a higher physical activity level as explained by Fitzgerald G K (2004) [20].

While the study has significantly demonstrated the effectiveness of perturbation training in balance and function in patients with knee osteoarthritis, further study can be done to find out the effectiveness of perturbation training along with traditional training in subject with knee OA to return to a higher level of physical activity. This study further recommends that the repeated measurement should be conducted to evaluate whether there occurs any sustained or carry-over effect after the treatment. The study should be replicated in large scale randomized clinical trial, including a large group and longer, follow up. It is suggested that further studies of perturbation training should be conducted in normal population. It is also advised that further studies be conducted with the inclusion of much precise objective measurement tools of function and balance like balance master, force platform system, EMG, etc. It is suggested that further studies be conducted to find out which component in the perturbation training improves balance.

One of the limitations of this study is that the study assessed short-term progress in functional performance. There was no follow up done; thus, long-term results of the treatment could not be measured. The sample size for the study was small, which might have affected the generalization of the study. In the present study, measurements for balance and function was done manually. This might have caused human errors, which in turn might have affected the reliability of the study. Duration of the study was less. The present study was unable to conclude which component in the perturbation had contributed more to the improvement in balance and function of the patients.

CONCLUSION

Osteoarthritis of knee causes alteration in balance and function. The present study provides evidence that perturbation training, when given as an adjunct to conventional physiotherapy, improves balance and function in subjects with grade III OA knee. Stability and functional capabilities improve with perturbation training in osteoarthritis knee patients. Perturbation training enables the therapist to perform treatment more dynamically and also helps to improve balance and function. Addition of perturbation training with a traditional rehabilitation program for subjects with degeneration of knee may help improve treatment effectiveness. The technique is also cost-effective so using the method in clinical settings is feasible. Hence perturbation training should be included as part of a treatment regime in the management of a patient with grade III osteoarthritis of the knee.

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