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Effectiveness of functional task training (FTT) versus EMG bio-feedback training to reduce pain, improve strength and functional mobility in knee osteoarthritis

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***Abstract*---**Study design :Quasi –experimental study. Objectives : To compare the effectiveness of Functional task training Versus EMG biofeedback, along with conventional physical therapy in the management of knee osteoarthritis. Background*:* Osteoarthritis is the most common disease affecting synovial joints characterized by degenerative structural remodeling of joint cartilage and of underlying subchondral bone, which again leads to pain and disability. The aim of the study was to compare the effectiveness of Functional task training Versus EMG biofeedback along with conventional physical therapy to reduce pain, improve strength and functional mobility in knee osteoarthritis Methods: In the 5- week intervention study, 30 participants diagnosed with knee osteoarthritis were divided into two groups by convenience sampling, Group A:(n=15) Functional task training along with conventional exercise program was applied and Group B:(n=15) EMG biofeedback along with conventional exercise program. For both groups, treatment consisted of 1 session/day, 5 days/week for 5 weeks. Data was collected and analyzed using SPSS 23. Results: A significant reduction in pain ($p<0.05$), improvement in the strength of the quadriceps muscle ($p<0.05$) and increase in knee function between ($p<0.05$) pre- and post- treatment stages in both groups. At the end of five weeks, the EMG biofeedback group was significantly better than the FTT group. Conclusion: In the quasi-experimental condition used in this study, the use of EMG biofeedback along with conventional exercise program was more

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effective when compared to FTT along with conventional exercise program.

***Keywords*---**knee-osteoarthritis, EMG-biofeedback, FTT, NPRS, modified WOMAC.

Introduction

Osteoarthritis is the most common disease affecting synovial joints characterized by degenerative structural remodeling of joint cartilage and of underlying subchondral bone, which again leads to pain and disability. Osteoarthritis of knee is the most common form of osteoarthritis. Osteoarthritis is the second most common rheumatologic problem and it is the most frequent joint disease with a prevalence of 22% to 39% in India.[11] OA is more common in women than men, but the prevalence increases dramatically with age. Osteoarthritis is also known as degenerative arthritis, which commonly affects the hands, feet, spine, and large weight-bearing joints, such as the hips and knees.[11]

Most cases of OA have no known cause and are referred to as primary OA. Primary osteoarthritis is mostly related to aging. It can present as localized, generalized, or as erosive OA. Secondary osteoarthritis is caused by another disease or condition. OA was estimated to be the 10th leading cause of nonfatal burden. Pathological changes in the late stage of OA include softening, ulceration, and focal disintegration of the articular cartilage. Synovial inflammation also may occur. Typical clinical symptoms are pain, particularly after prolonged activity and weight-bearing; whereas stiffness is experienced after inactivity.[11] Exercise programs have a primary importance in the prevention and treatment of knee,[1 3]supervised exercise.[24] recent practice guidelines have a reflected recognition that exercise, including both aerobic and strengthening, as well a range of motion, are essential elements of any treatment program for osteoarthritis of the knee.[5] Traditional exercises tend to focus on the isolation of one or more muscle groups (e.g., quadriceps) in an attempt to address the impairment. Considerable evidence in the literature confirms that strengthening exercises should be employed in the treatment of knee OA; however, confusion exists as to what exercises are the most appropriate and beneficial in meeting the needs of the patient with OA.[31]Functional task training focuses at the activity level by strengthening and adapting postural strategies to environmental demands through functional task performance. This type of activity requires coordinated functional movements, task specific balance requirements and incorporates multiple muscle groups and joints working in multiple planes[31]. Functional task exercises involve interplay of cognitive perceptual and motor functions and closely linked to individual dynamic environment. It helps to enhance muscle strength, flexibility, or balance and to improve functional ability, mobility into the Participants (activities of daily living) ADL'S. This approach in the exercise treatment is specific with expected functional outcomes. Dynamic control of knee during weight bearing activities closed chain exercises with low intensity and high repetition are effective than open chain exercises for improving stability and muscular endurance and function in the knee.[39]

EMG biofeedback may be defined as the technique of using equipment to reveal to human beings some of their internal physiologic events, normal and abnormal, in the form of visual and audible signals to teach them to manipulate these otherwise involuntary or unfelt events by manipulating the displayed signals. In clinical practice, it is used to help the patient develop greater voluntary control in terms of either neuromuscular relaxation or muscle reeducation following injury. EMG-biofeedback assisted exercise programs are suggested as they increase compliance with exercise and motivation of Participants.[37] The objective of this study was to compare the effectiveness of Functional task training & conventional physical therapy, and EMG-biofeedback & conventional physical therapy, on pain, muscle strength and functional mobility in participants with knee osteoarthritis.

Methods

Participants: All the participants diagnosed with Tibio-femoral Osteoarthritis and referred from orthopedic outpatient department, who fulfilled the selection criteria, were divided by convenience sampling (followed by random allocation by lottery method without replacement) method. The procedure was clearly explained to all the participants and their signed consent was obtained. Distribution into groups was carried out through random allocation by lottery method without replacement: The participants were asked to select a card out of 30 (15-group A, 15-group B) and according to the card selection the participant were assigned to group A and group B. Inclusion criteria were, participants diagnosed with Stage 2 & 3 tibiofemoral OA of knee (Kellgren Lawrence classification), based on radiographic results obtained from orthopaedicians report, unilateral involvement, between the ages of 45- 65 years, presence of knee pain > 3 months(chronic knee pain), able to walk 100 feet without resting and without an assistive device. Participants were excluded if they had presence of a neurological disease, secondary OA uncontrolled low or high blood pressure, uncontrolled cardiopulmonary or respiratory condition, the inability to rise from and return to a chair without assistance, any additional musculoskeletal diseases or surgeries, actively participating in any other exercise program, taking anti-inflammatory medication.

All the participants completed a detailed orthopedic assessment. The Orthopedic assessment obtained information about demographic detail, medical history, surgical history, investigation reports and analysis of pain, muscle strength and functional mobility of the participants. Participants, who fulfilled the selection criteria were informed about the study, and requested to sign written informed consent form. Pre-participation evaluation form consisted of NPRS, HHD and modified WOMAC index. Pain was assessed by NPRS, muscle strength with a HHD and functional mobility by modified WOMAC. The participants were allocated into two groups (GROUP A- 15 & GROUP B- 15). Group A participants were treated with FTT along with conventional physical therapy, and Group B participants were treated with EMG biofeedback along with conventional physical therapy. Each participant was evaluated prior to the first session, after every week of treatment, and after the last session, for intensity of pain, ROM, & prior to the first session and after the last session for functional mobility.

Training Program

The treatment protocol was given for 5 days/week for 5 weeks. Conventional physical therapy protocol included: Isometric exercises for knee (Static quadriceps exercise, Knee terminal extension exercises) , Active range of motion (AROM) exercises for knee (straight leg rise exercise , Side straight leg raise-1, Side straight leg raise-2 , Back Straight Leg Raise, Seated Knee Extension Wall slides), Moist heat pack, passive stretching (Calf, Hamstring and quadriceps). Functional task training: Unilateral balance, Squat with arms forward, Lateral squats, Forward or backward leans, Squat with diagonal reach, Walk around obstacle, Rotational Lunges, Lunge and chop.[27]

EMG Biofeedback: The participants were positioned in the supine lying position. Electrode placement: The skin just proximal to the patella was scrubbed with spirit pad. Two carbon rubber electrodes were used over the belly of quadriceps muscle. After electrodes were affixed, a baseline activity level was determined. The initial selection of threshold value was different for each patient (because of individual differences in amount of subcutaneous tissue, edema and ability to contract the quadriceps muscle) and was set so that the participants had to contract primarily the knee extensor and exert maximally to reach the threshold. The participants were instructed to contract the quadriceps muscle to their EMG threshold level, to maintain the audible signal for 10 seconds on, and to rest for 10 seconds off. Isometric exercises for knee (Static quadriceps exercise, Knee terminal extension exercises) , Active range of motion (AROM) exercises for knee (straight leg rise exercise , Side straight leg raise-1, Side straight leg raise-2 , Back Straight Leg Raise ,Seated Knee Extension Wall slides).

Outcome measure and parameters

- Intensity of Pain using NPRS
- Isometric muscle Strength(extensors) using Hand held dynamometer
- Functional Mobility using WOMAC scale

Intensity of pain

- An NPRS (numerical pain rating scale) is described as an 11-point scale with scores from 0 to 10. The NPRS consists of asking the patient to rate his or her perceived level of pain intensity on a numerical scale from 0 to 10, with 0 = no pain and 10 = worst possible pain. The number stated by the patient as representing his or her level of pain intensity is the basic datum for the NPRS.

Knee Extensors muscle strength testing

- Isometric Knee Extensors strength was measured bilaterally, using a baseline hydraulic hand-held dynamometer. Participants sat upright on the examination table with the hips flexed at 90 degrees and knees flexed at approximately 60 degrees. The contralateral side was tested first, and then the ipsilateral side.

- The participants were asked to build force to a maximum over a 2-second period and maintain the maximum effort for approximately seconds. The participants were then requested to stop. The participants were made to perform the test three times, and the best of it was recorded. A pause of 10-20 seconds was provided between each trial.[7,8]

Functional mobility (WOMAC score)

- The Western Ontario McMaster Universities Osteoarthritis Index (WOMAC) questionnaire is a validated, reliable, self-administered questionnaire to assess symptoms and functional capacity. Questions of the WOMAC include topics of pain, stiffness, and physical function that are recorded using a 5-point Likert scale. A low score of 0 represents no symptoms/limitations and a high score of 4 corresponds to severe symptoms/limitations. There are 96 total possible points calculated from the WOMAC in which 20 possible are recorded for pain, eight possible are recorded for stiffness, and 68 possible are recorded for physical function. The higher the overall score, the more symptomatic and physically limited the participant is.
- Procedure
  All participants underwent an initial baseline assessment of Intensity of Pain, Knee extensor muscle strength and WOMAC score for functional mobility. At the completion of the 5-week intervention, all participants completed follow-up assessments The testing procedures were the same as those used in the initial baseline assessments.

Statistical Analysis

- The distribution of participants into 2 groups by random allocation by lottery method, Baseline values for intensity of pain, quadriceps muscle strength & WOMAC were compared inter group and intra groups using Wilcoxon signed rank test, Paired t-test, unpaired t-test, Mann Whitney U test.

Results

There were conducted total 30 participants, which divided into 2 groups. In the Group-A: FTT & Conventional Physical therapy & in the Group –B: EMG Biofeedback &conventional physical therapy. Table: 1 and Graph:1 shows that the mean age of participants in Group-A(55.42) and Group –B (54.93). No statistically significant difference was found between the ages of the participants in both groups, proving that the groups are homogenous in terms of age. Table 1& Graph: 2 shows that the gender distribution among Group-A and Group-B. A total of 13 male and 17 female participants participated in the study. Out of thirty participants, Group –A consisted of 6 males and 9 females, Group-B consisted of 7 males and 8 females.

Table 2 & Graph 3 shows the inter group comparison of pre treatment scores of NPRS. This comparison was done using Mann Whitney U test. The p-Value is >0.05. It shows that there is no statistically significant difference between the pre treatment scores of NPRS between groups A and B, hence proving that the groups

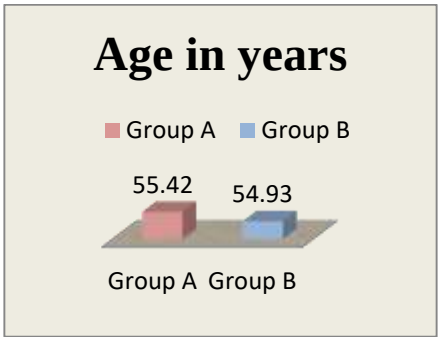
are homogenous. Table 2 & Graph 4 shows the inter group comparison of pre treatment scores of strength of knee extensors. This comparison was done using Independent t test. The p-Value is >0.05. It shows that there is no statistically significant difference between the pre treatment scores of strength of knee extensors between groups A and B, hence proving that the groups are homogenous. Table 2 & Graph 5 shows the inter group comparison of pre treatment scores of Modified WOMAC. This comparison was done using Mann Whitney U test. The p-Value is >0.05. It shows that there is no statistically significant difference between the pre treatment scores of Modified WOMAC between groups A and B, hence proving that the groups are homogenous. Table 2 & Graph 6 shows the intergroup comparison of NPRS score after 5 weeks. Statistically significant difference ($p<0.05$) in NPRS score was found between Group-A and Group-B. This comparison was done using Wilcoxon signed rank test.

Table 2 & Graph 7 shows the intergroup comparison of Knee Extensors strength score after 5 weeks. Statistically significant difference ($p<0.05$) in Knee Extensors strength score was found between Group-A and Group-B. This comparison was done using independent t-test. Table 2 & Graph 8 shows that the intergroup comparison of Modified WOMAC score after 5 weeks. Statistically significant difference ($p<0.05$) in Modified WOMAC score was found between Group-A and Group-B. This comparison is done through Wilcoxon signed rank test.

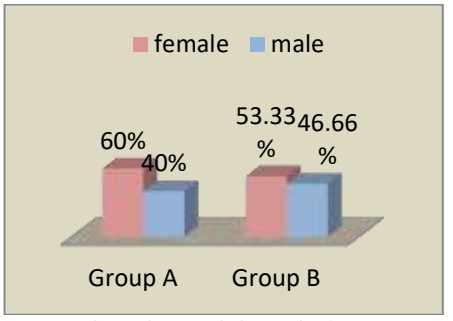
Figure & Tables

Table 1 Summary of Participant Demographics

		Group –A (N=15)	Group - B(N=15)
Age	Mean	55.42	54.93
	±SD	±6.64	±6.68
Sex	Male	6 (40%)	7(46.66%)
	Female	9(60%)	8(53.33%)

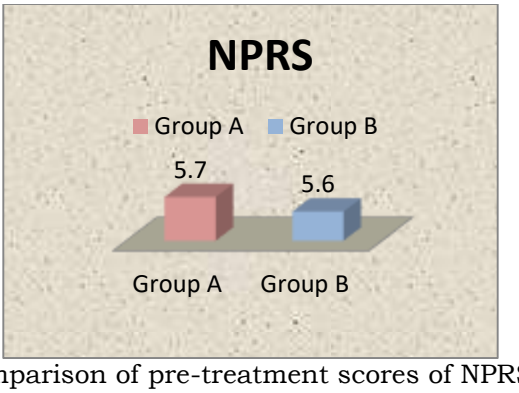


Graph 1: comparison of mean age between Group A and Group B

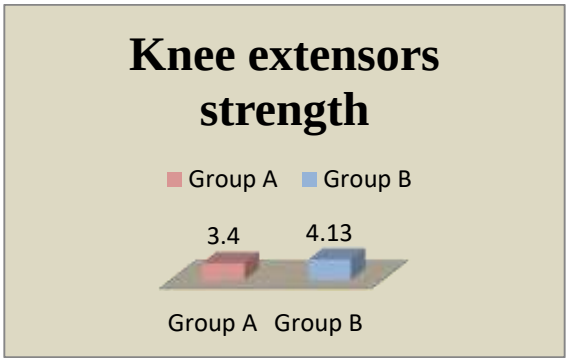


Graph 2: Percentage of male and female in Group A and Group B

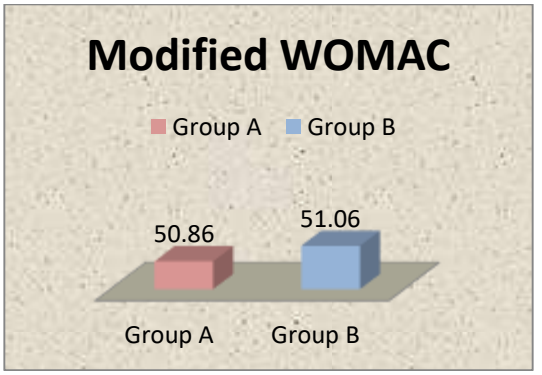
Table 2	Pre intervention and Post intervention Score			
Outcome measures	Pre intervention		Post intervention	
	Group-A	Group-B	Group-A	Group-B
NPRS	5.7	5.6	3.73	2.06
Knee extensor strength	3.4	4.13	5.13	7.13
Modified WOMAC	50.86	51.06	46.8	37.8



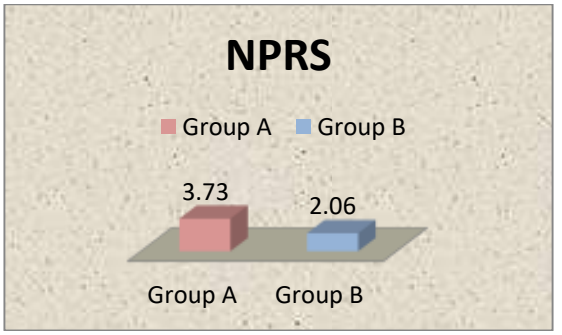
Graph 3: comparison of pre-treatment scores of NPRS between Group A and Group B



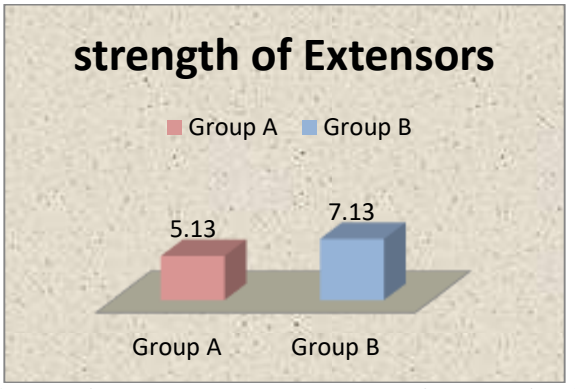
Graph 4: comparison of pre-treatment scores of strength of knee Extensors between Group A and Group B



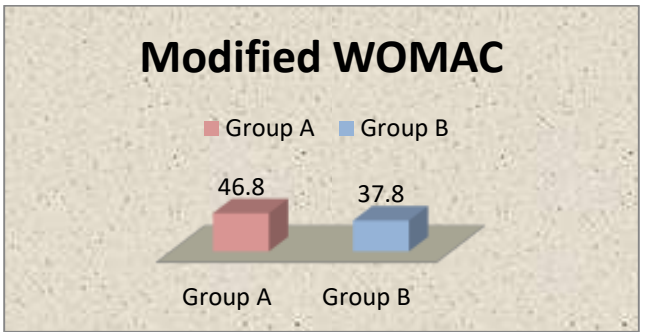
Graph 5: comparison of pre-treatment scores of Modified WOMAC between Group A and Group B



Graph 6: comparison of Post-treatment scores of NPRS between Group A and Group B



Graph 7:comparison of post -treatment scores of strength of knee Extensors between Group A and Group B



Graph 8: comparison of post-treatment scores of Modified WOMAC between Group A and Group B

Discussion

Osteoarthritis is one of the most common causes of disability in the world. Osteoarthritis is regarded as a whole joint disease with a multifactorial etiology, including increased mechanical stress, ligament derangements, cartilage degradation, subchondral bone changes and muscular impairments Furthermore; secondary synovial inflammation plays a role in Osteoarthritis, notably in the early stage. Some studies tried to define risk factors such as age, genetic predisposition, obesity, joint congruency, increased mechanical stress and greater bone density[12].

IN the OA occurs when the dynamic steady state between destructive forces and repair mechanisms destabilises the joint homeostasis. This imbalance is thought to be the driving force in this progressive disease and may produce pain and disability. The role of bone density in OA is currently debated. Typically, a reduced bone density of the subchondral bone is observed in the early stages of OA. later stage, subchondral bone sclerosis and higher bone density are seen radiologically[12].

The inflammatory changes in OA synovium include synovial hypertrophy and hyperplasia with an increased number of lining cells, and an infiltration of the

sublining tissue with a mixed population of inflammatory cells including synovial macrophages, activated B and T lymphocytes. Local levels of pro-inflammatory cytokines such as interleukin (IL)-1b, tumor necrosis factor (TNF) a, and IL-6 produced by these cells are detectable in early OA[35]. Treatment options available for treating knee osteoarthritis include analgesics prescribed by general practitioners, surgical interventions, physiotherapy, and manual therapy. In this study, efforts was made to determine the effectiveness of FTT along with conventional physiotherapy and EMG-biofeedback along with conventional physiotherapy, in the reduction of pain, attained a significant improvement in the strength of knee flexors and extensors muscles and functional mobility in participants with knee Osteoarthritis .

The pre, post values of NPRS, KNEE muscle strength and modified WOMAC at baseline and after 5 weeks were taken and this comparison shows that EMG – biofeedback was effective in pain intensity, strength of knee muscle (flexors and extensor) and modified WOMAC in participants with knee osteoarthritis. The results found in this study disclosed that after five weeks of intervention program of both the groups, Group –A, which received FTT along with conventional physiotherapy and Group – B, which received EMG –biofeedback along with conventional physiotherapy attained a statistically and clinically significant improvement after that treatment intervention. ($p< 0.005$).A wide variety of treatment protocol for knee osteoarthritis is available, and yet the most effective management has remained as an area of debate.

Alternately, functional task training focuses at the activity level by strengthening and adapting postural strategies to environmental demands through functional task performance. This type of activity requires coordinated functional movements, task specific balance requirements and incorporates multiple muscle groups and joints working in multiple planes. EMG biofeedback is a method of retraining muscle by creating new feedback systems as a result of the conversion of myoelectrical signals in the muscle into visual and auditory signals. EMG uses surface electrodes to detect a change in skeletal muscle activity, which is then fed back to the user usually by a visual or auditory signal. EMG biofeedback can be used to either increase activity in weak or paretic muscle or it can be used to facilitate a reduction in tone is a spastic one. EMG biofeedback has been shown to be useful in both musculoskeletal and neurological rehabilitation[36].

This suggests that both interventions were effective in reducing pain intensity, improvement in the strength of knee flexors and extensors muscles and functional mobility in participants with knee Osteoarthritis. The result of this study revealed that through a significant improvement was found after treatment in both groups, Group-B showed greater improvement .The above exposed statement suggests that both the FTT and EMG-biofeedback can be employed along with conventional exercise program in the effective management of participants in improving pain intensity, knee extensors strength and functional mobility in the knee Osteoarthritis.

Conclusion

The results indicate that the treatments in both groups are effective in participants with knee osteoarthritis to reduce pain, improve muscle strength and functional disability. but combined EMG-Biofeedback along with conventional physiotherapy is more effective in the management of knee osteoarthritis.

Key points

Findings: This study was conducted on participants with knee osteoarthritis. The study was done to compare effect of FTT along with conventional physiotherapy, and EMG-biofeedback along with conventional physiotherapy pain, muscle strength and modified WOMAC in Participants with knee osteoarthritis in local population. The participants were randomly divided into two Groups, group A&B consisting 30 participants selected by simple Random sampling method (lottery method).

After 5weeks of the study result shows EMG-biofeedback along with conventional physiotherapy is more effective in reduction of pain, improvement in muscle strength (knee flexors and knee extensors) and modified WOMAC in participants with knee osteoarthritis. Implications: FTT along with conventional physical therapy and EMG-Biofeedback with conventional physical therapy applied to the participants of the knee Osteoarthritis. The findings are accordance with the study by shahnawaz et.al.2011 who investigated the efficacy of electromyographic biofeedback training on pain and functional status in osteoarthritis of knee and had concluded that The addition of electromyographic- biofeedback to isometric exercise program has been shown to produce greater reduction in pain intensity and improved functional status than isometric exercises alone over a 3 week period. Caution: The present results having some limitation: No control group was present, No long term follow up was taken and Home program was not taught to the Participants.

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