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A Comparative Study of Isometric Exercises Verses Isotonic Exercises on Pain and Functional Ability among Adults with Osteoarthritis of Knee

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Abstract: ***Background: Osteoarthritis is the most common form of arthritis and extremely prevalent among individuals over forty years of age. It is the leading cause of pain and disability in elder people worldwide. Pain, swelling, decreased range of motion; functional impairment and bony deformity are major clinical features of osteoarthritis. Method: 60 Patients were screened as per inclusion and exclusion criteria with grade 2 – 3 knee osteoarthritis. The patients were assigned into three groups by convenient random sampling method. GROUP A: (n=20): were treated with isometric exercises. GROUP B: (n=20): were treated with isotonic exercises. GROUP C: (n=20): Control group. Hot pack and TENS was common intervention in all the groups. We measured pain and disability of knee at 0 day, 2nd week and 4th week. At the end of 4th week analysis was done using paired and unpaired t-test and significant results were found. Results: Both groups A and B showed statistically significant improvements in within group analysis in terms of pain and functional ability, but there was no statistically significant difference between the two groups. Conclusion: The present study concluded that both groups A and B produced similar treatment effects for patients suffering from osteoarthritis of knee. Hence, null hypothesis was accepted and alternate hypothesis was rejected.***

Keywords: Hot pack; isometric exercise; isotonic exercise; osteoarthritis; TENS.

1. Introduction

Osteoarthritis (OA) is the common progressive musculoskeletal condition that usually affect joints, but it mainly affects the hip and knee as predominant weight-bearing joint (Bortoluzzi et al. 2018). Knee osteoarthritis (OA) is a major cause of musculoskeletal disability in the old population, affecting both males and females as reported by the World Health Organization on the global burden of disease (Murray et al. 1997). Knee osteoarthritis manifests as pain, joint stiffness, decreased quadriceps strength, physical disability, but also impacts overall disease outcome and quality of life. Knee osteoarthritis is characterized by structural modifications of primarily articular cartilage and the subchondral bone, Hoffa's fat pad, synovia, ligaments and muscles, leading to the concept of observing OA as a whole joint disease (Loeser et al. 2012). Altogether 10%–15% of adults over 60 have some degree of osteoarthritis, and with an ageing population it is becoming an increasingly important disease. Osteoarthritis is classified into two groups. Primary osteoarthritis can be localized or generalized, commonly found in post-menopausal women, with development of Heberden's nodes. Secondary osteoarthritis has an underlying cause, such as trauma, obesity, Paget's disease, or inflammatory arthritis. Age, previous knee injuries, obesity (increased body mass index (BMI)), joint malalignment and instability that result in increased mechanical stress are all strong risk factors for the development of knee OA (Vina et al.2018). Physical inactivity is also another important contributor to the increasing prevalence of OA, causing higher susceptibility to knee damage due to less stable and weaker joints (Berenbaum et al. 2018).

The basic pathophysiological processes that causes osteoarthritis and as well as the pain-causing mechanisms remain unclear, but low-grade inflammation in the periarticular structures seems to play an important role related to both pain, decreased function and disease progression (Berenbaum et al. 2018). Cartilage degeneration involves a change in the chondrocyte phenotype called chondrocyte hypertrophy, which in pathological situations can be induced by altered mechanical loading of chondrocytes (Woong M et al 2003). This is normally seen in endochondral ossification in growth plates, fracture callous, and osteophyte formation, the latter being feature of OA joint pathology. This hypertrophic state is characterized by abnormal cell behavior with increased resorption of collagen and proteoglycan in extracellular matrix, culminating in cell death (Poole AR et al. 2007).

A wide variety of treatments are available for osteoarthritis of the knee including education, hydrotherapy, footwear and walking aids, other rehabilitation measures, physical therapy (SWD, UST, TENS, galvanic current, exercises etc), systemic drug therapy, intraarticular drug therapy and surgery (Thomas KS et al. 2002). Combinations of treatment interventions are often selected over a single approach. Studies have shown benefits of exercise in reducing pain and improvement in functions in patients with knee OA (Fransen M et al 2001). Muscle strengthening through resistance exercises (RX) increases physical function, decreases pain due to OA, and reduces self-reported disability (Lange AK et al. 2008). Both aerobic walking and quadriceps strengthening exercises have shown to reduce pain and disability in patients with knee osteoarthritis. Quadriceps strengthening, however, can be achieved in a variety of ways and many trials use complex hospital based regimens and

sophisticated machinery not readily available to the majority of patients with osteoarthritis (Roddy et al. 2005). Isometric exercises are also used in the rehabilitation of individuals with pathologies in which resisted movements through the full range of motion (ROM) are contraindicated because of crepitus, pain, effusion, and insufficient healing. Isometric exercises do not necessarily require equipment, they may be performed anywhere. These exercises are appropriate for the early phase of strengthening programs for OA knee patients (Bandy et al. 1993).

Many studies have been conducted on efficacy of Resistance exercises in reducing pain and improve functional ability in patients of osteoarthritis. But till date no research is available to compare the effectiveness between isometric and isotonic exercises to reduce pain and improve functional ability in knee osteoarthritis. In case, if the protocol works it will be a boon to ortho physiotherapist for improving functional ability and reduce pain which is important in managing various tasks in day-to-day life. Thus, it will be helpful to engage them successfully in physical activity. Furthermore, it will increase their independence level, thus helping them & their care takers lead a stress-free life

2. Literature Survey

Bennell & Hinman (2005) in the meta-analysis of their review highlights recent important research, future directions, and clinical applications for exercise and knee osteoarthritis. The review covers exercise prescription for symptomatic relief, and its potential role in reducing development and slowing progression of osteoarthritis. Meta analysis support recommendations that exercise is important in osteoarthritis management. Based on studies showing a relation between weaker quadriceps strength and increased risk of developing knee osteoarthritis, particularly in women, strength training may be able to prevent knee osteoarthritis. Therefore, they concluded that quadriceps strengthening helps to prevent knee OA and associated pain and disability.

Miyaguchi et al. (2003) analyzed the biochemical changes in the joint fluid, and pain relief resulting from isometric quadriceps exercise in patients with osteoarthritis of the knee. Nineteen osteoarthritic knees in 17 patients with joint effusion were included. The patients performed isometric quadriceps exercise for 3 months. Isometric muscle torque at 30 and 60 flexion, pain as measured using the visual analog scale and biochemical markers in joint fluid were evaluated before and after the exercise. They concluded that isometric quadriceps exercise resulted in significant changes in joint fluid biochemical parameters, and these changes, at least in part, may explain the ameliorative effect of muscle exercise for osteoarthritis of the knee.

Topp et al. (2002) compared 16 weeks of isometric versus dynamic resistance training versus a control on knee pain and functioning among patients with knee osteoarthritis (OA). A total of 102 volunteer subjects with OA of the knee randomized to isometric (n_32) and dynamic (n_35) resistance training groups or a control (n_35). Strength exercises for the legs, 3 times weekly for 16 weeks were given to the static group and dynamic group received exercise across a functional range of motion; isometric: exercises at discrete joint angles. On the basis of results they concluded that both forms of training are equally effective in controlling pain and improving function.

Thomas et al. (2002) determined whether a home based exercise program including quadriceps strengthening exercises can improve outcomes in patients with knee pain. 786 men and women aged >45 years with self reported knee pain were randomized to four groups to receive exercise therapy, monthly telephone contact, exercise therapy plus telephone contact, or no intervention. Patients in the no intervention and combined exercise and telephone groups were randomized to receive or not receive a lacebo health food tablet. Primary outcome was self reported score for knee pain on the Western Ontario and McMaster universities (WOMAC) osteoarthritis index at two years. Secondary outcomes included knee specific physical function and stiffness (scored on WOMAC index), general physical function (scored on SF-36 questionnaire), psychological outlook scored on hospital anxiety and depression scale), and isometric muscle strength. The concluded that home based exercise programme including knee isometric exercises are very effective in reducing pain and disability.

3. Material and Methods

Patients were taken from the OPD of Dasmesh college of Physiotherapy Faridkot and OPD of Orthopaedics Department of Guru Gobind Singh Medical College, Faridkot and written informed consent was received from all patients enrolled in the study. 60 patients between the age of 50-70 years were included according to inclusion criteria i.e. (1). Patients having unilateral localized or diffused osteoarthritic knee pain. (2). Patients with symptomatic unilateral OA Knee with grade 2 – 3 according to Kellgren and Lawrence criteria. (3). Male patients are only taken. (4). Patients having knee pain for at least 2 months. Patients were divided into 3 groups, Group A (20 patients) were treated with isometric exercises only. Group B (20 patients) were treated with isotonic exercises. Group C (20 patients) control group. Hot pack and TENS were common intervention in all the three groups.

4. Procedure

Group A: 20 patients with osteoarthritis of knee were treated with isometric exercises. Hot Pack was given in supine position. Hot pack was applied over the affected knee for 10 min. TENS was given for 15 minutes. Two electrodes were placed on painful area of the affected knee with frequency 100 Hz. Stimulations were applied with dose well tolerated by patient.

Isometric Exercises

- For quadriceps Muscle:-

Patient was lying in supine position. A rolled-up towel was placed under affected knee. Patients were asked to contract his/her quadriceps by pushing against towel roll for 10 sec and then relax for 5 sec. 1 set of 10 repetitions were performed.

- For Hamstring Muscle:-

Patient was lying in supine position. A Rolled-up towel was placed under the ankle. Patients were asked to contract his/her hamstring by pushing against towel roll for 10 sec and then relax for 5 sec. 10 repetitions per set, 1 session per day, 3 days a week for 4 weeks were performed.

Group B: 20 patients with osteoarthritis of knee were treated with isotonic exercises. Hot Pack was given in supine position. Hot pack was applied over the affected knee for 10 min. TENS was given for 15 minutes. Two electrodes were placed on painful area of the affected knee with frequency 100 Hz. Stimulations were applied with dose well tolerated by patient.

Isotonic Exercises

- For quadriceps Muscle:-

Patient was positioned in high sitting. Resistance for isotonic exercises was given with thera-band as it gives progressive resistance throughout functional range of motion. Patients were asked to extend his leg against resistance and relax. 10 repetitions per set, 1 session per day, 3 days a week for 4 weeks were performed.

- For Hamstring Muscle:-

Patients were lying in prone position. Patients were asked to perform leg curls. Resistance was given with Thera-band. 1 set of 10 repetitions were performed.

Group C: Patients of group c were asked to maintain their normal level of physical activity. Conventional treatment of hot pack and TENS were given.

Outcome Measures

Patients were assessed at baseline, 2nd week and 4th week by:

- Assessment of knee pain using VAS.
- Assessment of knee disability using Western Ontario and McMaster Universities Arthritis Index.

5. Results

Statistical Analysis:

The data was described as mean and standard deviation, for normally disturbed data. ANOVA was used to compare between variable within each group, while student unpaired t test was used to compare between three groups. The P value was set at level less than 0.05.

Group A

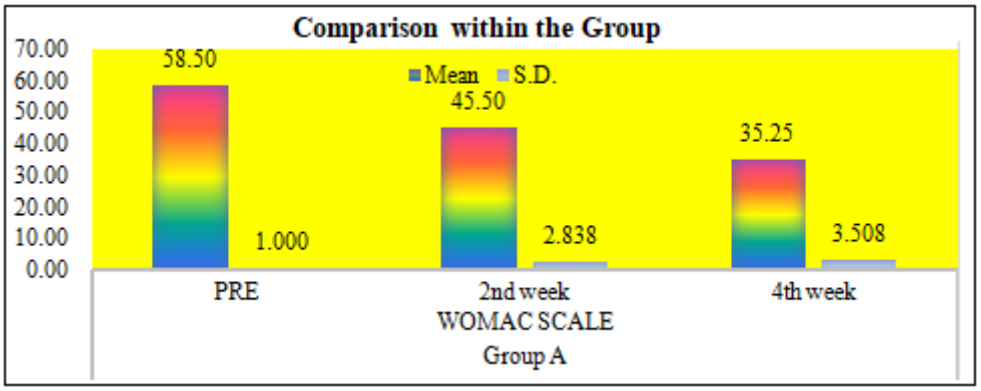

Table 1.1 describes comparison of pre intervention and post intervention values of WOMAC Scale within group A. Where Pre-interventions Mean+-SD of WOMAC Scale was 58.50+-1.000 and that of Post- intervention was 35.25+-3.508. The value of F Test as calculated was 617.260 which was statistically significant, at P<0.05.

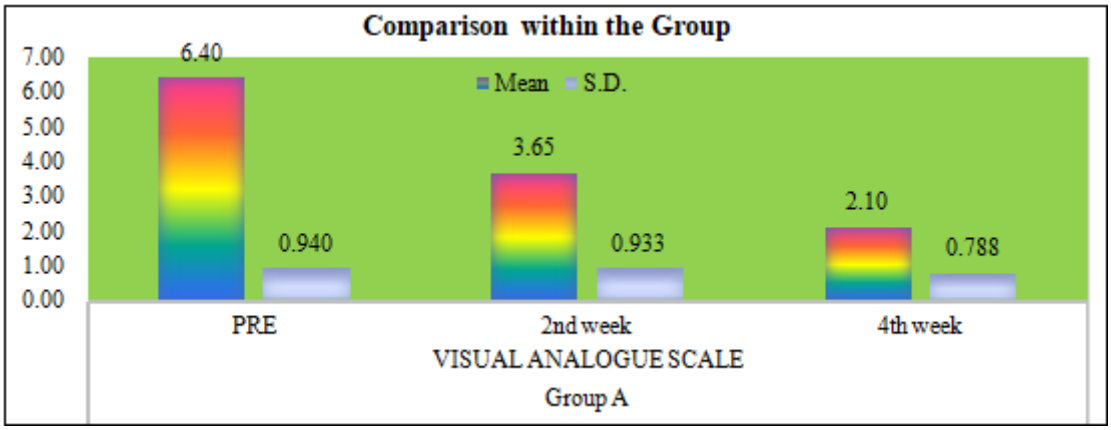

Table 1.2 describes comparison of pre intervention and post intervention values of Visual Analogue Scale within group A. Where pre- interventions Mean+-SD of Visual Analogue Scale was 6.40+-0.940 and that of post-intervention was 2.10+-0.788. The value of F Test as calculated was 328.660 which was statistically significant, at P<0.05.

GROUP B

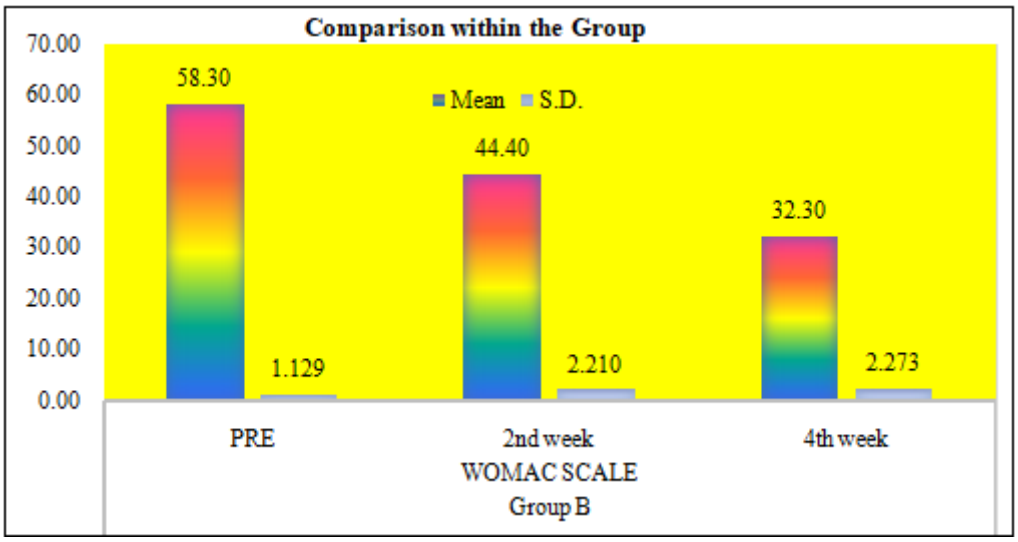

Table 1.3 describes comparison of pre intervention and post intervention values of WOMAC Scale within group B. Where pre-intervention Mean+-SD of WOMAC Scale was 58.30+-1.129 and that of post- intervention was 32.30+-2.273. The value of F Test as calculated was 854.600 which was statistically significant, at P<0.05.

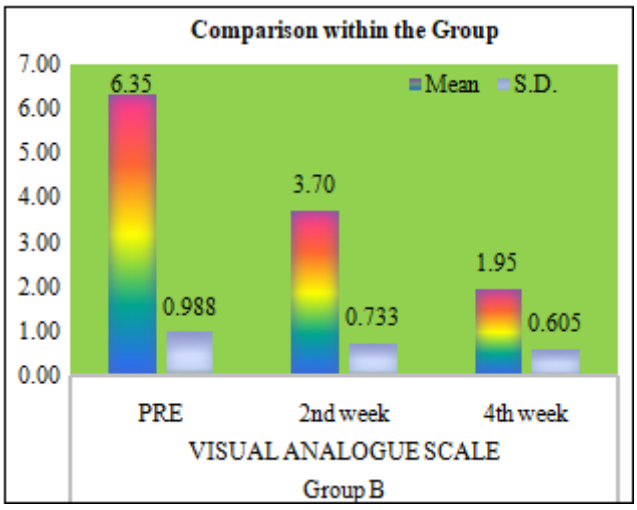

Table 1.4 describes comparison of pre intervention and post intervention values of Visual Analogue Scale within group B. Where pre- intervention Mean+-SD of Visual Analogue Scale was 6.35+-0.988 and that of post-intervention was 1.95+-0.605. The value of F Test ascalculated was 318.780 which was statistically significant, at P<0.0

Group C

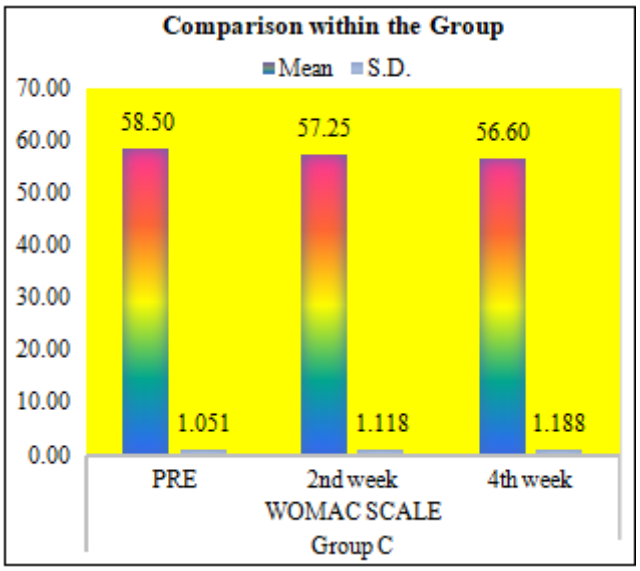

Table 1.5 describes comparison of pre intervention and post intervention values of WOMAC Scale within group C. Where pre-intervention Mean+-SD of WOMAC Scale was 58.50+-1.051 and that of post- intervention was 56.60+-1.188. The value of F Test as calculated was 44.200 which was statistically significant, at P<0.05.

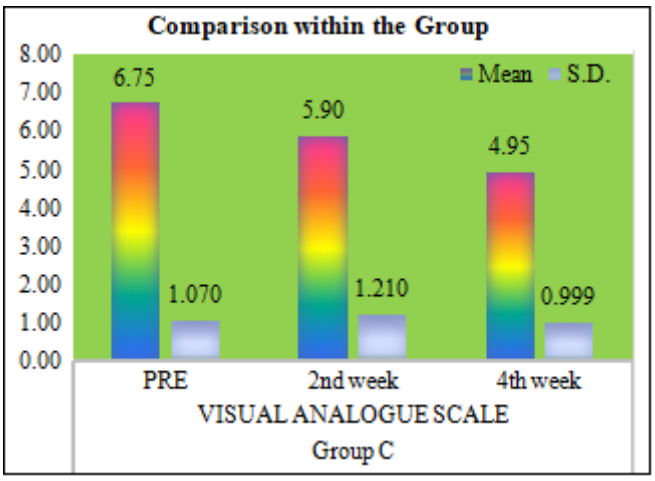

Table 1.6 describes comparison of pre intervention and post

intervention values of Visual Analogue Scale within group C. Where pre- interventions Mean+-SD of Visual Analogue Scale was 6.75+-1.070 and that of post-intervention was 4.95+-0.999. The value of F Test as calculated was 89.310 which was statistically significant, at P<0.05.

Within group analysis

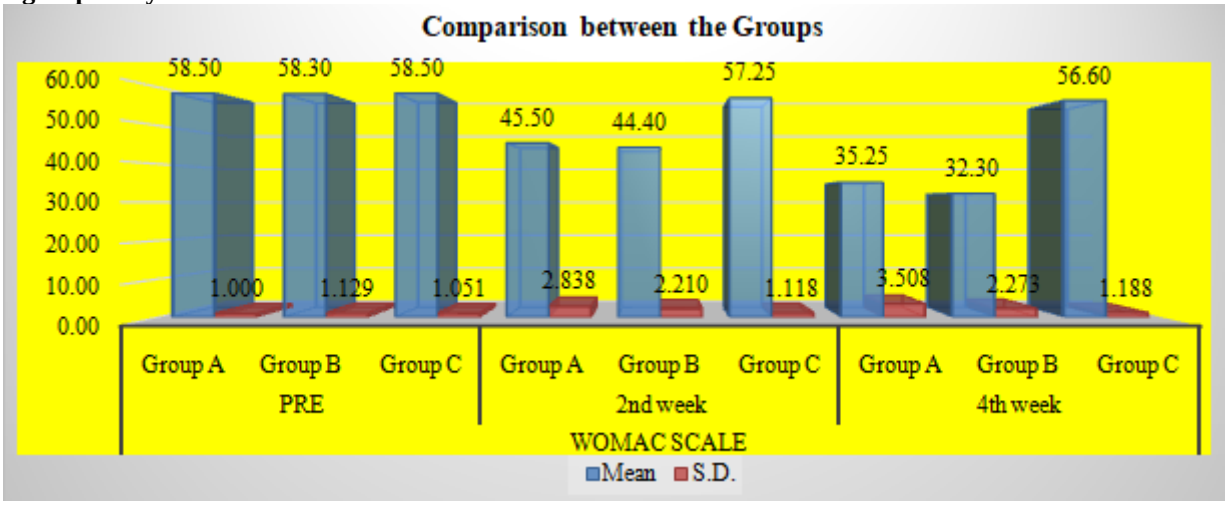

Table 1.7 describes comparison values of pre intervention values of WOMAC Scale among Group A, Group B and Group C. Where pre intervention Mean+-SD of WOMAC scale of Group A was 58.50+-1.000, Group B was 58.30+-1.129 and Group C was 58.50+-1.051. The F test value was 0.237, which is statistically not significant, at P <0.05.Where post intervention Mean+-SD of WOMAC scale of Group A was 35.25+-3.508, Group B was 32.30+-2.273 and Group C was 56.60+- 1.188. The F test value was 558.754, which is statistically significant, at P<0.05.

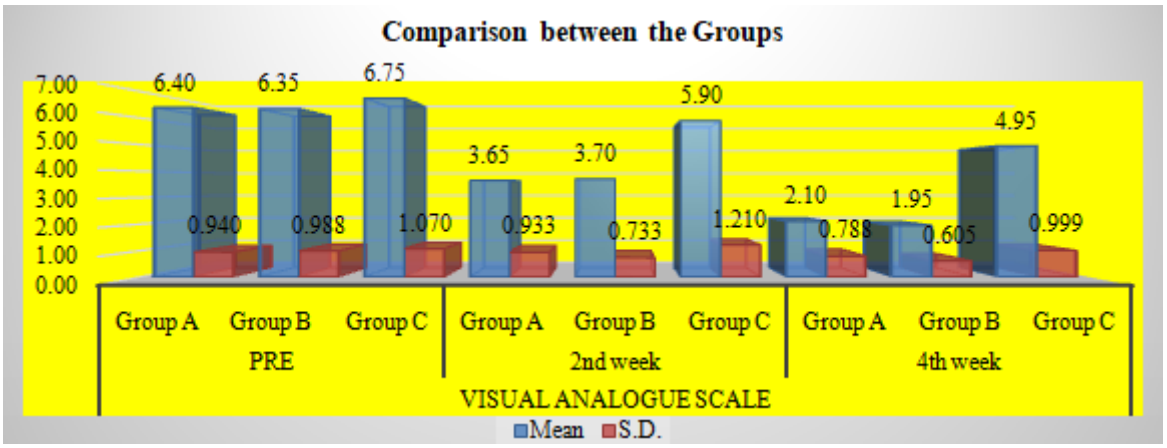

Table No. 1.8 describes comparison values of pre intervention values of Visual Analogue Scale among Group A, Group B and Group C. Where pre intervention Mean+-SD of visual analogue scale of Group A was 6.40+-0.940, Group B was 6.35+-0.988 and Group C was 6.75+-1.070. The F test value was 0.948, which is statistically not significant, at P<0.05. Where post intervention Mean +-SD of visual analogue scale of Group A was 2.10+-0.788, Group B was 1.95+-0.605 and Group C was 4.95+- 0.999. The F test value was 86.407, which is statistically significant, at P<0.05.

6. Discussion

The present study was undertaken to compare the effect of Isometric exercises versus Isotonic exercises on pain and functional ability among adults with osteoarthritis of the knee. Within group analysis of both the groups showed statistically significant improvement in pain and disability in osteoarthritis knee patients (i.e. reduction in pain and disability). One possible mechanism by which these exercises may have reduced the pain and disability in subjects with OA knee is by increase in strength. Currier et al observed a significant increase in strength after only 10 daily sessions of isometric exercise. There is no statistically significant difference between isometric exercise and isotonic exercise on pain and functional ability in osteoarthritis knee patients was found. Both the exercises have shown to be equally effective.

Our results support the findings of previous studies indicating that strength training reduces pain and improves physical function in people with knee OA. A reduction of pain may result from improvement of muscle strength and this comes with the results of O'Reilly et al and Balint et al who concluded that improved quadriceps strength is associated with less knee pain and less disability. Another

possible mechanism by which these isometric exercises may have reduced the pain and disability in subjects with OA knee is by relief of reflex inhibition. A 'reflex inhibition' mechanism is an important cause of quadriceps weakness in knee OA patients in addition to disuse atrophy. Reflex inhibition leads to neurogenic inhibition of the quadriceps muscle. Another possible mechanism for the reduction in pain in both the groups can be due to the application of TENS. Our findings are similar with the findings of Durmu (2010) who concluded that addition of TENS to hot pack and exercise program is more effective in decreasing knee pain and related disability and quality of life. TENS, a well known physical therapy modality is widely used for the treatment of pain caused by OA. Various theories have been suggested for its mechanism of action. These theories include inhibition of nociceptors, blockage of pain transmission in afferent nerves, sympatheric blockage, gate control theory and increase in release of endogen opiates.

This study showed that both the exercises i.e. isometric exercise and isotonic exercise when combined with hot pack and TENS were equally effective for patients with OA knee and the treatment protocol was clinically practicable and relatively brief. Such improvements may delay or even avoid the need for surgical interventions. Hence the protocols were cost effective.

7. Conclusion

This study concluded that though both groups A and B showed statistically significant outcomes in within group analysis in terms of pain and functional ability, but there was no statistically significant difference between the two groups for any of the variables studied i.e. VAS and WOMAC. Thus we can conclude that both the exercises i.e. isometric exercise and isotonic exercise when combined with hot pack and TENS application shows similar treatment effects for people suffering from osteoarthritis of knee.

There was no statistical significant difference between isometric exercise and isotonic exercise on pain and functional ability in osteoarthritis knee patients. Hence, null hypothesis was accepted and alternate hypothesis was rejected.

8. Limitations of the Study

1) The sample size for the study was small.
2) Only unilateral cases were taken for the study.
3) OA Grade 1 and 4 were not been included in the study.
4) External factors affecting the progress cannot be controlled.
5) Home exercise program was not advised because it cannot be monitored.
6) This study patient's physical function, emotional function and social levels were not considered.
7) Cofounding Variables like functional limitation and environment factors were not considered.
8) The study was limited to assess only the pain intensity by using visual analogue scale and Western Ontario and McMaster Universities Arthritis Index.
9) There was no follow up

9. Future Scope

1) The treatment was given for four weeks but follow up was not done therefore long term effects of the treatment can be noticed.
2) The study can be performed with a large sample size.
3) The study can be performed with bilateral OA knee and OA grade 1, 4 can also be studied.

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