IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

EFFECTS OF FORWARD VS BACKWARD PEDALING ON PAIN, DISABILITY AND FUNCTIONAL PERFORMANCE IN KNEE OSTEOARTHRITIS PATIENTS: A COMPARATIVE STUDY

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Abstract: The main purpose of the study was to investigate the effect of forward vs backward pedalling on Pain, Disability and Functional performance in Knee Osteoarthritis patients and to find out which pedalling direction offers more advantage in knee osteoarthritis patient. The study was a Pre and Post Experimental design study, involving three groups, i.e., forward pedalling group, backward pedalling group and a control group. Thirty patients diagnosed with mild to moderate knee OA of both the gender between the age group of 40-60 years, selected by sample of convenience method and completed 3 weeks of cycling intervention on stationary cycle, performed 5 days per week. Subject in controlled group did only conventional exercises for 3 weeks. Primary Outcome measure included KOOS (Knee Injury and Osteoarthritis Outcome Score) and NPRS (Numeric Pain Rating Scale) and TUG (Timed Up and Go) Scale was the Secondary outcome measure.

Result showed both forward and backward pedaling are effective in reducing pain and disability and improving functional performance in knee osteoarthritis. Also, there is no additional benefit or difference in the effect of either of the pedaling direction and both can be used for rehabilitation of knee osteoarthritis.

Index Term: Knee osteoarthritis, Stationary Cycle, Forward pedaling, Backward pedalling, Conventional exercises, Pain, Disability, Functional performance.

1.INTRODUCTION

Osteoarthritis is a common progressive health problem among adults. It is a chronic degenerative disease that affects the whole joint including meniscus, ligament, articular cartilage, causing synovial and capsular thickening. There is also bony remodelling, joint effusion and bony spur at the margins of the joints (Kisner and Colby, 2007). Osteoarthritis is one of the leading causes of locomotor disability. Osteoarthritis of weight bearing joints is related to reduce musculoskeletal and cardiovascular function which reduces patient functional capacity. This causes reduced usual activities at home, work and recreation time (Minor MA et al, 1989; Philbin EF et al, 1995; Ries MD et al, 1995). Knee OA patients also show impairment in terms of ambulation, joint movement and care and emotional and psychological function (Majani G et al, 2005). Aerobic exercise has beneficial effects on joint pain and tenderness, functional status and cardio-respiratory function in knee OA patients (Brosseau L, 2004). Most common aerobic exercise include walking and cycling. Cycling causes reduction in pain and enhances quality of life of OA patients (Multani NK, 2005).

Stationary cycling has been shown to produce effects of aerobic exercise training in healthy adults (Badenhop DT et al, 1982; Foster VL et al, 1980). In OA patients its effectiveness has not been investigated because of the belief that repetitive cyclic loading causes additional injury to the joint (Radin EL et al, 1972). Studies shows that the mechanical forces experienced by the knee during cycling is same as in case of walking (Ericson MO, Nisell R,1987; 1986), therefore cycling can be used to produce training effect in knee OA patients. It has been found that stationary cycling at lower intensity was as effective as stationary cycling at higher intensity in improving functional performance, ambulatory and aerobic endurance capacity and reducing knee pain in OA patients (Mangione KK et al, 1999). Stationary cycling has been used for rehabilitation of patients with a variety of knee joint disorders. In comparison to full weight bearing activities like running and walking, pedalling causes less compressive force across knee joint and minimizes

ACL strain (Neptune RR, Kautz SA;2000). Researchers have suggested that pedalling backward might offer similar benefit over forward direction pedalling, as in case of walking (Bressel E, 1998)

NEED AND SIGNIFICANCE OF THE STUDY

Studies have shown that pain and disability in osteoarthritis patients may be decrease by walking (Kovar PA et al, 1992). Stationary cycling is another alternative exercise to achieve the aerobic exercise benefit. Studies have been done to compare the effect of walking versus cycling on quality of life and functional performance among knee osteoarthritis patients (Sheth MS et al, 2014). Finding of the study suggest that both the form of aerobic training, i.e., stationary cycle and walking improve functional status and reduce pain in knee OA patients. However, there is very few research or study comparing the effectiveness of forward and backward cycling in knee osteoarthritis patients. Hence the need of this study was to evaluate and comparing the effectiveness of forward and backward pedaling on pain, disability and functional performance in knee osteoarthritis patients.

RESEARCH METHODOLOGY

The study was a Pre and Post Experimental design study, involving three groups, i.e., forward pedalling group, backward pedalling group and a control group.

3.1Population and Sample

30 patients diagnosed with mild to moderate knee OA of both the gender between the age group of 40-60 years will be selected by sample of convenience method. To be eligible for the study the participants should fulfil the inclusion and exclusion criteria. Inclusion criteria involves- Knee pain score during activity on NPR (Numeric pain rating) Scale between 4 to 7 out of 10. , Patients diagnosed with knee OA by an Orthopaedics, unilateral or bilateral knee OA with Kellgren/ Lawrence score between 1 and 3,ability to do cycling on stationary cycle, indication for physiotherapy due to OA impairment, At least 90 degree of knee ROM, Stable baseline blood pressure according to the American College of Sports Medicine guidelines for exercise, Ability to read and understand Hindi or English language.

Exclusion criteria includes Symptoms and radiographic features of Hip or Ankle osteoarthritis, Any Inflammatory joint disease in lower extremity, Corticosteroid injection for more than 3 months

3.2 Data and Source of Data

For this study data has been collected From the Elite Care Physiotherapy Centre and New Hope Physiotherapy Clinic, New Delhi.

3.3 Theoretical Framework

Variables of the study contains dependent and independent variable. The study used pre-specified method for the selection of variables. The study used the Stock returns are as dependent variable. Dependent variable involves forward pedaling and backward pedalling and dependent variable was Pain, Disability and Functional Performance.

Group Allocation- Three groups (Grp 1, Grp 2, Grp 3) Group 1: Perform forward pedaling for 30min. Group 2: Perform backward pedaling for 30min. Group 3: Control Group-receive only conventional exercises.

Conventional Exercise include hot pack for 5min, static quadriceps exercise, knee extension in high sitting, straight leg raising (15 reps), as warm up (5min). Cool down session consists of stretching of tendoachillis and hamstrings. Total duration of intervention was 3 weeks perform 5 days in a week.

The subjects who fulfil the inclusion and exclusion criteria will be randomly assigned to one of the three groups after obtaining written informed consent from the patients. Assessments will be done before the intervention starts (at baseline) and after 3 weeks. The total duration of one exercise session was 45min which include 10min warm up, 30min of cycling and 5min of cool down.

Grp 1 and Grp 2 perform forward and backward cycling respectively for 30min at perceived exertion of 11- 13, as per the **Borg Scale**. The seat height was adjusted for each patient individually such that knee flexion of no more than 10º were allowed at the lowest pedal rotation point. Wheel tension was set at either mild or at negligible tension for cycling group groups. Subjects increases the intensity of cycling by increasing the pedaling cadence (rpm), not the resistance.

3.4. Statistical Tool and Econometric Model

Statistical analysis was done with IBM SPSS statistics 24. The primary outcome variable was KOOS subscale: symptom, pain, function in daily activity, function in sports and recreational activity and knee related quality of life. The secondary outcome variables were NPRS and time up and go (TUG) test. A statistical comparison of values at baseline and after 3 week of intervention was done for all the 30 subjects. Analysis of variance (ANOVA) and T test were applied, assuming the p value <0.05 to be significant

test were applied to analyse the changes in outcome variables within the group. ANOVA were used to detect differences in outcome variable between the groups

3.4.1. Descriptive Statistics

KOOS (Knee Injury and Osteoarthritis Outcome Score): The KOOS was developed to get knowledge of patient's opinion about their knee and other related problem. It consists of five subscales including Pain, Stiffness, Activities of daily life (ADL), Sport and recreation activities, and quality of life related to knee (QOL). Scoring is done on a 5-point Likert Scale from 0 (no problem) to 4 (extreme problem) and final score is converted into 0–100-point scale. A lower score signifies greater impairment. The KOOS is a reliable, valid, responsive, self-explanatory and patient-administered instrument and usually takes about 10 minutes to complete (Roos EM & Lohmander LS, 2003). KOOS test-retest reliability was high.

3.4.2. NPRS (Numeric Pain Rating Scale)

NPRS is a valid and responsive scale for measuring pain intensity in patients with OA. It is also a reliable tool (ICC: 0.64 to 0.86) in patients with musculoskeletal pain and orthopaedic problem (Price DD et al, 1994; Gallasch CH, Alexandre NM, 2007). The NPRS is a self-administered scale with a lower score indicates less pain and takes less than 1 min to complete.

TUG (Timed Up and Go): TUG measures the time required by a patient to stand up out of a chair, walk 3m, turn and walk back, returning into the chair. To evaluate the intervention goals (physical functioning), it is recommended to use TUG in combination with questionnaires, example-KOOS (Stratford P.W et al, 2006).

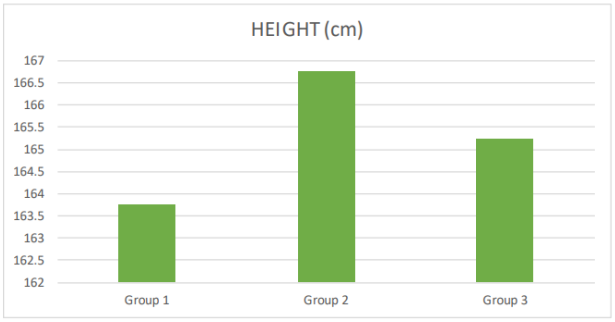
RESULTS AND DISCUSSION

4.1. Results of Descriptive Statics of Study Variables

A total of 30 subjects were selected according to the inclusion & exclusion criteria and were assigned into one of the 3 groups (Grp 1- forward pedalling, Grp 2- backward pedalling, Grp 3- control group). No significant difference was there between the demographic characteristics of subjects in either of the 3 grp, as reported in table 5.1. Participants in the forward (n=10) and backward pedalling (n=10) group completed 3 weeks of cycling intervention, performed 5 days per week. Subjects in the control (n=10) group did only conventional exercise for 3 weeks. Detailed assessment was done at baseline and after 3 weeks of intervention.

Table5.1: Baseline Demographics Data of subjects

	Group 1	**Group 2**	**Group 3**
Age	49.50 ±7.26	52.40± 7.82	47.30± 6.29
Height	163.75 ±11.56	166.75± 14.76	165.25 ±10.30
Weight	63 ± 6.65	66.80 ±10.15	64.40 ±6.11
BMI	23.68± 3.37	24.17± 3.70	23.68± 2.36
No. of Male and Female	Male-5 Female-5	Male-5 Female-5	Male-7 Female-3
K/L Scale	Grade 1-3 Grade 2-7	Grade 1-1 Grade 2-8 Grade 3-1	Grade1-3 Grade 2-7



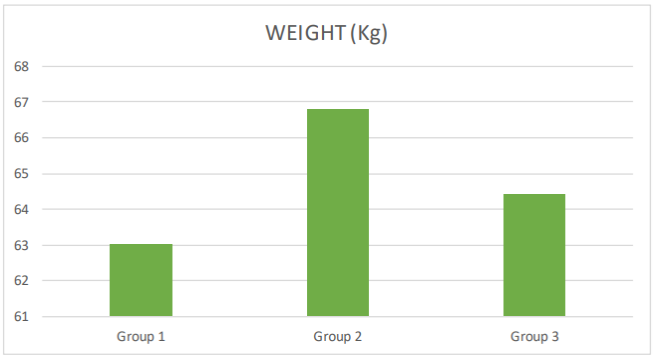


Figure 5.1: showing mean height of subjects in the 3 groups.

Figure5.2: showing mean weight of subjects in the 3 groups.

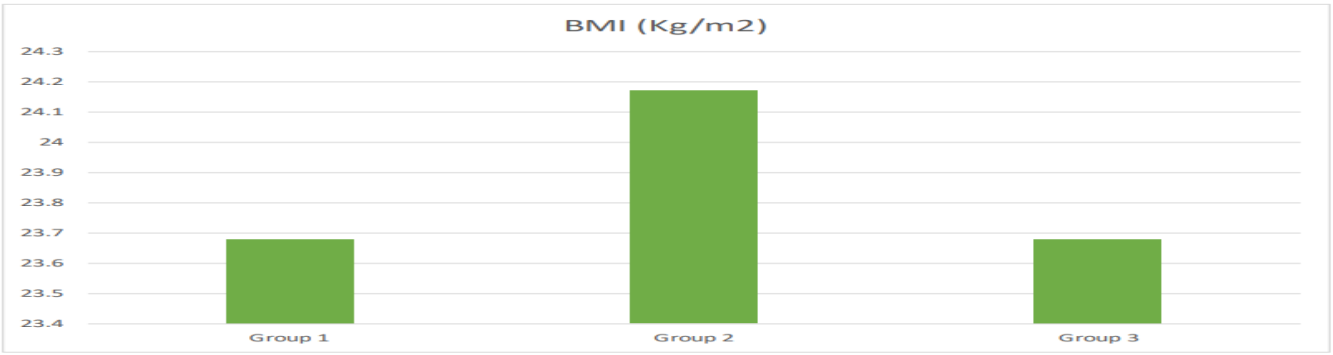
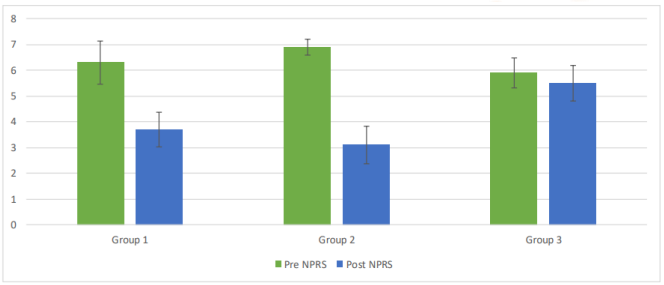


Figure5.3: showing mean BMI of subjects in 3 groups

NPRS: Significant difference were noted between Pre and Post intervention NPRS score in Grp 1 and 2. Grp 3 shows a very little improvement in Post NPRS score (Table 5.2). Significant difference was noted between Grp 2 & 3 and Grp 3 & 1 in Post intervention NPRS score. No significant difference was noted between Grp 1 & 2.



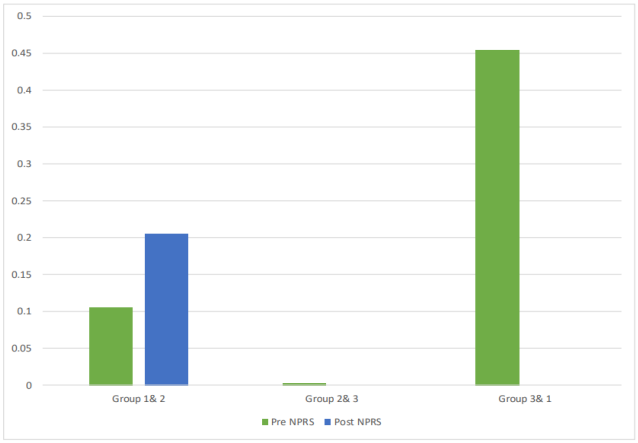


Figure5.4: Showing Pre and Post intervention NPRS score in three group

Figure5.5: showing between group comparison of Pre and Post intervention NPRS

TUG Test: Significant difference were noted between Pre and Post intervention TUG score in Grp 1, 2 and 3 (Table 5.4). Significant difference was noted between Grp 2 & 3 and Grp 3 & 1 in Post intervention TUG score. No significant difference was noted between Grp 1 & 2

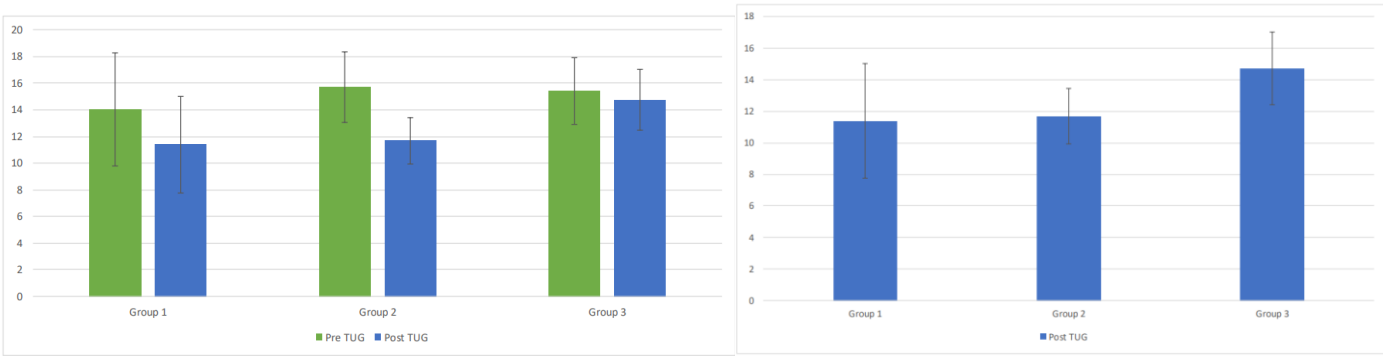


Figure5.6: Showing Pre and Post intervention TUG score in three groups.

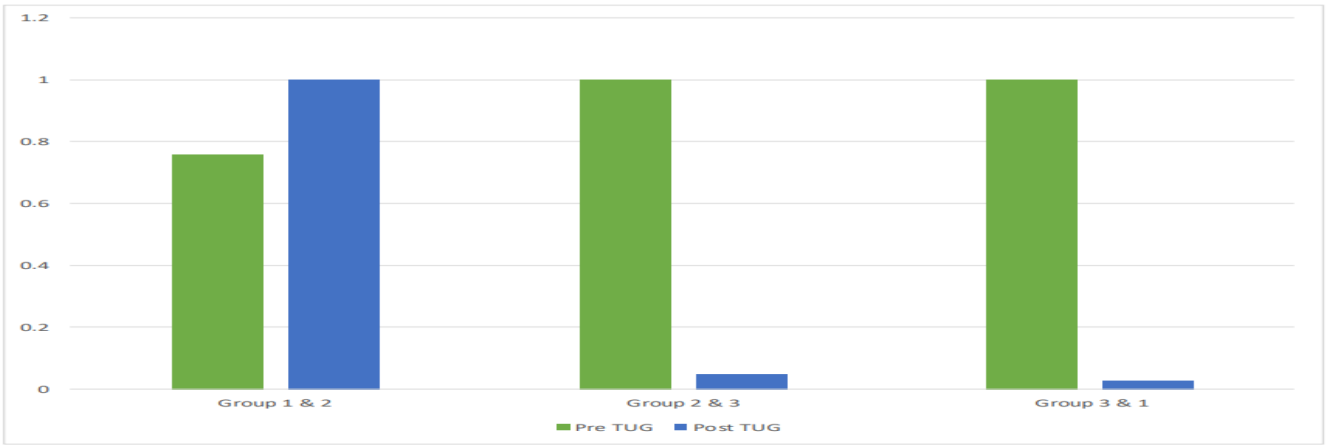


Figure 5.7: showing between group comparison of Pre and Post intervention TUG score

KOOS SYMPTOM subscale: Significant difference were noted between Pre and Post intervention KOOS symptom score in Grp 1 & 2. Grp 3 did not show significant difference in Post KOOS symptom score (Table 5.6). Significant difference was noted between Grp 2 & 3 and Grp 3 & 1 in Post intervention KOOS symptom score. No significant difference was noted between Grp 1 & 2.

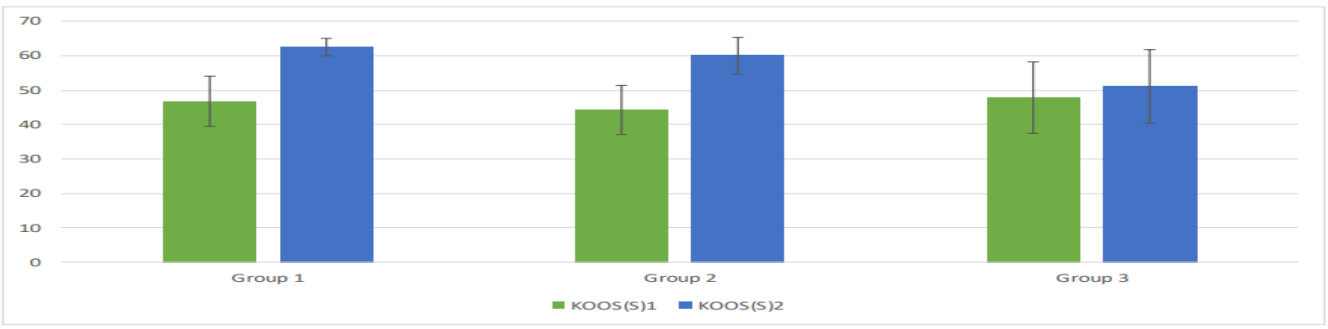


Figure 5.8: Showing Pre and Post intervention KOOS symptom score in three groups

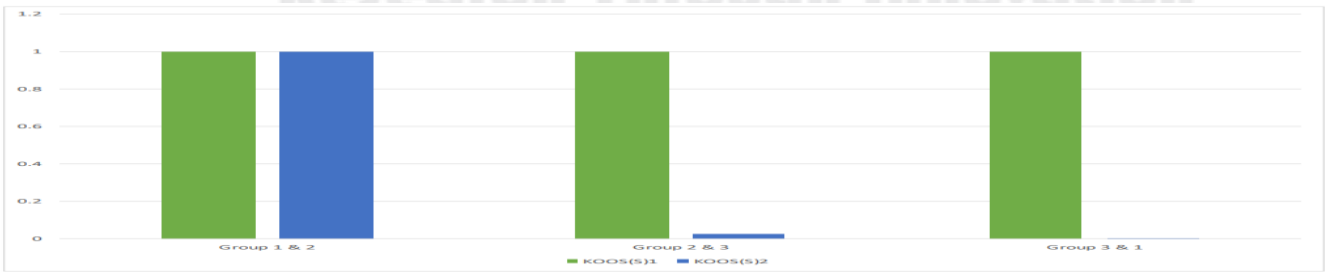


Figure 5.9: showing between group comparison of Pre and Post intervention KOOS symptom score

KOOS PAIN subscale: Significant difference were noted between Pre and Post intervention KOOS pain score in Grp 1, 2 and 3 (Table 5.8). Significant difference was noted between Grp 2 & 3 and Grp 3 & 1 in Post intervention KOOS pain score. No significant difference was noted between Grp 1 & 2.

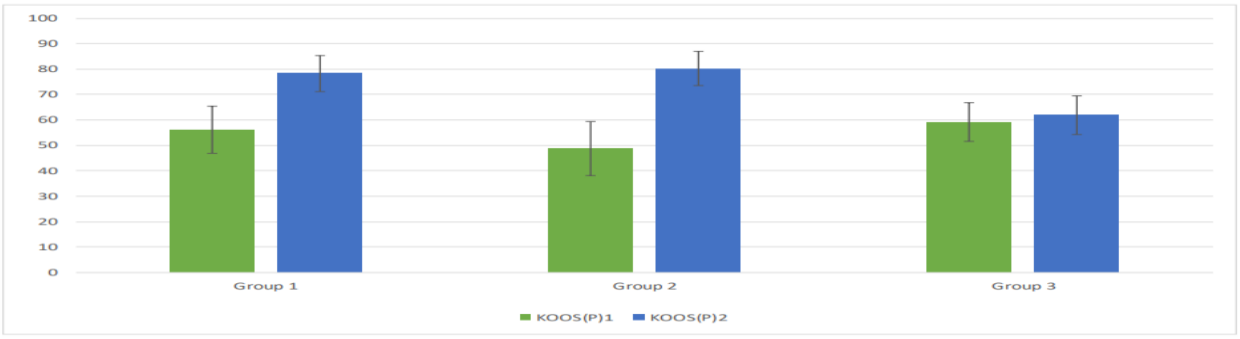


Figure 5.10: Showing Pre and Post intervention KOOS pain score in three groups.

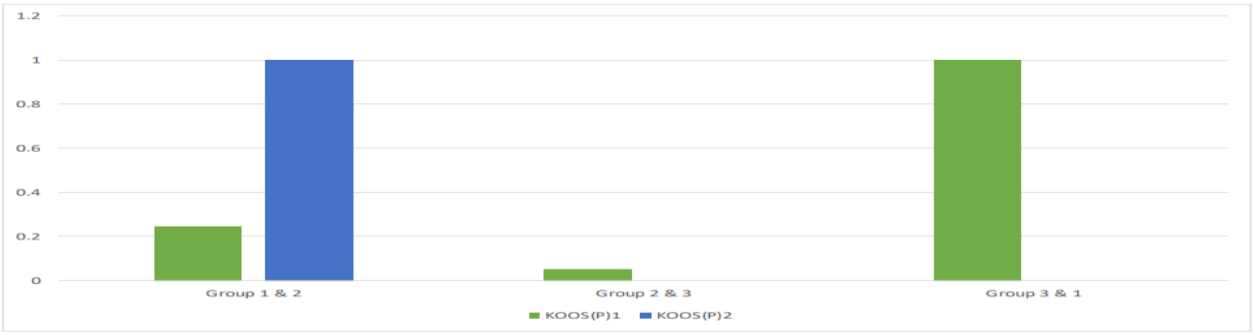


Figure 5.11: showing between group comparison of Pre and Post intervention KOOS pain score

KOOS function in DAILY ACTIVITY subscale: Significant difference were noted in Pre and Post intervention KOOS daily activity score in Grp 1, 2 and 3 (Table 5.10). Significant difference was noted between Grp 2 & 3 and Grp 3 & 1 in Post intervention KOOS daily activity score. No significant difference was noted between Grp 1 & 2 (Table 5.11).

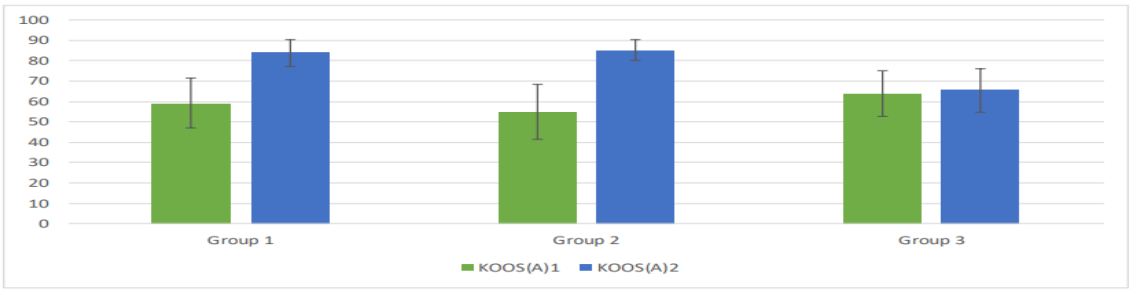


Figure5.12: Showing Pre and Post intervention KOOS performance in daily activity score in three groups

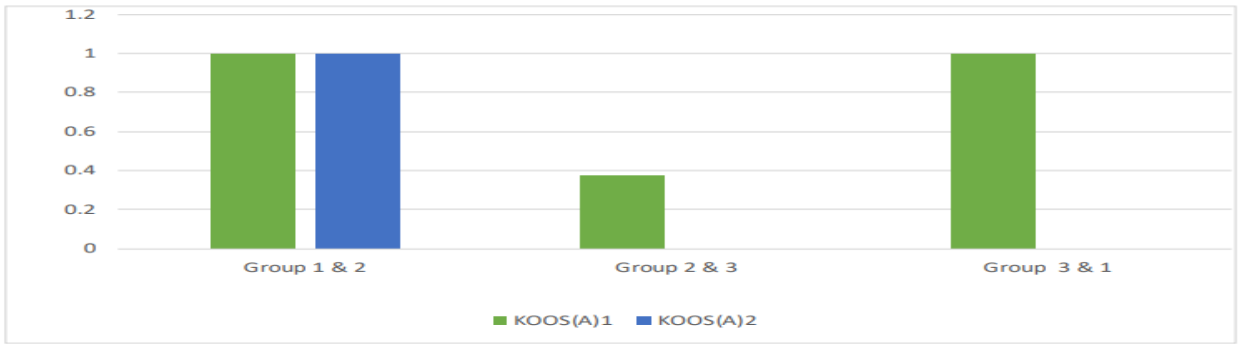


Figure 5.13: Showing between group comparison of Pre and Post intervention KOOS performance in daily activity score

4.2. Discussion

The main purpose of the study was to see the effect of forward versus backward pedaling on pain, disability and functional performance in knee osteoarthritis patients and to find out which pedaling direction offers more advantage to knee osteoarthritis patient. 30 patients with knee osteoarthritis were selected and divided into 3 grps (Grp 1- forward pedaling, Grp 2- backward pedaling and Grp3- control group). The main results of this study were that, 3 weeks of forward and backward pedaling significantly reduce pain and disability and improve functional performance in Group 1 and Group 2. Significant difference was noted in the outcome measures between Group 1 & 3 and Group 2 & 3; however, no significant difference is seen between Group 1 & 2. The study shows a significant reduction in NPRS scores in Group 1 and Group 2. In contrast, Group 3 did not show significant difference in NPRS score. This is in accordance with the study that moderate intensity aerobic exercises can improve pain threshold level and energy level, improve self-efficacy and physical self-concept, reduce depression and in turn decrease pain level by inducing release of endorphins into the bloodstream and also create a sense of euphoria (Ettinger et al, 1997).

The study shows a statistically significant improvement in TUG scores between Group 1 & 3 and Group 2 &3; however, no significant improvement was seen between Group 1 & 2. The finding is in accordance with the study that shows that aerobic exercises are beneficial for prevention of disability related to ADL and improves older person's functional independence (Penninx BW et al, 2001). Static cycling has been shown to facilitate improvement in aerobic fitness and promote specific strengthening in the lower limb musculature (Roddy E et al, 2005). A decrease in knee pain is related with the improvement in strength in the surrounding knee joint muscles and thus reduces disability.

The study shows a statistically significant improvement in KOOS symptom, Pain, performance in daily activity, KOOS performance in sport and recreation activity subscale in Group 1 and Group 2 as compared to Group 3 which do not shows any significant improvement. Regular moderate intensity aerobic exercise (examplestationary cycling) and education about joint protection technique has been recommended for prevention and management. Physical activity may break the vicious cycle of symptoms found in osteoarthritis patients including reduction of aerobic fitness, muscle flexibility, balance and proprioception, increased risk of depression, lack of self-confidence, decreasing functional capacity and independence level and development of risk factors for cardiovascular disease and comorbidities (Ettinger WH et al, 1997 and Brandt et al, 2008).

There was no statistically significant difference in NPRS, TUG, KOOS subscales (symptom, pain, function in daily activity, performance in sport and recreation and knee related quality of life) between Group 1 (Forward Pedaling) and Group 2 (Backward Pedaling). This suggest that both the pedaling direction are equally effective in decreasing pain and reducing disability and improving physical function performance in knee osteoarthritis patients. There are no extra benefits of forward and backward pedaling over one another, as well as no additional adverse effects of either of the pedaling direction.

Previous experimental studies have shown that muscles perform similar function during pedaling in either of the direction as the EMG timing was similar (Ting LH et al, 1999). In another study, pedaling simulations model were used to study mechanical energy analysis to identify how muscles generate, absorb or transfer energy during different pedaling direction. The results showed that muscle contributions to particular biomechanical functions during forward and backward pedalling remains largely same and did not change according to pedaling direction (Neptune RR et al, 2000).

Conclusion of the study was both forward and backward pedaling are effective in reducing pain and disability and improving functional performance in knee osteoarthritis. Also, there is no additional benefit or difference in the effect of either of the pedaling direction and both can be used for rehabilitation of knee osteoarthritis.

5. ACKNOWLEDGMENT

I would like to express my sincere gratitude to all the individuals who have contributed to the completion of this paper. Their valuable insights, support, and encouragement have played an instrumental role in shaping this work. Thank you for your invaluable contributions.

REFERENCES

Acheson, R. M., &Collart, A. B. (1975). New Haven survey of joint diseases. XVII. Relationship between some systemic characteristics and osteoarthrosis in a general population. Annals of the rheumatic diseases, 34(5), 379- 387.

Akeson, W. H., Amiel, D., & LaViolette, D. (1967). The connective-tissue response to immobility: a study of the chondroitin-4 and 6-sulfate and dermatansulfate changes in periarticular connective tissue of control and immobilized knees of dogs. Clinical orthopaedics and related research, 51, 183-198.

Alford, J. W., & Cole, B. J. (2005). Cartilage restoration, part 1 basic science, historical perspective, patient evaluation, and treatment options. The American journal of sports medicine, 33(2), 295-306.

American College of Sports Medicine. (2013). ACSM's guidelines for exercise testing and prescription. Lippincott Williams & Wilkins. Anderson, J. J., &Felson, D. T. (1988). Factors associated with osteoarthritis of the knee in the first national Health and

Nutrition Examination Survey (HANES I) evidence for an association with overweight, race, and physical demands of work. American journal of epidemiology, 128(1), 179-189.

Arnoldi, C. C., Linderholm, H., & Mussbichler, H. (1972). Venous engorgement and intraosseous hypertension in osteoarthritis of the hip.J Bone Joint Surg Br, 54(3), 409- 421.

Arokoski, J. P. A., Jurvelin, J. S., Väätäinen, U., &Helminen, H. J. (2000). Normal and pathological adaptations of articular cartilage to joint loading. Scandinavian journal of medicine & science in sports, 10(4), 186-198

Aspden, R.M., & Li, B. (1997). Mechanical and material properties of the subchondral bone plate from the femoral head of patients with osteoarthritis or osteoporosis. Ann Rheum Dis, 56, 247-254.

Badenhop, D. T., Cleary, P. A., Schaal, S. F., Fox, E. L., & Bartels, R. L. (1982). Physiological adjustments to higher-or lower-intensity exercise in elders. Medicine and science in sports and exercise, 15(6), 496-502.

Bohannon, R. W. (2006). Reference values for the timed up and go test: a descriptive meta-analysis. J GeriatrPhysTher, 29, 64-68.

Brandt, K. D., & Mankin, H. J. (1993). Pathogenesis of osteoarthritis. In W. N. Kelly (Ed.), Textbook of Rheumatology (pp. 1355-1373). Philadelphia, PA: W.B. Saunders.

Brandt, K. D., Dieppe, P., &Radin, E. L. (2008). Etiopathogenesis of osteoarthritis. Rheumatic Disease Clinics of North America, 34(3), 531-559.

Bressel, E., Heise, G. D., & Bachman, G. (1998). A neuromuscular and metabolic comparison between forward and reverse pedalling. Journal of Applied Biomechanics, 14, 401-411

Ericson, M. O., & Nisell, R. (1986). Tibiofemoral joint forces during ergometer cycling. *The American journal of sports medicine*, *14*(4), 285-290.

Ericson, M. O., & Nisell, R. (1987). Patellofemoral joint forces during ergometric cycling. *Physical Therapy*, *67*(9), 1365-1369.

Ettinger, W. H., Burns, R., Messier, S. P., Applegate, W., Rejeski, W. J., Morgan, T., ... & Craven, T. (1997). A randomized trial comparing aerobic exercise and resistance exercise with a health education program in older adults with knee osteoarthritis: the Fitness Arthritis and Seniors Trial (FAST). *Jama*, *277*(1), 25-31.

Ettinger, W. H., Burns, R., Messier, S. P., Applegate, W., Rejeski, W. J., Morgan, T., ... & Craven, T. (1997). A randomized trial comparing aerobic exercise and resistance exercise with a health education program in older adults with knee osteoarthritis: the Fitness Arthritis and Seniors Trial (FAST). *Jama*, *277*(1), 25-31.

Foster, V. L., Hume, G. J., Byrnes, W. C., Dickinson, A. L., & Chatfield, S. J. (1989). Endurance training for elderly women: moderate vs low intensity. *Journal of Gerontology*, *44*(6), M184-M188.

Gallasch, C. H., & Alexandre, N. M. C. (2007). The measurement of musculoskeletal pain intensity: a comparison of four methods. *Revista Gaúcha de Enfermagem*, *28*(2), 260-260.

Kisner, C., & Colby, L. A. (2007). Therapeutic exercises (5th ed.). Philadelphia, PA: F.A. Davis Company.

Kovar, P. A., Allegrante, J. P., MacKenzie, C. R., Peterson, M. G., Gutin, B., & Charlson, M. E. (1992). Supervised fitness walking in patients with osteoarthritis of the knee: a randomized, controlled trial. *Annals of internal medicine*, *116*(7), 529-534.

Majani, G., Giardini, A., & Scotti, A. (2005). Subjective impact of osteoarthritis flare-ups on patients' quality of life. *Health and quality of life outcomes*, *3*(1), 1-8.

Mangione, K. K., McCully, K., Gloviak, A., Lefebvre, I., Hofmann, M., & Craik, R. (1999). The effects of high-intensity and low-intensity cycle ergometry in older adults with knee osteoarthritis. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences*, *54*(4), M184-M190.

Minor, M. A., Webel, R. R., Kay, D. R., Hewett, J. E., & Anderson, S. K. (1989). Efficacy of physical conditioning exercise in patients with rheumatoid arthritis and osteoarthritis. *Arthritis & Rheumatism: Official Journal of the American College of Rheumatology*, *32*(11), 1396-1405.

Neptune, R. R., Kautz, S. A., & Zajac, F. E. (2000). Muscle contributions to specific biomechanical functions do not change in forward versus backward pedaling. *Journal of biomechanics*, *33*(2), 155-164.

Philbin, E. F., Groff, G. D., Ries, M. D., & Miller, T. E. (1995). Cardiovascular fitness and health in patients with end-stage osteoarthritis. *Arthritis & Rheumatism: Official Journal of the American College of Rheumatology*, *38*(6), 799-805.

Price, D. D., Bush, F. M., Long, S., & Harkins, S. W. (1994). A comparison of pain measurement characteristics of mechanical visual analogue and simple numerical rating scales. *Pain*, *56*(2), 217-226.

Radin, E., Paul, I., & Rose, R. (1972). Role of mechanical factors in pathogenesis of primary osteoarthritis. *The Lancet*, *299*(7749), 519-522.

Roddy, E., Zhang, W., & Doherty, M. (2005). Aerobic walking or strengthening exercise for osteoarthritis of the knee? A systematic review. *Annals of the rheumatic diseases*, *64*(4), 544-548.

Roos, E. M., & Lohmander, L. S. (2003). The Knee injury and Osteoarthritis Outcome Score (KOOS): from joint injury to osteoarthritis. *Health and quality of life outcomes*, *1*(1), 1-8.

Sheth, M. S., Thakkar, M., & Vyas, N. N. (2014). Effect of cycling versus treadmill walking on function and quality of life in patients with osteoarthritis of knee. *International Journal of Medical Science and Public Health*, *3*(11), 1393-1398.

Stratford, P. W., & Kennedy, D. M. (2006). Performance measures were necessary to obtain a complete picture of osteoarthritic patients. *Journal of clinical epidemiology*, *59*(2), 160-167.

Ting, L. H., Kautz, S. A., Brown, D. A., & Zajac, F. E. (1999). Phase reversal of biomechanical functions and muscle activity in backward pedaling. *Journal of Neurophysiology*, *81*(2), 544-551.