International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 8; Issue 11 (B); November 2019; Page No.20432-20435
DOI: http://dx.doi.org/10.24327/ijcar.2019.20435.3992

Research Article

EFFECT OF FORWARD WALKING, BACKWARD WALKING AND SIDE WALKING TRAINING PROGRAM ON GAIT SPEED AND PHYSIOLOGICALCOST INDEX IN ELDERLY POPULATION HAVING KNEE OSTEOARTHRITIS - EXPERIMENTAL STUDY

Ranveer Kumar Mahato[1], Lalli Singh[2] and Neeta J Vyas[3]

[1,2]Pioneer Physiotherapy College, Ajwa Nimeta Road Sayajipura, Vadodara. 390019
[3]IKDRC-ITS College Of Physiotherapy Medicity, Ahmedabad. 380016

A R T I C L E I N F O

Article History:
Received 4th August, 2019
Received in revised form 25th September, 2019
Accepted 23rd October, 2019
Published online 28th November, 2019

Key words:

Knee osteoarthritis, path mechanics, side walking, forward walking, backward walking, gait speed, physiological cost index.

A B S T R A C T

Background: There are studies suggesting effectiveness of walking on quadriceps muscle strength and pain in elderly population with knee osteoarthritis. Osteoarthritis leads to difficulty in walking which ultimately ends up in slow walking. The current study aimed to investigate the effect of different walking training exercises program on gait speed and physiological cost index in individuals with knee osteo arthritis.
Aim: The aim of this study was to assess the effectiveness of walking training program on gait speed and physiological cost index.
Method: Ninety six patients with primary diagnosis of knee osteoarthritis (grade 1- grade 2), aged 60 - 80years, were selected in the study as per the inclusion-exclusion criteria. Walking training program consists of forward walking, backward walking and side walking was taught to the Participants. They received 30 sessions, 5 days/week for a period of 6 weeks. Further the data obtained was compared for any change at baseline data and 6 weeks.
Results: Paired t test was used for analyzing the results. Our results showed statistical significant improvement in gait speed and physiological cost index.($p \leq 0.005$)
Conclusion: Walking training program is an effective adjunct to conventional treatment in increasing gait speed and physiological gait index in individuals with knee osteoarthritis.

INTRODUCTION

Osteoarthritis is among one of the common conditions affecting all sex, ages and races including high and low income countries. It has become the global cause of disability.[1,2]

The word "osteoarthritis" originated from the Greek word "osteo" meaning "of the bone", "arthro" meaning "joint", and "itis" meaning inflammation.[3]

OA is a non-inflammatory progressive disorder of movable joints, particularly weight bearing joints. American College of Rheumatology Diagnostic and Therapeutic Committee defined OA as "A heterogeneous group of conditions that lead to joint symptoms and signs which are associated with defective integrity of articular cartilage, in addition to relative changes in the underlying bone at the joint margins".[3,4]

Prevalence of knee osteoarthritis is more compared to any other joints in the body [5].Knee OA leads to terrible restriction in mobility whereas symptoms of knee OA includes pain, stiffness, joint enlargement, crepitus, muscle weakness, deformity, impaired proprioception, reduced joint motion, and disability[6]. This leads to deterioration of health-related quality of life.[5,6]

Gait speed is as important as sixth vital sign and it indicates about health status of an individual.[7]Literature suggests that slow gait speed is a significant independent risk factor for disability, hospitalization and mortality[8].However, there is always a decline in Gait Speed with aging in both men and women. Specifically, a decrease in gait speed of 0.1 m/s leads to 10% decrease in the ability to perform instrumental activities of daily living.[9] Potter *et al* found that elderlypeople with a gait speed of 0.25 m/s were more likely to be dependent in one or more activities of daily living. Moreover, slowed gait speed in the older adult populationhas been related to an increased risk for falls, which, in turn, often leads to a loss of independent living.[10] To evaluate the effectiveness of walking system assessment of the energy expenditure of walking is frequently performed.[9] MacGregor[9] was a person to introduce Physiological cost index which measures linear correlation between VO_2 and heart rate (HR) [10]. It just needs simply recording of HR at rest and while walking. Physiological Cost Index has been measured for patients with different locomotion disorders[11] and also in lower limb amputees walking with prosthesis[12].However, changes in heart rate can

Corresponding author:* **Ranveer Kumar Mahato
Pioneer Physiotherapy College, Ajwa Nimeta Road
Sayajipura, Vadodara. 390019

be referenced to gait speed, and this calculation provides the physiologic cost index (PCI; heart rate change divided by gait speed).[13, 14]Metabolic demand of walking is reflected by PCI. Walking is a closed kinetic chain exercise program which allows initiation of weight bearing and early mobilization in knee rehabilitation[15,16]. According to wallis *et al*[17] indicated that 70 min walking per week was safe, feasible, and tolerated by people with severe knee OA; however, longer walking-periods may exacerbate knee pain levels[17]. In contrast, worsening of OA-related symptoms after a walking program in person with knee OA was also reported [16,17]. Evaluation of the relationship between knee osteoarthritis and Gait speed is clinically meaningful. Thus, we hypothesized that a less intensive walking program such as forward walking, backward walking and side walking program could provide an additional benefit on gait speed. Therefore, the primary aim of the present study was to observe the effect of forward walking, backward walking and side walking training program on gait speed in individuals with knee OA. The secondary aims were to evaluate physiological cost index before and after walking training program in individuals with knee OA.

METHODS AND MATERIAL

The research design used for the study was experimental study. Participants received 30 sessions, 5 days per week for a period of 6 weeks. Each treatment session lasted for 45 minutes. Both male and female participants with a clinical diagnosis of unilateral or bilateral Osteoarthritis of Knee (grade 1 and grade2) satisfying the inclusion and exclusion criteria were selected for the study. The sample size was 96. Sample design was Simple Random Sampling.

The inclusion criteria for the study: Male and female geriatric participants clinically diagnosed with osteoarthritis of knee by Orthopaedician; Age more than 60 years; Participants having grade 1 and grade 2 as per Kellgren and Lawrence scale; The participants fulfilling clinical criteria listed by the American College of Rheumatology: knee pain and any three out of six: age > 50 years, morning stiffness lasting < 30 minutes, crepitus on active motion, bony tenderness, bony enlargement, no warmth on touch; Participants having knee pain for more than 6 weeks; Participants with unilateral or bilateral involvement of knee; Willingness to participate in the study.

The exclusion criteria for the study were: Participants with inflammatory joint disease of lower extremity, neurological disorder (motor and sensory loss), cardiac or metabolic condition; Participants involved in any form of physical exercise for lower extremity for at least 3 months; Participants taking pharmacological interventions; Participants taking an intra- articular injection for knee since last 6 months; Participants with history of recent surgery to hip, knee, ankle joint involving ligament, meniscus; Participants with balance problem. After receiving the ethical approval from the ethical committee, participants were screened and selected according to inclusion criteria. They were requested to participate in the study. The participants were briefed about the nature of study and the duration of intervention in the language best understood by them. All doubts and queries were cleared regarding the study, if any. An informed written consent form, previously approved by the Institutional Ethical Committee was then obtained from the participants. (annexure 1) .

Procedure for forward walking: 17-19 The participants initially were made to walk 5 steps forward, 4 steps backward and 4 steps sideways and were observed for any discomfort. If no discomfort then, participant was made to walk forward for 12 minutes per session. The participants were first familiarized with the forward walking on flat surface (distance 20meters) such that during forward walking, the heel strike the ground first instead of the toe. The participants received forward walking on flat surface (distance 20 meters) at their maximum pace. The session included 12 minutes of forward walking following 3 minutes of rest time. The therapist was walking besides the participant. The protocol followed was forward walking for 15 minutes, 5 days/ week for duration of 6 weeks.

Procedure for backward walking: 17-19. The participants were first familiarized with the backward walking on flat surface (distance 20meters) such that during backward walking, the toes strike the ground first instead of the heel. Practice session was made for backward walking with support of wall. The participants received backward walking on flat surface (distance 20 meters) at their maximum pace. The session included 12 minutes of backward walking following 3 minutes of rest time. The therapist was walking besides the participant. The protocol followed was backward walking for 15 minutes, 5 days/ week for duration of 6 weeks.

Procedure for side walking: Similarly the participants were first familiarized with the side walking on flat surface (distance 20meters) such that during side walking, the lateral arch of the foot touch the ground first instead of the heel. Practice session was made for side walking with support of wall. The participants received side walking on flat surface (distance 20 meters) at their maximum pace. The session included 12 minutes of side walking following 3 minutes of rest time. The therapist was walking besides the participant. The protocol followed was backward walking for 15 minutes, 5 days/ week for duration of 6 weeks.

Total 45 minutes of walking training program was given and the difference between baseline and post 6 weeks was noted.

RESULTS

Data analysis**:** Statistical analysis was performed on the data obtained from 96 patients. Data was analyzed using SPSS 20. Descriptive statistics for all outcome measures (gait speed and physiological cost index) were expressed as mean and standard deviations. Test of significance such as paired t test was used for comparing data within each group. Data was considered statistically significant with $p<0.05$.

Table 1

Individuals with knee OA No.of Participants	96	Mean (Age and Standard deviation). 70±3.64
Male	56	
Female	40	

The above table shows that, there were total 96 subjects between the age groups of 60 to 80 years whose mean age was 70.33 years. 56 Male and 40 female participated in the study.

Table 2

No. of participants	Gait speed Pre	Post	Physiological cost index Pre	Post
N= 96 X±SD	0.788±0.084	0.827±0.082	0.424±0.069	0.3860±0.067
▲	0.03896		0.03817	
P	0.001		0.001	

▲ X±SD = Mean and standard deviation
= Mean difference of pre-treatment and post-treatment

Above table shows there is a significant difference in gait speed and physiological cost index among individuals with knee osteoarthritis with $p<0.05$.

DISCUSSION

The purpose of the study was to determine the effects of walking training program, which includes forward -backward and side walking on gait speed and physiological cost index in individuals with knee osteoarthritis. The main objectives of the present study were to measure the effect of walking training program at baseline and post interventions among individuals with knee osteoarthritis.

Results of the present study showed that walking training program is effective in improving gait speed and physiological cost index in individuals with knee osteoarthritis.

There was a significant improvement in gait speed ($p<.0.05$) and physiological cost index($p<.0.05$) among individuals with knee osteoarthritis, moreover the gender based difference was also noted.

The improvement in gait speed in individuals with knee osteoarthritis can be because of kinematics and kinetics of walking program. Forward walking improves postural stability.[24],[25] Also it gives aerobic effect which promotes nutrition and remodeling without increasing stress in the affected joint. It helps in reduction of pain by releasing endorphins which gives analgesic effects thereby improving in gait speed.[25]Ahmd *et al* Concluded with the study that 6 weeks of retro and forward walking training helps in quadriceps strength and improving quality of life of an individuals.

During back-ward walking knee flexion during stance is more and during swing phase is less. Moreover, the eccentric activity of quadriceps muscles during backward walking is reduced at the knee joint; this is in turn leads to reduction of compressive force on knee joint. Thus pain reduces and as the pain reduces walking speed improves**.** Literature suggests that backward walking helps in increasing quadriceps strength which helps in reduction of patellofemaoral pain. Various studies is been done in understanding the role of backward walking in individuals with knee osteoarthritis. P Shankar *et al*, concluded that retro walking helps in improving womac index he added that retro walking helps in increasing the extension moment.[25-27]

Side walking causes the strengthening of gluteal muscles, hip abductors and all the major muscles of hips and thighs. Stability and flexibility is improved by side walking, even lateral abdominal muscles are recruited for stabilization of pelvis and spine.[28] This also becomes one of the factors for improving gait speed among individuals with knee osteoarthritis.

Regular walking exercises are beneficial, and it is recommended to reduce pain and disability in people with knee OA.[25,26,27]In contrast to it Toda *et al*[24] concluded a study suggesting worsening of knee symptoms due to walking program in individuals with knee osteoarthritis.[24]

The result of the study also shows significant difference in physiological cost index. The reduction in index was observed. In the present study, to estimate the energy expenditure physiological cost index was calculated on basis of gait speed and heart rate. As resting heart rate decreases with age, PCI has same range for all ages.[27,28,29]

Literature suggested that the PCI was a reasonable estimate of energy expenditure and it can be used to find out locomotors disability, and functional performance of the individuals.[28,29] Graham *et al* concluded that physiological cost index is influenced by pace of walking.[30-35] Physiological cost index increases in the person who has difficulty in ambulation. Generally it increases stress on cardiovascular system thereby increasing heart rate.[31,32] Walking at comfortable pace provides less stress on cardiovascular system. In this study walking training program was induced which ultimately trains the cardiovascular system and helps in reducing hear rate. Several studies supports our study finding, which says physiological cost index usually decreases with improvement in gait speed.[35]

CONCLUSION

On the basis of present study, it can be concluded that walking training program is a suitable adjunct to conventional physiotherapy treatment in increasing gait speed and physiological cost index in individuals with knee osteoarthritis.

Clinical implication

Osteoarthritis leads to disability. Walking is an activity which is hampered fast leading to slow gait speed. This study proves that walking training program that is forward walking backward walking and side walking helps in increasing gait speed, moreover walking is cost effective it doesn't need any specialist.

Thus, it helps in individuals with knee osteoarthritis to live less burden free life.

References

1. Zhou Y, Wang T, Hamilton JL, Chen D. Wnt/β‐catenin signaling in osteoarthritis and in other forms of arthritis. Curr Rheumatol Rep 2017; 19:53.
2. Chen D, Shen J, Zhao W, Wang T, Han L, Hamilton JL, *et al.* Osteoarthritis: Toward a comprehensive understanding of pathological mechanism. Bone Res 2017; 5:16044.
3. Arya R K, V Jain. Osteoarthritis of the knee joint: An overview. Journal, Indian Academic of Clinical Medicine.2013; 14 (2):154-162.
4. Symmons D, C Mathers, B P fleger. Global burden of osteoarthritis in the year 2000. Global burden of Disease. 2000
5. Neogi T. The epidemiology and impact of pain in osteoarthritis. Osteoarthr Cartil. 2013;21(9):1145-53.
6. van der Esch M, Knoop J, van der Leeden M, Roorda LD, Lems WF, Knol DL, *et al*. Clinical phenotypes in patients with knee osteoarthritis: a study in the Amsterdam osteoarthritis cohort. Osteoarthr Cartil. 2015;23(4):544-9.
7. Jönsson T, Ekvall Hansson E, Thorstensson CA, Eek F, Bergman P, Dahlberg LE. The effect of education and supervised exercise on physical activity, pain, quality of life and self-efficacy - an intervention study with a reference group. BMC Musculoskelet Disord. 2018;19(1):198.

8. Hurley M, Dickson K, Hallett R, Grant R, Hauari H, Walsh N, *et al*. Exercise interventions and patient beliefs for people with hip, knee or hip and knee osteoarthritis: a mixed method review. Cochrane Database Syst Rev. 2018;4:CD010842. https://doi.org/10.1002/14651858.CD010842.pub2.
9. Mac Gregor J. The evaluation of patient performance using long-term ambulatory monitoring technique in the domiciliary environment. Physiotherapy. 1981;67:30-33
10. Judge JO, Schechtman K, Cress E. The relationship betweenphysical performance measures and independence in instrumentalactivities of daily living. J Am Geriatr Soc. 1996;44:1332-1341.
11. Rogers ME, Rogers NL, Takeshima N, Islam MM. Methods to assessand improve the physical parameters associated with fall risk in olderadults. Prev Med. 2003;36:255-264.
12. Astrand PO, Rodahl K. 3rd Edition. New York: Mc-Graw-Hill; 1986. Textbook of Work Physiology.
13. Kavlak Y, Uygur F, Korkmaz C, Bek N. Outcome of orthoses intervention in the rheumatoid foot. Foot Ankle Int. 2003 Jun;24(6):494-499.
14. Danielsson A, Willén C, Sunnerhagen KS. Measurement of energy cost by the Physiological Cost Index in walking after stroke. Arch Phys Med Rehabil. 2007;88:1298-1303. [PubMed] [Google Scholar]
15. Raja K, Joseph B, Benjamin S, Minocha V, Rana B. Physiological cost index in cerebral palsy: its role in evaluating the efficiency of ambulation. J Pediatr Orthop. 2007 Mar;27(2):130-136.
16. Hachisuka K, Umezu Y, Ogata H, Ohmine S, Shinkoda K, Arizono H. Subjective evaluations and objective measurements of the ischial-ramal containment prosthesis. J Uoeh. 1999;21(2):107-118.
17. Jan MH, Tang PF, Lin JJ, Tseng SC, Lin YF, Lin DH. Efficacy of a targetmatching foot-stepping exercise on proprioception and function in patients with knee osteoarthritis. J Orthop Sports Phys Ther. 2008;38(1):19-25.
18. Ojoawo AO, Olaogun MO, Hassan MA. Comparative effects ofproprioceptive and isometric exercises on pain intensity and difficulty inpatients with knee osteoarthritis: a randomized control study. TechnolHealth Care. 2016;24(6):853-63.
19. Takacs J, Krowchuk NM, Garland SJ, Carpenter MG, Hunt MA. Dynamic balance training improves physical function in individuals with knee osteoarthritis: a pilot randomized controlled trial. Arch Phys Med Rehabil. 2017;98(8):1586-93
20. McAlindon TE, Bannuru RR, Sullivan MC, Arden NK, Berenbaum F, Bierma- Zeinstra SM, *et al*. OARSI guidelines for the non-surgical management of knee osteoarthritis. Osteoarthr Cartil. 2014;22(3):363-88.
21. Egan BA, Mentes JC. Benefits of physical activity for knee osteoarthritis: a brief review. J Gerontol Nurs. 2010;36(9):9-14.
22. Hochberg MC, Altman RD, April KT, Benkhalti M, Guyatt G, McGowan J, *et al*. American College of Rheumatology 2012 recommendations for the use of non-pharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. Arthritis Care Res. 2012;64(4):465-74.
23. Wallis JA, Webster KE, Levinger P, Singh PJ, Fong C, Taylor NF. The maximum tolerated dose of walking for people with severe osteoarthritis of the knee: a phase I trial. Osteoarthr Cartil. 2015;23:1285-93.
24. Toda Y. The effect of energy restriction, walking and exercise on lower extremity lean body mass in obese women with osteoarthritis of the knee. J Orthop Sci. 2001;6:148-54.
25. Shankar P, R M Bhandiwad R, P Hi. Effectiveness of retrowalking in chronic osteoarthritis of knee joint. Innovative Journal of Medical and Health Science.2013: 3 (1): 19-22.
26. Somashekar, R Raja, Sridharamurthy J, Timsina S, Jha V. A study to compare the effectiveness of transcutaneous electrical nerve stimulation with retrowalking versus ultrasound therapy with retrowalking in chronic osteoarthritis of knee. Journal of Evolution of Medical and Dental Science.2015; 4 (60): 10494- 10503
27. Vasoya R, Vikani R. Effect of retrowalking in osteoarthritis of knee. R K University.2015:1- 60.
28. Hu, h *et al* .control of lateral muscles in walking .Hum Mov Sci. 2012 Aug;31(4):880-96. doi: 10.1016/j.humov.2011.09.002. Epub 2011 Nov 26.
29. Butler p *et al*. physiological cost index walking of normal childrens and its use as an indicator for hanidcap. Dev Med Child Neurol. 1984 Oct;26(5):607-12
30. Jaiyesimi AO, Fashakin OG. Reliability of physiological cost index measurements. Afr J Med Med Sci. 2007;36:229-234.
31. Bailey MJ, Ratcliffe CM. Reliability of physiological costindex measurements in walking normal subjects using steadystate,non-steady-state and post-exercise heart rate recording. Physiotherapy. 1995;81:618-623.
32. Danielsson A, Willen C, Sunnerhagen KS. Measurement ofenergy cost by the physiological cost index in walking afterstroke. Arch Phys Med Rehabil. 2007;88:1298-1303.
33. Sienko Thomas, S., Moore, C., Kelp-Lenane, C., and Norris, C. Simulated gait patterns (the resulting effects on gait parameters, dynamic electromyography, joint moments and physiological cost index). Gait Posture. 1996; 4: 100-107
34. Boyd, R., Fatone, S., Rodda, J. *et al*. High- or low-technology measurements of energy expenditure in clinical gait analysis?. Dev Med Child Neurol. 1999; 41: 676-682
35. Jzerman, M.J. and Nene, A.V. Feasibility of the physiological cost index as an outcome measure for the assessment of energy expenditure during walking. Arch Phys Med Rehabil. 2002; 83: 1777-1782

****