The Effect of Two Selected Exercise Protocols alongside Attention Instructions on the Pain and Balance of Male Elderly Suffering Knee Osteoarthritis

Homa Pouradeli [a], Heydar Sadeghi [b,c*], Yahya Sokhangouei [d], Mohammad Ali Azarbayjani [e]

a Department of Sports Biomechanics, Faculty of Physical Education and Sport Sciences, Central Branch of Azad University, Tehran, Iran; **b** Department of Sport and Injury Biomechanics, Faculty of Physical Education and Sport Sciences, Kharazmi University, Tehran, Iran; **c** Department of Sport and Injury Biomechanics, Kinesiology Research Center, Kharazmi University, Tehran, Iran; **d** Department of Physiotherapy, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran; **e** Department of Sports Physiology, Central Branch of Azad University, Tehran, Iran

Corresponding Author:** Heydar Sadeghi, Department of Sport and Injury Biomechanics, Faculty of Physical Education and Sport Sciences, Kharazmi University, Tehran, Iran, ***E-mail: sadeghih@yahoo.com

Submitted: 2021-03-06; **Accepted**: 2021-06-03; **Doi:** https://doi.org/10.22037/jcpr.v6i3.32894

Abstract

Introduction: Despite numerous treatments, definitive treatment for osteoarthritis has not yet been found. However, due to the symptoms of osteoarthritis of the knee, the latest non-pharmacological therapies include reducing pain and weakness, improving range of motion, and facilitating performance in daily activities are on the rehabilitation protocols. The objective of this study was to investigate the effect of two selected training protocols on pain and balance in elderly men with knee osteoarthritis. **Materials and Methods:** In this semi-experimental study, 31 elderly men aged 60 to 80 years with knee osteoarthritis from the elderly center of Kerman were assigned into two groups including electrotherapy plus knee extensor exercise group and electrotherapy plus hip abductor exercise group. The individuals in each group were randomly divided into two subgroups: the external focus and the internal focus. The exercises were performed three times a week for eight weeks. To assess pain, a VAS scale, and to assess a static, dynamic and total balance, Romberg, TGUG, and TBT tests were used before and after the test, respectively. Analysis of covariance or ANCOVA at a significant level of 0.05 was used for statistical analysis of data considering the effect of focus of attention. **Results:** The results showed that there was a statistically significant difference between pre- and post-exercise in pain, static balance, dynamic balance, and total balance test, but there was no statistically significant difference between the two exercises group. There was no statistically significant difference between external and internal focus and there was no significant interaction between variables (P>0.05). **Conclusion:** According to the results of the research, strength training of the hip abductor muscles along with common treatments and attention-oriented guidelines can be recommended for pain management and improving the level of performance of the elderly with osteoarthritis of the knee.

Keywords: Attention instructions; Balance; Knee osteoarthritis; Pain; Strength Training

Please cite this paper as: Pouradeli H, Sadeghi H, Sokhangouei Y, Azarbayjani MA. The Effect of Two Selected Exercise Protocols alongside Attention Instructions on the Pain and Balance of Male Elderly Suffering Knee Osteoarthritis. J Clin Physio Res. 2021; 6(3): e39. Doi: https://doi.org/10.22037/jcpr.v6i3.32894

Introduction

Today, with the advances of different sciences and control of different diseases, human lifespan has increased, whereby a major part of the population of any country is claimed by the elderly, whose number is progressively increasing especially in developing countries. Nevertheless, due to the physiological conditions associated with the elderly period, the number of people suffering chronic diseases resulting from aging is increasing (1). Knee osteoarthritis is one of the most serious and common joint diseases in the elderly associated with pain and disability as well as decreased independence in doing routine life activities, thereby reducing the quality of life (2, 3). Epidemiological studies confirmed that symptoms of knee osteoarthritis in 40% of 65-year-old people or older can be observed(4). Accordingly, researchers have directed their attention to examine methods for coping with and treating this disease.

Knee osteoarthritis, due to pain and joint inflammation, has an inhibitory effect on contraction of knee muscles; over time, it causes atrophy of the muscles, diminished muscular power, and impaired normal patterns of gait or movement including walking. There is evidence suggesting that pain intensity in this disease is associated with the degree of knee muscle weakness and functional disorders of patients (5). Weak quadriceps muscle is one of the first symptoms of knee osteoarthritis which

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0). Downloaded from: http://journals.sbmu.ac.ir/ physiotherapy

alongside pain is one of the primary clinical symptoms. One of the most important strategies in those suffering from knee osteoarthritis for pain mitigation is reducing walking speed and increasing the hip internal moment in the middle and last phases of walking or lateral bending of the trunk. It is possible that the weakness of hip abductor muscles is the cause of this strategy (6). Three-dimensional analysis of some activities (such as squat on one leg or landing from jumping) have shown that the hip abductor muscles can play an effective role in controlling the movements of hip and knee in the frontal plane (7). Some studies have reported that reduced power of the hip abductor in those suffering knee osteoarthritis can occur, which may lead to increased hip adduction moment (8). Overloading knee during walking can be one of the causes of progression of knee osteoarthritis. It is reported that the hip abductor muscles may be involved in loading the knee joint through controlling the movements of trunk and hip in the frontal plane (9). Occurrence of pain alongside muscle weakness can increase imbalance and body oscillation, thereby predisposing the person to falling on the ground (10). Macrae *et al.* (11) believed that muscle weakness in the hip abductors, knee extensor and flexors, as well as ankle dorsi flexor is associated with the risk of falling. According to the American rheumatology Association and European rheumatologic society in 2000, proper physical activities involving improvement of the cardiovascular capacity, strengthening the muscles, and increasing the range of motion have been recommended for those with knee osteoarthritis to reduce pain and increase the muscle power (12).

With aging and decreased level of neuromuscular functions, identification of more detailed factors affecting people's performance becomes further important. One of these factors is focus of attention directed with instructions and feedbacks given to the performer. Attention is a neuropsychological pattern through which the central nervous system affects the information intake (13). Attention is also one of the most important constraints affecting human learning and performance, whose focalization is a method for enhancing its efficiency (14). The focus of attention can be internal (focus on body movements) or external (focus on the effects of motion in the environment or its consequences). Smoothness, consistency, accuracy, and quality of performing the skills and movements of a person largely depend on their focus of attention of the performer during implementation of the skill (15). The accuracy and quality of movements are heavily dependent on what the performer focuses on. It is claimed that the primary stages of any learning begin with attention. If attention is inadequate, the performance of the person will be impaired. Accordingly, since both the implementation and learning process are dependent on focus of the learner on the skill practice and how fast the skill is learned and maintained (16) and also considering the diminished attention among the elderly, selection of the type of focus of attention can also influence better performance and learning of new exercises in these individuals.

In spite of numerous treatment methods, no definite treatment has yet been found for this disease. Nevertheless, considering the abnormal symptoms of knee osteoarthritis, the treatment goals should involve mitigating pain and weakness, improving the range of motion, and facilitating performance in daily activities (12). Further, considering the diminished attention among the elderly, which seems to affect the learning and performance of exercises, the aim of this study was to examine the impact of two methods including electrotherapy and strength exercise of knee extensor and hip abductor muscles on pain and balance of elderly men suffering from knee osteoarthritis with emphasis on type of focus of attention.

Materials and Methods

The statistical population of this semi-experimental study, with a pre-and posttest design, consisted of elderly men suffering from knee osteoarthritis residing in elderly care centers of Kerman city. In order to determine the number of subjects, using G Power 3.1 software and considering statistical power 0.8 and effect size of 0.5 at alpha level 0.05, the sample size was obtained as 32 (one person passed away during the research and 31 completed their exercises). The subjects fulfilling the inclusion criteria were chosen through purposeful sampling method, and then randomly assigned into two electrotherapy plus knee extensor exercise group and electrotherapy plus hip abductor exercise group. Exercise group of electrotherapy and knee extensor exercises consisted of 16 subjects divided into two 8-person groups, 8 performed the exercises with external attention instruction and 8 with internal attention instructions. The electrotherapy and hip abductor exercise group consisted of 15 persons, divided into two groups, 8 and 7 in each, whereby 8 performed the exercises with external attention instructions and 7 with internal attention instructions. The inclusion criteria were at least three months of knee pain, average pain during walking larger than 3 according to visual analog scale (VAS), and suffering from grade 2-3 osteoarthritis according to Kellgern-Lawrence Grading. The exclusion criteria were knee surgery, intraradicular injection of corticosteroids over the past six months, history of neurological diseases, participation in exercise programs over the past six months, and use of oral corticosteroids within four weeks before initiating the research or suffering from mixed arthritis and rheumatoid arthritis (17-20).

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0). Downloaded from: http://journals.sbmu.ac.ir/ physiotherapy

Table 1. The exercise protocols used in the study

Group name	Type of exercise	Method
Knee extensor muscles strength training	Full knee extension in sitting position on a chair until 60° of flexion using Thera band	First four weeks: 2 sets, 10 reps, 5 s second four weeks: 3 sets, 10 reps, 10 s
	Full knee extension in sitting position on a chair plus ankle weight	First four weeks: 2 sets, 10 reps, 5 s second four weeks: 3 sets, 10 reps, 10 s
	Direct leg lifting in lying position until 30° flexion of hip plus ankle weight	First four weeks: 2 sets, 10 reps, 5 s second four weeks: 3 sets, 10 reps, 10 s
Hip abductor muscles strength training	Hip abduction exercise isometrically against the wall	2 sets, 10 reps, 5 s
	Hip abduction in standing position using Thera band	First four weeks: 3 sets, 10 reps, 5 s second four weeks: 3 sets, 10 reps, 10 s
	Hip abduction in lying position on one side plus ankle weight	First four weeks: 3 sets, 10 reps, 5 s second four weeks: 3 sets, 10 reps, 10 s

Table 2. The demographic characteristics of subjects

Variable	Group	Mean (SD)	No.	*P*-value
Height (cm)	Electrotherapy plus knee extensor exercise group	166.11 (2.23)	16	0.24
	Electrotherapy plus hip abductor exercise group	162.73 (1.74)	15	
Weight (kg)	Electrotherapy plus knee extensor exercise group	57.22 (2.77)	16	0.41
	Electrotherapy plus hip abductor exercise group	60.32 (2.52)	15	
Age (year)	Electrotherapy plus knee extensor exercise group	72.69 (1.04)	16	0.55
	Electrotherapy plus hip abductor exercise group	71.67 (1.39)	15	

After becoming familiar with the objective and process of the research, the subjects completed the written informed consent form as well as demographic questionnaire including age, weight, height, history of exercise, history of disease, history of any direct impact to the knee, and medications. The research protocol was approved by the motor sciences research Center of Kharazmi University with the ethics code of IR-PAK-1000-101.

For pain assessment, VAS was used, which characterizes the pain usually in the form of a 10-cm ruler, whereby the patient reports one point based on his/her emotion about the status of current pain. In order to investigate the static balance, Romberg test was used. For this test, the subjects stood on a flat surface with no shoes and with closed eyes, while the hands hanged alongside the body, and the ankles also attached to each other. The duration the subjects were be able to maintain this position was considered as their score. Every test was performed in three replications and with one minute of rest between each test run. In order to investigate dynamic balance, time to get up and go (TUG) test was utilized. This test involves some stages including getting up from the chair, traversing a 3-m distance, returning the 3-m path, and sitting on the chair. The duration which the subject was able to perform this test was considered as the score. This test was conducted in three replications and with 2-min rest interval between each test run. In order to evaluate the total balance, total balance test (TBT) was used. This test was performed in a rectangular 4*2m field. The subjects first traversed the path from the left side. They first sat on a chair with no armrest; when the test began at station 1, they got up the chair. The test had six stations and after this station, the test was finished. Thereafter, the subject traversed the second path, whereby after getting up off the chair, they traversed the previous path from end to the start and this time from the right side. In order to calculate the score, a chronometer was used. The test was performed three times with 2-min interval rests between each replication, and the best time recorded from every test was utilized (21). Throughout the entire time of running the tests, the tester remained close to the subjects in order to prevent their fall.

In both groups of electrotherapy and knee extensor exercises as well as the electrotherapy and hip abductor exercises, all subjects used transcutaneous electrical nerve stimulation (TENS) with 50-100 Hz frequency for 15 minutes (breast type) plus continuous ultrasound with frequency 3 MHz and intensity of 1.5 w/cm2 for 5 min around the knee joint by a physiotherapist. In the electrotherapy and knee extensor strength exercises, three exercises were included. The exercises related to the hip abductor were also three exercises presented in Table 1. Those in the electrotherapy and knee extensor exercises group were randomly divided into two subgroups of external focus of attention and internal focus of attention. In other words, half of the subjects of each group performed the exercise with internal focus instructions, and the other half performed the exercises with external attention instructions. In the internal attention group,

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0). Downloaded from: http://journals.sbmu.ac.ir/ physiotherapy

Table 3. The results of covariance for investigating the effects between the measured variables

Variable	Subgroups	Mean of squares	F-statistic	Significance level
Pain (VAS)	Between two exercise groups	0.46	0.11	0.74
	External and internal focus of attention	0.00	0.00	0.99
	Pre and post-exercise	60.11	14.45	0.00 *
	The interaction effect of type of exercise, focus of attention before and after measurement	0.50	0.12	0.94
Static balance (Romberg)	Between two exercise groups	160.03	1.33	0.26
	External and internal focus of attention	27.02	0.22	0.63
	Pre and post-exercise	60161.79	501.34	0.00*
	The interaction effect of type of exercise, focus of attention before and after measurement	204.75	1.70	0.19
Dynamic balance (TUG)	Between two exercise groups	0.11	0.01	0.89
	External and internal focus of attention	5.44	0.80	0.37
	Pre and post-exercise	1300.85	191.90	0.00*
	The interaction effect of type of exercise, focus of attention before and after measurement	1.95	0.28	0.83
Total balance test (TBT)	Between two exercise groups	48.71	0.60	0.44
	External and internal focus of attention	221.09	2.76	0.11
	Pre and post-exercise	33672.78	420.59	0.00*
	The interaction effect of type of exercise, focus of attention before and after measurement	108.86	1.36	0.27

before every run, sign information was presented with emphasis on the involved organ and attention to the muscle contraction. Throughout the entire exercise, the subject was asked to pay attention to contraction of muscles involved during their movement. In the external attention group, before every run, the sign information was presented with emphasis on external factors. For this purpose, the tester hold his hand as guide at the end of the range of motion, and was asked the subject to perform the movement while looking at the hand until reaching it and completion of movement. In the electrotherapy and hip abductor exercise group, the subjects were divided into two subgroups of external and internal focus of attention, and as with the electrotherapy plus knee extensor exercise group, the focus of attention instructions were given to both groups.

The exercises were performed for eight weeks and as three sessions per week (Table 1). In the early weeks, contraction was kept until 5 s. In the second four weeks, it was kept on to 10s. To prevent possible problems, exercises used in previous researches were employed (18, 22). In case of increasing pain and inflammation, the level of resistance, replications, or number of courses were reduced. For warming up and cooling down in the exercise sessions, static stretching was performed. The exercise was conducted in both groups on both legs. For the exercises requiring use of an ankle weight for both the knee extensor muscles and hip abductor muscles, the primary weight was calculated according to the 10 maximum repeats of the subject in order to determine the amount of weight that the elderly could use in exercise without fatigue,(23). After completing the eight weeks of the exercise period, posttest including re-examination of the level of pain and balance were performed on the subjects.

For data analysis, first quantitative variables were examined in terms of normality by Schapiro wilk test. For data analysis and investigating differences of pre-and post-values of desired indicators between the two exercise groups and considering the focus of attention, covariance or ANCOVA test, which is an integrated model of ANOVA was used at the significance level of 0.05.

Results

The mean and standard deviation of the demographic characteristics of the subjects are presented in Table 2. The results showed no significant difference between groups in the demographic variables. Based on the obtained results (Tables 3 and 4), there was a significant difference between the pre-and post-exercise values of pain, static balance, dynamic balance, and total balance of the subjects with decreased pain and increased balance in both groups.

On the other hand, no significant difference was observed between the two types of exercise including electrotherapy plus knee extensor exercises and electrotherapy plus hip abductor exercises regarding the examined variables. There was also no significant difference either between external and internal focus of attention, and no significant interaction effect was found between the variables (P>0.05).

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0). Downloaded from: http://journals.sbmu.ac.ir/ physiotherapy

Table 4. Mean and standard deviation of the research variables

Variable	Type of exercise	Focus of attention	Mean (SD)	No. of subjects
Pain (VAS)	Electrotherapy plus hip abductor exercise group	External	3.38 (2.38)	8
		Internal	2.25 (2.43)	8
	Electrotherapy plus knee extensor exercise group	External	3.25 (3.60)	8
		Internal	2.57 (2.44)	7
Static balance (Romberg)	Electrotherapy plus hip abductor exercise group	External	82.50 (41.87)	8
		Internal	58.25 (42.51)	8
	Electrotherapy plus knee extensor exercise group	External	71.50 (58.58)	8
		Internal	92.86 (61.18)	7
Dynamic balance (TUG)	Electrotherapy plus hip abductor exercise group	External	17.10 (7.53)	8
		Internal	19.69 (9.74)	8
	Electrotherapy plus knee extensor exercise group	External	17.61 (6.22)	8
		Internal	15.84 (7.59)	7
Total balance test (TBT)	Electrotherapy plus hip abductor exercise group	External	161.13 (26.53)	8
		Internal	165.62 (39.76)	8
	Electrotherapy plus knee extensor exercise group	External	165.88 (38.54)	8
		Internal	155.75 (40.98)	7

Discussion

Regarding the effect of electrotherapy as well as knee extensor muscle strength exercises with hip abductor on the pain and balance of elderly men suffering from knee osteoarthritis, the results showed that pain was decreased and balance was improved in all groups. Concerning the direct relationship between muscle power and maintaining balance, naturally it seems that resolving the problem of declare power could be effective to control balance (24). Since muscle weakness, lack of flexibility, diminished synergistic mechanisms of muscles as well as motor control problems in planning are involved in falling, a treatment exercise program can be an effective strategy to prevent falling. This is because it can lead to enhanced muscle power, flexibility, and movement control (24). Strengthening the lower limb muscles has extracted attention as an available treatment because of their role in reducing the knee pain as well as improving the performance in addition to their potential ability in reducing loads on the knee joint (19). The important issue in our study was attention to strengthening the hip abductor muscles. The muscles around the knee play an important role in absorbing shock and joint stability. The weakness of these muscles causes interference in the biomechanics of the knee joint and pain severity (25). There is evidence suggesting that pain intensity in this disease is directly associated with the extent of weakness of knee muscles and functional disorders of patients (5). Meanwhile, it seems that hip abductor muscles alongside other muscles especially knee extensor muscles can have an important role in osteoarthritis disease (10). Hip abductor muscles are important in controlling the hip and knee movements in the frontal plane (7, 26). Overloading on the knee joint during walking, because of weakness of the hip abductor muscles, can result in progression of knee osteoarthritis (27). The results of this research concurred with the findings of Braghin *et al.*, Colak *et al.*, and Bennell *et al.* (18, 28, 29). Further, in a research by Thorp *et al.* (8), they found that focus on the hip muscles, instead of only focus on the knee muscles, may be an effective biomechanical method in treating patients suffering from knee osteoarthritis. Across all of the above-mentioned studies, reduced pain and improved balance as well as performance were observed following the therapeutic exercise interventions. On the other hand, the results of this research were different from the findings of some other studies. For example, Sled *et al.* investigated the effect of eight weeks of strength training for abductor muscles on the power of hip abductor muscles, pain, and function in patients with knee osteoarthritis. They found no significant change in indicators of post intervention (9).

Further, our results showed that there was no significant difference between the strength exercises of knee extensor and hip abductor muscles in reducing the symptoms of disease, which was not in line with some other studies. In a study by Verma *et al.* (30), the effect of strengthening the hip abductor muscles and knee extensor muscles was evaluated on pain and performance of patients with knee osteoarthritis. It was found that among the evaluated factors such as pain and functioning, improvement was observed in both groups, and this improvement was greater in the hip abductor and knee extensor exercise group compared to the knee extensor group. The difference might be attributed to the fact that in the study by Verma *et al.* (30), the hip abductor group performed the exercises related to the quadriceps and the exercises were of

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0). Downloaded from: http://journals.sbmu.ac.ir/physiotherapy

mixed type. However, in the present study, the hip abductor exercises group only dealt with strengthening the hip abductor muscles. Possibly, for this reason, the knee extensor and hip abductor groups did not show significant differences. Therefore, use of mixed exercises may be more effective than employing only one type of exercise.

Our results also indicated that there was no significant difference in any of variables when comparing the internal and external focus of attention. Concerning the type of focus of attention. Sturmberg *et al.* conducted a review study on focus of attention and feedback regarding treatment of musculoskeletal problems. They stated that there was still no research directly accessing the effect of external and internal focus of attention on the pain and functioning of patients with musculoskeletal paints (31). It seems that this study is novel regarding use of focus of attention during performance of exercises. The findings of the present research were in line with the findings of Maxwell and Masters (32) regarding the superiority of the type of focus of attention. They examined the participants in a dynamic balance task with external and internal focus of attention conditions. Their resulted did not show advantages for external attention over internal attention. Then, they expected that by adding a second attention seeking task, a detrimental effect could occur on the internal focus of attention compared to the external one. However, implementation done by the two groups was not affected by the second task. They concluded that the balance task is relatively easy and may not have loading for attention resources to handle it (32). Meanwhile, some studies over the past decade have shown better effect of the external focus of attention against internal one on doing various movement or motor tasks, especially controlling the posture and balance (33, 34), which were in contrast to the findings of the present study. The difference may be attributed to the nature of the exercises given in this research. In other studies, the exercises were essentially balance exercises, whereas the exercises of present study were strength type and relatively easy. Possibly, in order to engage their focus of attention in this group of patients, more difficult and challenging exercises are required.

Since the elderly participating in this study were from those residing in elderly care home and almost inactive, one of the major limitations of the present study was that the exercises were relatively easy and less affected by their focus of attention instructions. Accordingly, it is suggested that a further research is conducted by benefiting from other exercises methods on active elderly suffering from knee osteoarthritis. The effectiveness of strength training on other lower limb muscles could also be evaluated in futurestudy.

Conclusion

Based on the results of the present study, it seems that strength exercises of the knee extensor muscles as well as strength exercises of the hip abductor muscles can be effective in improving the pain and balance of elderly men suffering from knee osteoarthritis. Among the exercise protocols in these patients, strengthening the hip abductor muscles can be notable. Possibly adoption of external focus of attention instructions during performance of exercises could be more effective than internal attention, though it requires further research. This can help therapists to benefit from both more traditional exercises and methods for treating knee osteoarthritis as well as other types of new exercises.

Acknowledgments

Hereby, we would like to appreciate the elderly who cooperated with us in this research. Further, we thank the unit of development of clinical research in Shafa hospital at Kerman University of medical sciences as well as Dr. Shiva Pouradeli for her kind consultation and cooperation in data analysis.

Conflict of interest:

None

Funding support:

None

Authors' contributions:

All authors made substantial contributions to the conception, design, analysis, and interpretation of data.

References

1. Khajavi D, Farrokhi A, Jaberi-Moghaddam A-A, Kazemnejad A. Effect of Strength and Balance Training Program on Maintaining Balance and Quality of Life in Older Male Adults With Fear of Fall. Salmand: Iranian Journal of Ageing. 2016;11(2):270-9.
2. Silverwood V, Blagojevic-Bucknall M, Jinks C, Jordan J, Protheroe J, Jordan K. Current evidence on risk factors for knee osteoarthritis in older adults: a systematic review and meta-analysis. Osteoarthritis and cartilage. 2015;23(4):507-15.
3. Shah Hosseini G, Negahban Siuki H, Madani S, Ebrahimi Takamjani E, Shaterzadeh M. Comparison of the effect of two therapeutic methods (traditional & new) on therapeutic parameters in patients with primary knee osteoarthritis. Razi Journal of Medical Sciences. 2004;10(37):735-41.
4. Lawrence RC, Felson DT, Helmick CG, Arnold LM, Choi H, Deyo RA, et al. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States: Part II. Arthritis & Rheumatism. 2008;58(1):26-35.

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0). Downloaded from: http://journals.sbmu.ac.ir/ physiotherapy

5. Simons M, Tawy G, Rowe P, Gleeson N, Biant L, editors. Correlation of muscle strength and gait stability in patients with end stage osteoarthritis. Combined Orthopaedic Knee Societies Meeting; 2017.
6. Hinman RS, Hunt MA, Creaby MW, Wrigley TV, McManus FJ, Bennell KL. Hip muscle weakness in individuals with medial knee osteoarthritis. Arthritis care & research. 2010;62(8):1190-3.
7. Pollard CD, Sigward SM, Powers CM. Gender differences in hip joint kinematics and kinetics during side-step cutting maneuver. Clinical Journal of Sport Medicine. 2007;17(1):38-42.
8. Thorp LE, Wimmer M, Foucher K, Sumner D, Shakoor N, Block J. The biomechanical effects of focused muscle training on medial knee loads in OA of the knee: a pilot, proof of concept study. J Musculoskelet Neuronal Interact. 2010;10(2):166-73.
9. Sled EA, Khoja L, Deluzio KJ, Olney SJ, Culham EG. Effect of a home program of hip abductor exercises on knee joint loading, strength, function, and pain in people with knee osteoarthritis: a clinical trial. Physical therapy. 2010;90(6):895-904.
10. McAlindon T, Cooper C, Kirwan J, Dieppe P. Knee pain and disability in the community. Rheumatology. 1992;31(3):189-92.
11. MacRae PG, Lacourse M, Moldavon R. Physical performance measures that predict faller status in community-dwelling older adults. Journal of Orthopaedic & Sports Physical Therapy. 1992;16(3):123-8.
12. Bosomworth NJ. Exercise and knee osteoarthritis: benefit or hazard? Canadian Family Physician. 2009;55(9):871-8.
13. Wulf G, Shea C, Lewthwaite R. Motor skill learning and performance: a review of influential factors. Medical education. 2010;44(1):75-84.
14. Wulf G. Attention and motor skill learning: Human Kinetics; 2007.
15. Peh SY-C, Chow JY, Davids K. Focus of attention and its impact on movement behaviour. Journal of science and medicine in sport. 2011;14(1):70-8.
16. Wulf G. Attentional focus and motor learning: a review of 15 years. International Review of sport and Exercise psychology. 2013;6(1):77-104.
17. Laufer Y, Shtraker H, Gabyzon ME. The effects of exercise and neuromuscular electrical stimulation in subjects with knee osteoarthritis: a 3-month follow-up study. Clinical interventions in aging. 2014;9:1153.
18. Bennell K, Hunt M, Wrigley T, Hunter D, McManus F, Hodges P, et al. Hip strengthening reduces symptoms but not knee load in people with medial knee osteoarthritis and varus malalignment: a randomised controlled trial. Osteoarthritis and Cartilage. 2010;18(5):621-8.
19. Bennell KL, Hunt MA, Wrigley TV, Hunter DJ, Hinman RS. The effects of hip muscle strengthening on knee load, pain, and function in people with knee osteoarthritis: a protocol for a randomised, single-blind controlled trial. BMC musculoskeletal disorders. 2007;8(1):1-9.
20. Pisters MF, Veenhof C, Van Meeteren NL, Ostelo RW, De Bakker DH, Schellevis FG, et al. Long-term effectiveness of exercise therapy in patients with osteoarthritis of the hip or knee: a systematic review. Arthritis care & research. 2007;57(7):1245-53.
21. H S, Kh M, H N. Sport biomechanics laboratory manual. Tehran: Hatmi press; 2015.
22. Bennell KL, Kyriakides M, Metcalf B, Egerton T, Wrigley TV, Hodges PW, et al. Neuromuscular versus quadriceps strengthening exercise in patients with medial knee osteoarthritis and varus malalignment: a randomized controlled trial. Arthritis & Rheumatology. 2014;66(4):950-9.
23. Yalfani A, Naderi E, Shayesterudi Y. Comparing the effectiveness of hydrotherapy and physiotherapy in the management of knee osteoarthritis. 36-328:(2)8;2012 .پژوهش در علوم توانبخشی.
24. Spirduso WW, Francis KL, MacRae PG. Physical dimensions of aging. 1995.
25. Fransen M, Crosbie J, Edmonds J. Physical therapy is effective for patients with osteoarthritis of the knee: a randomized controlled clinical trial. The Journal of rheumatology. 2001;28(1):156-64.
26. Jacobs CA, Uhl TL, Mattacola CG, Shapiro R, Rayens WS. Hip abductor function and lower extremity landing kinematics: sex differences. Journal of athletic training. 2007;42(1):76.
27. Miyazaki T, Wada M, Kawahara H, Sato M, Baba H, Shimada S. Dynamic load at baseline can predict radiographic disease progression in medial compartment knee osteoarthritis. Annals of the rheumatic diseases. 2002;61(7):617-22.
28. Braghin RdMB, Libardi EC, Junqueira C, Nogueira–Barbosa MH, de Abreu DCC. Exercise on balance and function for knee osteoarthritis: a randomized controlled trial. Journal of bodywork and movement therapies. 2018;22(1):76-82.
29. Çolak TK, Kavlak B, Aydoğdu O, Şahin E, Acar G, Demirbüken İ, et al. The effects of therapeutic exercises on pain, muscle strength, functional capacity, balance and hemodynamic parameters in knee osteoarthritis patients: a randomized controlled study of supervised versus home exercises. Rheumatology international. 2017;37(3):399-407.
30. Verma S, Agarwal S. The effect of hip abductors strengthening exercise on knee pain and function in people with knee osteoarthritis. Sports Medicine Journal/Medicina Sportivâ. 2013;9(2).
31. Sturmberg C, Marquez J, Heneghan N, Snodgrass S, van Vliet P. Attentional focus of feedback and instructions in the treatment of musculoskeletal dysfunction: a systematic review. Manual therapy. 2013;18(6):458-67.
32. Maxwell JP, Masters R. External versus internal focus instructions: Is the learner paying attention? International Journal of Applied Sports Sciences. 2002;14(2).
33. Chiviacowsky S, Wulf G, Ávila L. An external focus of attention enhances motor learning in children with intellectual disabilities. Journal of Intellectual Disability Research. 2013;57(7):627-34.
34. Polskaia N, Richer N, Dionne E, Lajoie Y. Continuous cognitive task promotes greater postural stability than an internal or external focus of attention. Gait & posture. 2015;41(2):454-8.

This open-access article distributed under the terms of the Creative Commons Attribution NonCommercial 3.0 License (CC BY-NC 3.0). Downloaded from: http://journals.sbmu.ac.ir/ physiotherapy