

The Effect of Concentric Resistance Exercise with Open-Closed Chain Stabilization on Capacity Change 6 Minute Walk Test in Osteoarthritis Patients

Andi Halimah¹, Tiar Erawan², Hendrik³

^{1,2&3}Department of Physiotherapy, Health Polytechnic of Ministry of Health in Makassar, Indonesia

Abstract

Osteoarthritis knee is a complaint of pain and stiffness in the knee joint when getting up early, especially when sitting to stand while starting to walk as well as up or down stairs. Generally, cause neuromuscular disorders adaptation when walking so that there is the functional pain walking. This study aimed to determine the effect of open-closed chain stabilization exercise with concentric resistance training on the ability change of 6-minute walk test in patients with osteoarthritis knee. This study was conducted at Pelamonia Hospital, Makassar. The type of this research was the quasi-experiment. The sample of osteoarthritis patients who met the criteria was obtained for 24 divided randomly into two groups: the group that was given the concentric resistance training and the group that was given the open-closed chain stabilization exercise to improve the capability of 6-minute walk test, so this research used pretest-posttest with control groups design. The paired t-test showed a significant difference ($p = 0.000$) with a 6-minute walk test before the concentric resistance test of 319.75 ± 11.226 m and after the concentric resistance exercise 409.17 ± 18.556 m. Similarly, the open-closed chain stabilization exercise showed a significant difference ($p = 0,000 < 0.05$) with a 6-minute walk test before exercise $331,33 \pm 35,328$ m and after practice $431,42 \pm 49,024$ m. The independent t-test showed no significant difference ($p = 0.163$) between the concentric resistance training and the open-closed chain stabilization exercise on the ability of 6-minute walk test of knee osteoarthritis patients. The conclusion of this study is that there is no difference in the effect of concentric resistance training with open-closed chain stabilization exercise on the ability of 6 minute walk test of knee osteoarthritis patient.

Keywords: Stabilization Training Open-Closed Chain, Concentric Resistance Training, 6 Minute Walk Test, Knee osteoarthritis.

I. INTRODUCTION

The prevalence of osteoarthritis (OA) knee also continues to increase dramatically with age. Several cross-sectional studies found that the presence of previous injuries on knee joint was significantly associated with the incidence of osteoarthritis knee (Muraki et al, 2013).

Osteoarthritis knee is a common condition that contributes primarily to physical disability. Severe pain during weight-bearing activities such as standing, walking and up and down stairs causes the occurrence of disability in osteoarthritis knee. Based on the results of research with WOMAC scale measurement showed that the average of measurement results showed below 50% (the existence of disability) (Creamer et al, 2000).

The results of observations of researchers at Pelamonia Hospital, Makassar found about 22 patients with osteoarthritis knee who visited the Physiotherapy Polyclinic in September to December 2015. Based on the observations of researchers found that in general people with osteoarthritis knee obstacles as activity goes on and even up and down activities stairs.

Several interventions can be implemented such as strengthening training programs, flexibility exercises, and stabilization exercises. The strengthening exercise program that is often applied to osteoarthritis knee patients in the practice area is the concentric manual resistance. This exercise technique can produce improved quadriceps and hamstring muscle performance resulting in decreased pain and functional improvement.

The open-closed chain stabilization exercise has had a major impact on the osteoarthritis knee case of proprioceptive improvement and joint stability. The open-close chain is a form of stabilization exercise that is non-supportive and weight-bearing, where the open chain involves only movement in one joint, while the closed chain uses more than one joint that moves on the body weight to impose on more than one muscle group working at the same time either agonist or antagonist and increases activation of the proprioceptive member motion down (Karandika et.al, 2011). The results of the study of Mei-Hwa et al (2014) showed that both weight bearing and no weight-bearing exercises resulted in significant improvements at the WOMAC scale but weight bearing exercises resulted in significantly greater improvements than non-weight bearing exercises.

II. METHODS

This research was conducted at Pelamonia Hospital, Makassar, Indonesia. The type of this research was quasi-experiment by using pretest-posttest with control groups design. This study aimed to determine the effect of open-closed chain stabilization exercise with concentric resistant exercise on the ability of 6-minutes walk test in osteoarthritis patients. Measurements were made before and after an open-closed chain exercise and concentric resistance training was performed on the patient's osteoarthritis walking ability for 6 minutes.

The population of this research was osteoarthritis patients who visited at Physiotherapy Polyclinic of Pelamonia Hospital, Makassar, Indonesia that meets the criteria of the examination results shows constant knee pain (limited morning stiffness), the results of the radiological examination showed grade 2 and 3 osteoarthritis knee, not overweight, no lung and heart problems, aged 45-65 years and no contraindications for both forms of exercise. Samples of osteoarthritis patients who met the criteria obtained by using the formula of the sample, then selected by simple random sampling technique, so that the sample size of 24 people.

The data were obtained from the measurement of 6 minutes walk test ability in osteoarthritis patients in both groups (open-closed chain stabilization training group and treatment of concentric resistant training exercises). Both groups performed measurements before and after treatment of open-closed chain stabilization and concentric resistant training with the duration of contraction of 8-10 seconds, repetition of movement 3 times with the amount of therapy 10 times.

The training procedure was as follows:

1. Concentric resistance training

Patient position crook lying on her/his stomach, physiotherapist standing beside the patient. One hand therapist protected the patient's lower leg through the popliteal fossa and the other hand above the distal portion of the lower leg (as a manual prisoner). The patient was asked to move the knee joint towards flexion while the therapist's hands provide concentric resistance, then the patient was asked to move the knee joint towards the extension while the therapist's hand provides concentric resistance. For a prone sleeping position, one hand therapist above the distal portion of the lower leg, then the patient was asked to move the knee joint towards flexion while the therapist's hands provide concentric resistance, and the patient was asked to move the knee joint towards the extension while the therapist's hand provides concentric resistance. Duration of contraction 8-10 seconds, repetition of movement as much as 3 times each muscle with the amount of therapy as much as 10 times.

2. Open-closed chain stabilization exercises

a. Open chain

The patient sat on the bed with his legs dangling on his back with a sore leg dangling beside the bed, physiotherapist: standing next to the patient's bed with one hand on the anterior part of the knee joint and the other hand on the anterior distal portion of the lower leg. The patient's knee joint was positioned flexion of 45°, 30°, and extension 0°. In each position, the isometric contraction was applied to the quadriceps and hamstring muscles by means of the therapist's hand pushing down while the patient maintains the knee joint position (for quadriceps) and pushed up while the patient maintains the knee joint position (for hamstring). Duration of contraction 8-10 seconds, repetition of movement as much as 3 times each muscle with the amount of therapy as much as 10 times.

b. Closed chain

Patient crook lying and sitting on the bed with one leg pain that rests while the healthy leg does not support, the physiotherapist stood beside the patient's bed. Then, while raising the patient's ass was required to lift the healthy leg straight ahead and remain bridging, while the therapist's hands provided a boost in the proximal tibia of the patient towards the medial-lateral and the patient attempts to resist the impulse, maintained for 8-10 seconds, repeated 3 times with the number of therapies 10 times.

The data obtained by normality test. Normality test results obtained normal data, so proceed with the parametric test. To analyze the treatment group data before and after the open-closed chain stabilization training and the concentric resistance training were used paired t-test and to compare between the two exercise groups used independent t-test.

III. RESULTS

Characteristics of the sample consisted of age and sex characteristics. The results of the descriptive analysis showed an average age score of 47.92 ± 6.23 years for the concentric resistance training group and the value of 51.33 ± 4.397 years for the open-closed chain stabilization training group. This shows that the average subject belongs to old age, both in the concentric resistance training group and the open-closed chain stabilization group. On the gender characteristics were male subjects as much as 5 people (41.7%) and female subjects as much as 7

people (58.3%) for group of concentric resistance training and got men subject as many as 4 people (33.3%) And female subjects as many as 8 people (66.7%) for the open-closed chain stabilization group.

Table 1 shows the 6-minute walk test capability before and after the concentric resistance training was given for the duration of the contraction of 8-10 seconds, repetition of movement 3 times each muscle with the amount of therapy as much as 10 times.

Tabel 1. Comparison of Capacity Values 6 Minute Walk Test Before and After Given Concentric Resistance Training

Concentric Resistance Training				The difference of mean		t	p
Before		After		Mean (m)	SD (m)		
Mean (m)	SD (m)	Mean (m)	SD (m)			Mean (m)	SD (m)
319.75	11.226	409.17	18.556	89.42	14.003	-22.12	0.000

The result of Paired t-test showed the ability of 6 minutes walk test before given the concentric resistance training of 319.75 + 11.226 m and the value after given concentric resistant training equal to 409.17 + 18.556 m with difference of 89.42 + 14.003 m at t-value of -22.12 with a significant level of 0.000 (p-value <0.05), which means that there was a significant difference in the effect of a 6 minute walk test capability before and after given concentric resistance training. Thus it could be concluded that the provision of concentric resistance training can improve the ability of a 6-minute walk test for knee osteoarthritis patients.

Table 2 shows a 6-minute walk test capability before and after an open-closed chain stabilization exercise was performed on a duration of contraction of 8 to 10 seconds, repetition of movement 3 times each muscle with the number of therapies 10 times.

Table 2. Comparison of Capacity 6 Minutes Walk Test Before and After Given Open-closed Chain Stabilization Training

Open-closed Chain Stabilization Training				The difference of mean		t	p
Before		After		Mean (m)	SD (m)		
Mean (m)	SD (m)	Mean (m)	SD (m)			Mean (m)	SD (m)
331.33	35.328	431.42	49.024	100.08	18.633	-18.61	0.000

The result of Paired t-test shows the ability of 6 minutes walk test before the open-closed chain stabilization training was 331.33 + 35.328 m and the value after the open-closed chain stabilization training was 431.42 + 49.024 m with difference of mean equal to 100.08 + 18.633 m at t-value equal to -18.61 with significant level equal to 0.000 (p-value <0.05), which means that there was a significant effect difference of 6 minutes walk test capability before and after the open-closed chain stabilization exercise. Thus it could be concluded that the provision of open-closed chain stabilization exercise can improve the ability of 6 minutes walk test of patients with osteoarthritis of the knee.

Table 3 shows a comparison of 6-minute walk test capability between groups after exercise on a duration of contraction of 8 to 10 seconds, repetition of movement 3 times each muscle with the therapeutic amount of 10 times. Measurements were made to compare the 6-minute walk test capability between groups given concentric resistance training with the group given the open-closed chain stabilization exercise.

Table 3. Comparison of Capacity Values 6-Minutes Walk Test Between Group Resistance Concentric Training With Group Open-closed Chain Training

Type of exercise				T	p
Resistance Consentric		Open-closed Chain			
Mean (m)	SD (m)	Mean (m)	SD (m)		
409.17	18.556	431.42	49.024	1.470	0.163

The result of independent t-test was obtained by the ability of 6 minutes walk test after given concentric resistant training equal to 409.17 + 18.556 m and the value after given open-closed chain stabilization practice equal to 431.42 + 49.024 m at t value equal to 1.470 with significant level 0.163 (p-value >0.05). This shows no significant difference in effect between the concentric resistance training group and the open-closed chain stabilization

exercise on increasing ability 6-minute walk test of osteoarthritis knee joint. When viewed from the average value of the increase between the two groups, the average increase of open-closed chain stabilization training group is higher that is $100.08 + 18.633$ m compared to the average increase in concentric resistance training group that was $89.42 + 14.003$ m. Thus it could be concluded that the open-closed chain stabilization training is better than concentric resistance training on the improvement of 6 Minute Walk Test. For more details can be seen in Figure 1.

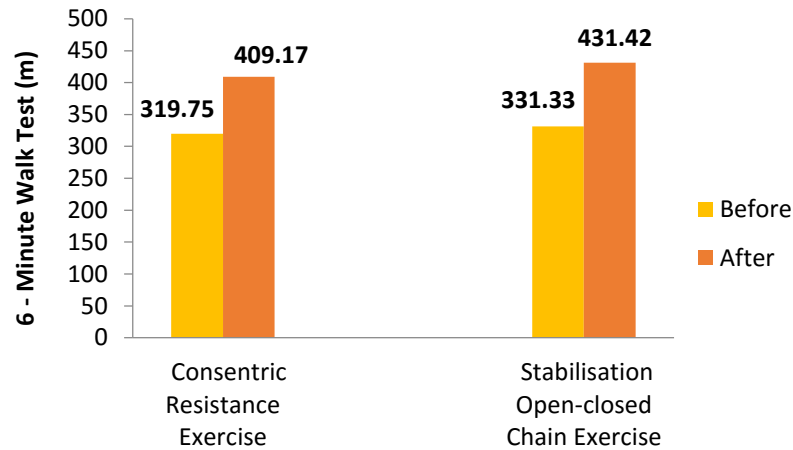


Figure 1. Comparison of capabilities 6-Minute Walk Test Between Concentric Resistance Exercise and Open-closed Chain Exercise

IV. DISCUSSION

The results of the analysis that the average subject belongs to old age both in concentric resistance training group and open-closed chain stabilization training group. It shows that subjects have osteoarthritis. This opinion is in line with WHO data which states that knee joint osteoarthritis attacks at the age between 45 - 64 years reaching 30% and the percentage has increased along with age. Most osteoarthritis is aged between 45-60 years and osteoarthritis disease is a chronic degenerative joint disease that generally attacks in the elderly group (Thomson, 1991; Saltri, 2008). For gender characteristics, most subjects were female, although both were equally likely to develop osteoarthritis. But the increasing age of the incident more attacking women. The statement is in line with Shield (2005) which states that before entering the age of 45 years osteoarthritis is more common in men and after age 55 years, this condition is more common in women. Furthermore, it is said that both men and women can be exposed to osteoarthritis with different distribution patterns.

Based on the data analysis, there was a difference of 6-minute walk test ability before and after given concentric resistance training on the duration of contraction 8-10 seconds, repetition movement 3 times each muscle with the amount of therapy 10 times. The occurrence of such differences can be explained that the practice of resistance with high intensity or concentric resistance shows great benefits to the improvement of the functional ability of knee (Mei-Hwa et al, 2009). Concentric resistance training is part of a muscle strength training program that uses manual resistance from physiotherapists. Large manual resistance can activate the strength of quadriceps femoris muscle because overload resistance can stimulate muscle strength improvement (Kisner and Colby, 2012). Research result Angela, et al. (2008) shows that resistance training can improve muscle strength and physical function with respect to the duration of walking. Nevertheless, the effect is only on improving muscle strength but not stimulating the improvement of proprioception or neuromuscular adaptation optimally during walking. Thus it can be concluded that concentric resistance training may affect the ability of a 6-minute walk test for osteoarthritis joints of the knee joint.

Based on the data analysis, there was a difference of 6-minutes walk test ability before and after being given open-closed chain stabilization training on the duration of contraction of 8-10 seconds, repetition movement 3 times each muscle with the amount of therapy 10 times. The occurrence of these differences can be explained that osteoarthritis knee joint generally occurs in the medial osteoarthritis knee which causes neuromuscular disorders adaptation when walking so that there is the functional pain walking. Neuromuscular control relies heavily on sensory feedback that affects the response to changes in external demands, whereas the normal response during movement and muscle activation patterns is to adapt to repetitive disorders. Patients with osteoarthritis knee have complaints of motion pain, quadriceps muscle weakness, and neuromuscular control disorders that may affect

external disorders (Deepak, et al., 2014). The open-closed chain stabilization exercise can improve the neuromuscular control system in addition to increasing muscle strength (Mei-Hwa et al, 2009). Similarly, the closed chain stabilization exercise has an effect on the ability of walk test because this stabilization exercise gives functional effect because there is a normal physiological load through the frame system, Synergistic muscle contractions and the use of normal proprioceptive feedback mechanisms (Susan, et al., 1996). Thus it can be concluded that the open-closed chain stabilization exercise has an effect on the ability of 6 minutes walk test of osteoarthritis patients knee joint.

Based on the data analysis, there was no significant difference in the 6-minute walk test between groups given concentric resistance training with the group given the open-closed chain stabilization exercise on the duration of the contraction of 8-10 seconds, repetition of movement 3 times each muscle with the amount of therapy 10 times. The mechanism of occurrence can be explained that concentric resistance training and open-closed chain stabilization exercises can increase muscle strength due to the effect of resistance on muscle load, So the muscles undergo the process of physiological adaptation and muscle strength is also influenced by factors such as anatomical and physiological types of skeletal muscle fibers, big skeletal muscle, the number of cross bridges involved. Physiological biochemical aspect is energy metabolism system especially anaerobic metabolism. Kinesiological biomechanical aspects such as joint angle, strength, the interaction of position between body parts with the overall style mechanics system (Kumar, 2004; Park & Sheng, 2007; Fox, 2011). Concentric resistance training also plays a role in improving muscle weakness and the limitation of activity that is influenced by biomechanical factors that play a role in knee joint stability (Knoop, et al., 2013). Thus both concentric resistance training and open-closed chain stabilization may effect the ability of a 6-minute walk test for osteoarthritis joints of the knee joint. But when viewed on the average difference in a 6-minute walkthrough test for knee joint osteoarthritis patients, it showed greater open-closed chain stabilization exercises than concentric resistance training. This happens because the open-closed chain stabilization exercise has a greater effect on the sensory activation of tendons, ligaments, capsules, and muscles so that proprioceptors in joints and muscles are more optimal (Edwin, et al., 1993)

V. CONCLUSION

Based on the results of the study can be concluded there is a difference of ability 6 minutes walk test before and after the provision of concentric resistance training and stabilization of open-closed chain. There was no difference in the effect of concentric resistance training and open-closed chain stabilization exercises on the improvement of a 6-minute walk test for osteoarthritis of the knee joint. However, given the difference in average, the practice of open-closed chain stabilization is greater than that of concentric resistance training on the improvement of a 6-minute walk test ability of knee joint osteoarthritis patients.

ACKNOWLEDGEMENTS

Thank you to the Director of Health Polytechnic of Ministry of Health in Makassar who has given an opportunity to the researcher to carry out the research. Acknowledgments are also conveyed to the Director of Pelamonia Hospital, Makassar who has been licensed to conduct research and osteoarthritis patients who have been willing to be the subject of this research.

REFERENCES

1. Angela, K. L., Benedicte, V., Maria, A. F. S. 2008. Strength Training for Treatment of Osteoarthritis of the Knee: A Systematic Review. *Arthritis Care & Research*. Vol. 59, No. 10; Page 1488–1494.
2. Creamer, P., Lethbridge-Cejku, M., Hochberg, M.C. 2000. Factors associate with functional impairment in symptomatic knee osteoarthritis. *Journal of Rheumatology*: Vol.39; pp 490 – 496.
3. Deepak, K., Charles, B. S., Darcy S. R., Katharine S. R. 2014. Individuals with medial knee osteoarthritis show neuromuscular adaptation when perturbed during walking despite functional and structural impairments. *Journal of Applied Physiology*. Vol. 116, pp. 13 – 23.
4. Edwin, Pitney, Kane, Cappaert, 1993, The Role of Limb Torque Muscle Action and Proprioception During Closed Kinetic Chain Rehabilitation of The Lower Extremity. *Journal of Athletic Training*, Vol. 1, pp. 10 – 19.
5. Fox, 2011. *Human Physiology*, 8th ed, MC Graw Hill, New York, pp. 10 – 11, 360 – 377.
6. Karandika, N., Ortiz-Vargas, O.O. 2011. Kinetic chain: a review of the concept and its clinical applications. *America. The American Academy of Physical Medicine and Rehabilitation*. Volume 3:739-745.
7. Kisner, C., Colby, L.A. 2012. *Therapeutic Exercise Foundation and Techniques*. Sixth Edition. Philadelphia: F.A. Davis Company.

8. Knoop, Dekker, Leiden, Esch, Thorstensson, 2013. Knee Joint Stabilization Therapy in Patient With Osteoarthritis of the Knee: a Randomized, Controlled Trial. *Osteoarthritis and Cartilage Journal*, Vol. 21, pp. 1025 – 1034.
9. Kumar, 2004. *Muscle Strength*, CRC Press, New York. pp. 45 – 5, 394 – 396.
10. Mei-Hwa, J., Chien-Ho, L., Yeong-Eu, L., Jiu-Jeni L., Da-Hon L. 2009. Effects of Weight-Bearing Versus Nonweight-Bearing Exercise on Function, Walking Speed, and Position Sense in Participants With Knee Osteoarthritis: A Randomized Controlled Trial. *Journal of ArchPhysio Med Rehabil*, Vol. 90
11. Muraki, S., Tanaka, S., Yoshimura, N. 2013. Epidemiology of knee osteoarthritis. *Journal of Sports Medicine*, Vol. 21; pp. 1 – 6.
12. Notoatmodjo, S., 2000, *Health Research Methodology*, Third ed, PT. Rineka Cipta, Jakarta.
13. Nugroho, H. S. W., 2014. *Analisis Data Secara Deskriptif untuk Data Numerik*. Ponorogo: Forum Ilmiah Kesehatan (Forikes).
14. Park, Leonard, Sheng Li, 2007. Perception of Finger Forces Within the Hand After Index Finger Fatiguing Exercise. *Journal Experimental Brain Research*, vol.182, no. 2, pp. 169–177.
15. Saltri P, 2008. *Study of Osteoarthritis Patients in General Hospital of Wahidin Sudirohusodo Makassar*, Thesis, Department of Physiotherapy, Health Polytechnic Makassar
16. Shield, 2005. *Osteoarthritis (Degenerative Arthritis)*, [www://www.arc.org.uk/auth info](http://www.arc.org.uk/authinfo), <access at May 7, 2017>
17. Susan, Doucette, Douglas, Child, 1996. The Effect of Open and Closed Chain Exercise and Knee Joint Position on Patellar Tracking in Lateral Patellar Compression Syndrome. *Journal of Orthopaedic and Sports Physical Therapy*, Vol. 23, No. 2, pp. 104 – 110.
18. Thomson, et. al., 1991, *Tidy's Physiotherapy*, 12th ed., Butterworth-Heinemann, Oxford.