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Effectiveness ofIsotonic Pelvic AbductorExercise onKnee Osteoarthritis

Running head:Abductor isotonic on Knee Osteoarthritis

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ABSTRACT*---*Background, *Osteoarthritis (OA) is the disorder with a high prevalence of sufferers that affects joints in knees. Abdominal abductor strengthening exercises in quadriceps and hamstring muscle can reduce dynamic loading on the medial side of the knee. Besides that, the addition of isotonic quadriceps femoral muscle and pelvic joint abductor muscles is considered to have effectiveness in reducing pain perception.*

Objectives: *This study aim to know the effect of additional isotonic exercises of femoral quadriceps through pain perception improvement, increasefemoral quadriceps strength, and increase physical function of patient with knee osteoarthritis (OA).*

Methods: *The sample size was 20 knee OA patients. Subjects were randomly divided to isotonicexercise of femoral quadriceps plus isotonic exercise of hip abductor group and the isotonic exercise of femoral quadriceps only group. The assessment and measurement were conducted in the pain perception of Visual Analog Scale (VAS), the strengthen of quadriceps femoral muscle (1 RM) and functional physic status of Western Ontario and McMaster Universities (WOMAC) Scale. This analysis was conducted used Mann Whitney test with SPSS software.*

Results*: The intervention group improved their perceived pain symptoms, decreasedstiffness subscale, and increased of physical function subscale of WOMAC (all $p<0.05$). The femoral quadriceps strength and pain subscale of WOMAC were improved in both groups ($p=0.0001$).*

Conclusions*: Isotonic exercise suplementation of hip abductor to isotonic exercise offemoralquadriceps provided additional benefits with respect to the perceived pain symptoms, decrease stiffness and increase physical function of patients with knee OA after three weeks of treatment.*

Keywords---*Osteoarthritis, Isotonic Joint Abductor, Isotonic Femoral Quadriceps*

I. INTRODUCTION

The American College of Rheumatology defines osteoarthritis (OA) as a heterogeneous condition that rises signs and symptoms in joints associated with the destruction of the articular cartilage joints integrity[1,2]. The prevalence of knee OA in Indonesia is quite high, reaching 15.5% in males and 12.7% in females [3]. Data of Medical Rehabilitation Installation of Dr Soetomo Teaching Hospital Surabaya during May 1, 2011 to April 30, 2012 showed the visit number of knee OA patients as many as 5640 patients (24.64%).

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Knee OA patientsusually have pain in knee joints thus the patient limits their movement and activities, especially in terms of walking, climbing stairs, rising from the chair and stand [2]. Muscle weakness in knee OA patients caused by pain and atrophy due to lack activity resulting in functional limitations in knee OA patients. A study reported that OA patients had significantly decreased muscle strength in the knee and hip joints. A study concluded that knee extensor muscle strength of knee OA patients was reduced by 20-40% and hip muscle strength was reduced by 16-27% compared to healthy group[4,5].

The knee endured 3-7 times of body weight during everyday activities. The medial side of the knee received 50% greater loadthan the lateral side causing the knee to have adduction momentum at stand and ambulation. This explains why 90% knee arthritis begins in the medial compartment[6]. Progressive cartilage damage and narrowed joint cracks in the medial compartment resultedVarusthus the distance between the knee and the vector ground reaction force increases [4,7]. External Knee Adduction Moment (KAM) is used as a load measure on the medial tibiofemoral joint indirectly because it is difficult to measure knee load directly. In the knee OA patient, it is proven that the higher KAM at standing position, the faster the increased damage of articular cartilage [8].

Knee OA patients experienced decreased walking speed, shortened stride length and shortened stance phase [9]. Knee OA patients tended to walk with the body tilted laterally on lower motion of sick sideas a mechanism of compensation done by the patient to reduce external Hip Adduction Moment (HAM). This condition was the result of abductor muscles weakness of the hip joint and if it was not corrected, the contralateral side pelvis would fall on the frontal area during the stance phase thus the external joint moment increases, the ground reaction force shifted to medial thus increasing the lever arm of the Varus torque.Therefore it is needed to reduce load on the medial side of knee, in order to reduce the progress of knee OA[7].

Quadriceps muscle plays a role in patellar movement through femoral intercondylar sulcus. Patella twists in an intercondylar sulcus during flexion and extension movements.The shifting path of the patellar movement increases the stress on the patellofemoral joint that triggers arthritis. Conventionally, the exercise regimen for knee OA is focused on strengthening quadriceps and hamstring muscles because the function of these muscles was to stabilize the knee joint.But this strategy alone does not seem enough to alter the biomechanics around the knee joint. Quadriceps and hamstring muscles primarily work on the sagittal plane and have little effect on the frontal plane required to neutralize varus torque and move the load from the medial compartment to the lateral [10].

A study compared hip joint strength in osteoarthritis group and healthy control group, concluded that there was a presence of pelvic joint muscles weakness in patients with knee OA and supported pelvic muscle strength exercise in the management of OA rehabilitation [11]. Another study of biomechanical effects of isometric and isokinetic exercises of quadriceps and hamstring muscles in knee OA patients with pelvic abductor muscle strengthening as addition of quadriceps and hamstring strengthening could reduce the dynamic loading on the medial side of the knee [10].

Based on the above information, the researchers wanted to observe the effectiveness of the addition of isotonic exercise of pelvic abductor muscle to decrease pain perception measured by Visual Analog Scale (VAS), increase of femoral quadriceps muscle strength by 1 MR rate and physical function status improvement measured with Western Ontario and McMaster Universities (WOMAC) index in patients with knee OA.

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II. METHODS

This was an experimental research (randomized pretest and posttest control group design). This research was conducted on January 2013 until complete in Medical Rehabilitation Unit of Dr. Soetomo Surabaya. The samples were new knee OA patients based on clinical symptoms and radiological examinations that met inclusion criteria and did not meet exclusion criteria. The sampling technique was consecutive sampling method and then randomized by lottery.

The inclusion criteria were new or old knee OA patients who met the clinical and radiological criteria according to American College of Rheumatology with degrees 2-3 according to the radiological criteria of Kellgren & Lawrence,able to do independent ambulation without aids, knee pain with VAS ≤5, free from painkillers and / or anti-inflammatory drugs, free from modalities or complementary alternative therapies, cooperative, willing to participate in this study and met the requirements in the explanatory sheet by signing or giving a thumbprint on the informed consent[12,13].

The exclusion criteria were knee contracture in flexion position ≥150 and pelvic contracture, substantial obesity with body mass index (BMI)>35 kg/ m^2, acute inflammation based on anamnesis and physical examination, cardiovascular disorders, arthroplasty in knee joints and pelvis either on the ipsilateral or contralateral side, injection of intra-articular hyaluronic acid 6 months earlier or injection of intra-articular glucocorticoids within the previous 3 months. Meanwhile, for the drop out criteria werefailing to keep up with the training schedule, the increasingly heavy knee joint pain (VAS = 2) or the subject could not tolerate it during the exercise session, the patient decides not to continue his involvement in the study.

The samples were knee OA patients who came to outpatient unit of Medical Rehabilitation Installation Dr. SoetomoTeaching Hospital Surabaya. Sampling should meet the inclusion criteria and be given explanations of the intent and purpose of the study then subjects were willing to sign or provide a thumbprint on the informed consent. Randomization of samples into the treatment group (received isotonic femoral quadriceps and hip abductor exercise) and control group.In both groups,it was performed a pain assessment (VAS), measurement of femoral quadriceps muscle strength (1 MR) and physical function status assessment (WOMAC) and recorded on the collection sheet. An1 MR submaximal test was done on each subject. In the treatment group, isotonic exercises of femoral quadriceps and hip abductor muscles with intensity of 40% from 1 MR, 15 repetitions, 3 series of exercises and 30 seconds rest for each series. The exercise was done twice a week for 3 weeks. In the control group, isotonic exercise of femoral quadriceps muscles only with intensity of 40% from 1 MR, 15 repetitions, 3 series of exercise and 30 seconds rest for each series.

The exercise was done twice a week for 3 weeks. The exercise was discontinued when the subject was tired, the pain could not be tolerated by the subject or pain increases 2 points VASA. The treatment group performed an in-home exercise program in the form of isotonic exercises of femoral quadriceps and pelvic abductor and each subject was given a home exercise sheetand home exercise instructions. The control group conducted a home-based exercise program consisting of isotonic exercises of femoral quadriceps muscles and each subject was given a home exercise sheet and home exercise instructions.The subjects were given an explanation for not getting modalities therapy, consuming pain relievers/anti-inflammatory drugs and/or complementary alternative therapies during the study

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period. After the treatment period was completed, assessment and re-measurement were performed on both groups regarding

pain perception (VAS), femoral quadriceps muscle strength (1 MR) and physical function status (WOMAC). Assessment was done 3 days after the end of the treatment period.Ethical appeals were submitted to the Ethics Commission for basic science / clinical research at Dr. Soetomo Surabaya.

All collected data was arranged in sheets then tabulated and processed statistically using SPSS (SPSS. Inc. Chicago IL). Normality test used Kolmogorov-Smirnov test.Homogeneity test using One-Sample Kolmogorov-Smirnov Test with significance value p <0.05 and using statistical analysis software SPSS 20.0. The VAS assessment data was ordinal data then tested with Wilcoxon signed rank test in each group and Mann Whitney test for comparison between groups. The WOMAC assessment data and muscle strength were the interval data then the normality test of each group used paired t test (normal)and Wilcoxon signed rank test (not normal). While for the inter-group used t-test (normal) and Mann Whitney test (not normal).

III. RESULTS

The demographic characteristics (Table 1) showed in treatment group, average age of 56.8 years, the youngest was 50 years and oldest was 68 years. In the control group, the average age was 58.7 years, the youngest was 50 years and the oldest was 68 years. The distribution of sex in the treatment group consisted of 10 females, while the control group consisted of 9 females and 1 male. The average BMI of treatment group was 27.70 while the control group was 26.81. The degree of OA in the treatment and control group wassimilar consisting of 8 subjects with degrees II and 2 subjects with degree III.Homogeneity test of diversity level of demographic characteristics was done to determine the effect on the results of the study (Table 1). In both groups there was no significant difference in age, sex, BMI and knee OA degree.

Table 1:Subject’s Characteristic

Note:

BMI: Body Mass Index

Average (mean) ± standard deviation (SD)

*p: Significance value p<0.05

Characteristic	Treatment group (n=10)	Control Group (n=10)	p*
Age (years)	56.80 ± 6.28 (50-68)	58.70 ± 7.00 (50-68)	0.531§
BMI (kg/m^2)	27.70 ± 3.33 (22.50-34.88)	26.81± 3.86 (23.30-32.89)	0.588§
Sex			
Female	10	9	1.000€
Male	-	1	
OA Degree			
Grade II	8	8	1.000€
Grade III	2	2	

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€ Chi-Square

The VAS scale was used to assess pain before and after treatment in each group. The VAS before and after intervention in control and treatment group could be seen in table 2. In the treatment and control group, there was significant decrease of VAS with significance value of 0.004. Comparison of VAS decrease between treatment group and control group showed significant difference with a significance value of 0.030 ($p < 0.05$) (Table 2).

Assessment of femoral quadriceps strength before and after intervention in the treatment group and control group could be seen in table 2.The treatment group showed a significant increase in femoral quadriceps muscle strength with $p < 0.0001$. In the control group also showed a significant increase in femoral quadriceps muscle strength with $p < 0.0001$. However, the comparison of femoral quadriceps muscle strength between treatment and control group did not show significant difference with $p = 0.382$.

Table 2: Variable before and after treatment

Variable	Treatment Group (n=10)		p	Control Group (n=10)		p
	Pre	Post		Pre	Post	
VAS	4.70±0.48	1.60±0.69	0.004	4.70±0.48	2.20±0.63	0.004
Femoral Quadriceps Strength	3.38±1.30	5.74±2.20	<0.001	2.71±1.01	4.59±1.62	<0.001
Pain Subscale (WOMAC)	14.90±2.51	8.00±3.50	<0.001	14.10±3.78	9.40±3.20	<0.001
Stiffness (WOMAC)	5.10±0.87	2.40±1.65	<0.001	4.40±0.97	3.10±1.10	0.002
Physical Function (WOMAC)	32.20±10.34	10.70±8.90	<0.001	28.50±12.05	20.80±10.60	0.031

Note:

VAS: Visual Analogy Scale

WOMAC: Western Ontario and McMaster Universities

Assessment of pain subscale with WOMAC before and after intervention of treatment group and control group could be seen in table 2. The statistical test results showed a decrease of average pain subscale score of WOMAC. The treatment group showed a significant reduction in painwith $p < 0.0001$. In the control group also showed a significant reduction in pain with $p < 0.0001$. However, comparison of pain reduction between treatment group and control group did not show significant difference with $p = 0.091$ (Table 3).

Table 3:Comparison Test Result Before and After Treatment

Variable	p
VAS (Visual Analog Scale)	0.030
Femoral Quadriceps Strength	0.382

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Pain Subscale Assessment Using WOMAC	0.091
Stiffness Assessment Using WOMAC	0.011
Physical Function Assessment Using WOMAC	0.003

Note:

WOMAC: Western Ontario and McMaster Universities

Decrease average scoreof stiffness subscale on WOMAC before and after intervention of the treatment and control group could be seen in table 2. The result of statistical test shows that there was a decrease average of stiffness subscale score on WOMAC. The treatment group showed significant decrease of stiffness with $p = 0.011$. In control group also showed a significant decrease of stiffness with $p = 0.002$. The comparison of decrease stiffness between treatment and control group showed significant difference with significance value $p = 0.011$ (Table 2).

Assessment of physical function subscale on WOMAC before and after intervention of treatment and control group could be seen in table 2. The result of average score before and after interventionshowed significant improvement with $p < 0.0001$. In the control group also showed significant improvement with $p = 0.031$.Comparison of physical function improvement between treatment group and control group showed significant difference with $p = 0.003$ (Table 3).

IV. DISCUSSION

This study compared the addition of isotonic exercises of pelvic abductor muscles to femoral quadriceps muscle exercise through decreased pain perception, increased femoral quadriceps muscle strength and increased physical function status in OA knee patients. The comparison of pain perception reduction between treatment and control group was statistically significant.This finding supported the research hypothesis that the addition of isotonic exercise of pelvic abductor muscle was more effective in reducing knee pain perception than isotonic exercise of femoral quadriceps muscle only in OA knee patients. This supported a study concluded that isotonic exercise had the greatest effect in reducing pain in knee OA patients compared to isometric and isokinetic exercise [14]. Another study found significant decrease of pain (VAS) before and after isotonic exercise of femoral quadriceps muscle in knee OA patients using EN-Tree [15].

The decrease pain perception measured with VAS in this study could be explained by statements and findings from other researchers stated that pelvic muscles, especially abductor muscles of hip jointplayed an important role in pelvic and trunk stabilization. The abductor muscles weakness of hip joint caused a fall ofpelvic contralateral side and the center of the body mass shifted towards the swing legs thus increasing the load on the medial compartment of the stance foot [16].Another study suggested that a high dynamic load on the medial part of knee increased the external KAM associated with knee pain severity. Isotonic exercises of abductor muscles of hip joint decreased the external knee adduction moment that affected the medial load reduction on knee thus could reduce pain on knee [7].

Knee OA patients also experienced impaired sensorimotor (proprioceptive) function causing eccentric contraction of quadriceps muscle disturbed. This resulted a heavy burden on knee for weight bearing activity. This could reduce the excessive burden on the knee therefore it could reduce pain in the knee [17]. The non-significant increase in femoral quadriceps muscle strength could be explained by the statements and findings of a study that found a significant increase in quadriceps muscle strength of subjects given the addition of isometric strength training and isokinetic muscle of joint abductor pelvic even though the average muscle strength increased. Quadriceps muscle strength did

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not cause a decrease in KAM. Pelvic muscles played a role in decreasing KAM by controlling the medial-lateral equilateral joints of the knee thus shifted the force in the lateral direction of knee joint and provided stabilization to the pelvis [7].

Knee OA is a degenerative disease that mostly experienced by elderly. A strength training programs in the elderly was given under the principle of low-resistance and low-repetition aimed at minimizing the burden on the joints and muscles adaptation. The exercise was given initially with mild to moderate resistance with 10-12 reps for 6-8 weeks [18].

A decrease KAM could decrease all WOMAC subscales including decreased stiffness and improved physical function. A previous study examined the decrease KAM in non-invasive biomechanical exercise in patients with knee OA [19]. The average pain decrease in treatment group was greater than in control group but the comparison of pain subscale decrease between treatment group and control group did not show significant difference. This finding was inconsistent with previous study that reduction of knee dynamic load in the addition of isotonic exercise of abductor muscle of hip joint caused a decrease in WOMAC pain subscale. Strengthening of pelvic abductor muscles in addition to quadriceps and hamstring strengthening exercises could reduce dynamic loading on the medial side of the knee OA patients thus could reduce pain [7].

The pain decrease of WOMAC subscale between treatment group and control group in this study might be based on the increase in femoral quadriceps muscle strength that was also not significant. The femoral quadriceps muscle played a role in patellar movement against the intercondylar femoral sulcus. Patella twisted in an intercondylar sulcus during flexion and extension movements. The shifting path of the patellar movement increased the stress on the patellofemoral joint that triggered arthritis [20].The average BMIin 2 groups showed that the study subjects were in excess body weight. A study concluded that women and increased BMI had a significant association with worse OA knee symptoms. In addition, the WOMAC pain subscale value was also more significant in women than in men [21].

The pain decrease of WOMAC between the treatment group and the control group was different from the significant reduction in VAS. This related to the question of pain in WOMAC constrained within 48 hours and on physical activities such as walking, standing, up and down stairs and others. While the question given to assess the VAS was about the pain felt by the subject within 24 hours and was not asked about pain felt on any activity.

V. CONCLUSION

It could be concluded thatthe addition of abductor pelvic muscles isotonic exercises on femoral quadriceps muscles were more effective inreducingpain perception (VAS) but not effective in increasing femoral quadriceps muscle strength compared to isotonic exercise only in knee OA patients.It was also more effective in reducing stiffness and improving the physical function of WOMAC than isotonic exercise of femoral quadriceps muscle only. However, the addition of pelvic abductor muscles to isotonic exercises of femoral quadriceps muscle was ineffective in relieving pain from WOMAC than isotonic exercise of femoral quadricepsmuscle only.

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