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ORIGINAL ARTICLE

Effect of Additional Extracorporeal Shockwave Therapy on Knee Functional Score: A Study in Patients with Knee Osteoarthritis Receiving Quadriceps Set Exercises

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ABSTRACT

Background: Osteoarthritis (OA) is the most common degenerative joint disease worldwide and a major cause of disability. Extracorporeal shockwave therapy (ESWT) is a novel treatment that promotes regeneration in musculoskeletal diseases. ESWT can trigger subchondral bone changes, inhibit cartilage degeneration, stimulate neovascularization, increase chondrocyte proliferation, and enhance angiogenesis, leading to improved knee function.

Objective: The goal of this study was to investigate the effect of adding ESWT on knee functional scores in patients with knee OA who perform quadriceps exercise sets.

Method: We performed a randomized controlled trial with total 28 individuals divided equally into the control (CG) and intervention groups (IG). Both groups received quadriceps exercise sets on daily basis for 4 weeks; the control group received sham ESWT and treatment group also received ESWT once a week for 4 weeks. We used Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) to assess knee function both before and after the 4 weeks treatment program.

Results: There was a significant increase in WOMAC score in both the intervention group ($p = 0.001$) and the control group ($p = 0.001$). There was a significant difference between WOMAC post treatment with p 0.019 and the p value for WOMAC comparation between group was 0.377 so it could be concluded that there was no significant difference.

Conclusion: Both groups showed significant results, with IG demonstrating a greater improvement than CG. However, no significant difference was found between the groups. In conclusion, ESWT benefits patients with OA.

Keywords: Extracorporeal Shockwave Therapy, Osteoarthritis, Quadriceps Set Exercises.

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INTRODUCTION

Osteoarthritis (OA) is the most common degenerative joint disease worldwide and is a major cause of disability in 60–70% of people aged ≥ 60 years.[1] By looking at data from WHO, there has been a 113% increase in the incidence of OA worldwide from 1990 to 2019, with prevalence increasing with age, with the incidence reaching 73% in those over 55 years of age.[2] The prevalence of knee OA in 2020 was 650 million people worldwide and by 2032 it is estimated that there will be an increase of 15.7%. According to the Indonesian Ministry of Health in Indonesia itself, there are 55 million people (24.7%) suffering from knee OA.[3–4]

Knee Osteoarthritis (OA) affects all elements of the synovial joint, where the most affected components being the cartilage and subchondral bone. Symptoms of OA disease include joint pain, muscle atrophy, and decreased joint range of motion (ROM). Sufficient knee ROM is important for daily activities such as standing from a chair, walking, squatting, and climbing stairs. With the progression of OA, physical limitation, pain, and functional limitations increase so it can contribute to limitation of activities such as ambulation, mobility, and daily activities. Decreased knee ROM is also be a predictor of the occurrence of OA and sign of pre-existing cartilage development due to increased local hydrostatic pressure causing chondrocyte apoptosis and further cartilage degeneration. Decreased ROM is one of the diagnostic criteria for knee OA according to the European League Against Rheumatism (EULAR) and can be caused by articular factors (joint space narrowing, osteophytes) and clinical factors (pain, edema). Although decreased ROM is characteristic of OA patients, there are still few studies assessing the relationship between articular factors and ROM.[7–9]

Joint dysfunction and symptoms, osteoarthritis index can be widely assessed using Western Ontario and McMaster Universities (WOMAC). WOMAC is used in clinical studies to assess the outcomes of osteoarthritis patients. WOMAC consists of 24 questions covering pain, stiffness, and physical function of the joints.[10] It is one of the most frequently used functional scoring systems for both research and medical evaluation purposes. Although functional scoring systems must be internationally accepted, translations into native languages and those adapted to local cultures and customs are also needed.[11]

Exercise is one of the recommended non-pharmacological therapies for OA patients. Increasing the strength of the quadriceps muscle which functions as a knee joint stabilizer and maintains postural stability can be achieved with isometric strengthening exercises. A systematic review reported that strengthening exercises can improve balance in patients with knee OA.[12] Isometric quadriceps exercises can improve knee ROM and minimize pain symptoms in the elderly during activity.[13]

Extracorporeal shockwave therapy (ESWT) is a new modality that provides a regenerative effect on musculoskeletal diseases.[14] The effects of ESWT on OA will trigger subchondral bone changes, inhibit cartilage degeneration, increase chondrocyte proliferation, trigger neovascularization and increase the regulation of angiogenic and osteogenic growth factors, reduce substance P and calcitonin gene-related peptide (CGRP) expression.[14] This can improve symptoms in patients with knee OA by reducing knee pain, increasing WOMAC scores, improving the 6-minute walk test, and improving ROM of the knee joint in patients with knee OA.[12] ESWT therapy is superior in improving the pain scale and WOMAC scores compared to laser therapy.[15]

METHODS

1. Subjects

This study was designed as single blind randomized control trial involving patients with grade 2-3 genu osteoarthritis according to the Kellgren Lawrence classification. All participants were recruited from the outpatient physical medicine and rehabilitation clinic at Diponegoro National Hospital (Semarang, Center Java, Indonesia) between October 2024 - December 2024. Ethical approval was obtained from the Diponegoro University Faculty of Medicine the Research Ethics Committee at the Health and Medical Research Ethics Commission of RSUP Dr. Kariadi Semarang (No. 529/EC/KEPK/FKUNDIP/X/2024).

A total of 30 participant was randomly assigned to intervention group (IGn=15) and control group (CGn=15). Randomization was performed using a computer-generated random number sequence. Allocation concealment was conducted using sequentially numbered, opaque, sealed envelopes prepared by an independent researcher. This study used a single-blind design in which the participants were blinded to the treatment allocation. At the end of the study, 2 participants from control group drop out because didn't do 2 exercises in a row.

The study inclusion criteria were female age between 50-65 years old with bilateral knee OA grade 2-3 according to Kellgren Lawrence criteria; BMI 23-29.9 kg/m2 (overweight and obesity grade I according to Asia-Pacific criteria); pain NRS <5,

Manual Muscle Testing (MMT) ≥ 4; Moca-INA >26; willing to participate in this study. The exclusion criteria were contraindication for the usage of ESWT (coagulopathy or use of anticoagulant drugs, active infection and signs of acute inflammation around the knee); musculoskeletal disorders (rheumatic arthritis, disorders of the vertebral trunk, hip joint, ankle joint, postural disorders: scoliosis, thoracic hyper kyphosis, lumbar hyper lordosis); neurological and vestibular disorders that affect balance (TBI, Parkinson's, stroke, vertigo); history of diabetes mellitus and uncontrolled hypertension, history of heart disease; visual disturbances or decreased vision that are not corrected; injury in the knee area (fracture, dislocation, subluxation, muscle, tendon, and ligament injuries); history of total knee replacement surgery or other surgery in the knee area; received corticosteroid and hyaluronic acid injection therapy in the last 3 months, TENS in the last 24 hours, and laser in the last 4 weeks, and within 4 weeks US Diathermy in the knee area; consumption of drugs that could affect balance (benzodiazepines, antihistamines).

Subjects were removed from the study if they skipped a ESWT therapy and/or did not perform quadriceps exercise sets for two consecutive days; received anti-inflammatory therapy (NSAIDs and corticosteroids) during the study period; there were ESWT side effects (pain NRS >6, edema, effusion, hematoma, bleeding); and patient decided not to continue participating in the study.

2. Intervention

The intervention group underwent focused ESWT therapy on the knee that is most painful in a sitting position with the knee 45-60 degrees flexed with an EFD of 0.16 mJ/mm2, a frequency of 12 Hz, 4000 pulses on the medial and lateral joint lines of the knee where the cartilage is located and control group received additional focused ESWT sham therapy with an EFD of 0.01 mJ/mm2, a frequency of 4 Hz, 4000 pulses, given once a week for 4 weeks. Both groups received daily quadricep set exercise, the quadricep set was done by doing isometric quadriceps knee extensor muscle strengthening set in supine position with legs straightened, patients were taught to press the knees down and tighten the thigh muscles, hold for 10 seconds, repeat 10 times, done 3 sets a day done every day for 4 weeks by being taught at the first meeting.

Compliance was determined by individual logbook (which record daily exercise, repetition, and adverse events) and the participant sent exercise videos to the researcher via WhatsApp every day.

3. Measurements

Knee functional level in this study measured using The Western Ontario and McMaster Universities (WOMAC). WOMAC is widely used to evaluate pain, stiffness, and physical function in patients with osteoarthritis. WOMAC consists of 24 questions covering pain, stiffness, and physical function. It is one of the most frequently used functional scoring systems in both clinical research and medical evaluation before and after the treatment. Each item is scored from 0 to 4, where for pain a score of 0 indicates no pain, and 4 indicates very severe pain. For strength a score of 0 indicates no stiffness, and 4 indicates stiffness to locking. For physical function a score of 0 indicates not difficult, and 4 indicates very difficult.[12] The scoring results with WOMAC can be divided into 5 groups, namely mild with a value of 0-24, moderate with a value of 25-48, severe with a value of 49-72, and very severe with a value of 73-94.

4. Statistical Methods

Data analysis was performed using SPSS version 22.0 (IBM Corporation, Armonk, NY). A P value less than 0.05 was considered statistically significant. Normality of the data was assessed using the Shapiro-Wilk test. The pre-treatment WOMAC scores ware normally distributed, therefore the between group comparation was analyzed using the Independent-t test. The post treatment WOMAC scores were not normally distributed, therefore the between group comparation was analyzed using the Mann-Whitney test. The changes in WOMAC scores were normally distributed; therefore, the comparison of the changes was analyzed using the Independent-t test. Within group comparation between pre and post WOMAC scores were analyzed using the Paired-t test.

RESULT

The characteristics of the participants were outlined in Table 1. Statistical analysis revealed no significant differences between the two groups (p value > 0.05), suggesting that the participants in both groups had comparable characteristics. Additionally, baseline measurements taken prior to the intervention showed no significant differences between the groups.

As shown in Table 2 the results between WOMAC pre-treatment and WOMAC post treatment in the intervention group, a p value of <0.001 was obtained so that it can be concluded that there is a significant difference, in the control group a p value of <0.001 was obtained so that it can be concluded that there is a significant difference.

DISCUSSION

Isometric quadriceps exercise set in this study was home exercise done by contracting the quadriceps muscle held for 10 seconds, repeated 10 times, done 3 sets/day, every day. In line with research by Anwer et al., strong quadriceps muscles will stabilize the knee joint in good alignment, reduce the pressure transmitted to the joint and minimize the effects of impact, so that it can reduce pain and damage to joint cartilage. Pain is one of the factors that affects function of the knee.[16]

The results of this study indicated that daily quadriceps set exercises for 4 weeks significantly improved the knee function of patients as assessed using WOMAC ($p<0.001$). These results were in line with a study by Anzari that showed 30 knee OA patients who received isometric quadriceps sets experienced improvements in pain, joint stiffness, and physical function. This is due to an increase in quadriceps muscle strength which causes increased joint and postural stability. Pain will be reduced and the patient's quality of life will increase.[17]

Another study conducted by Rusfid on patients with knee OA stated that giving isometric quadriceps sets at several angles can effectively improve dynamic balance, pain, and knee ROM. The study supports the results of this study, where there was an increase in balance function in the control group given isometric quadriceps set exercises. Isometric quadriceps set exercises can increase muscle strength that is essential for maintaining balance and performing daily activities such as changing positions from sitting to standing, climbing stairs, and walking.[17]

In this study, subjects performed isometric quadriceps set exercises at home. Researchers reminded and monitored the subjects to exercise, then the subjects recorded the exercises that had been done in their respective logbooks. Isometric exercise is an effective, efficient, and easy-to-do exercise method to increase muscle strength.[18]

Several studies have reported that patients with knee OA experience balance disorders and therefore have a higher risk of falling. Several influencing factors are pain, proprioception, ROM, and muscle strength.[7] In this study, the treatment group received additional focused ESWT therapy of 0.16 mJ/mm2, 4mHz, 4000 pulses on the medial and lateral joint lines of the knee where there is cartilage once a week for 4 weeks. The results of this study are supported by previous research by Choi et al. who gave ESWT to 18 subjects with grade 1-2 knee OA, where at the end of the 3rd VAS, WOMAC, and Lequesne index values improved.[19] Previous research by Naggar et al. stated that giving ESWT compared to LLLT for 4 weeks can both reduced pain and improved TUG scores in patients with knee OA.[20] However, there was no significant difference between the control group and intervention group in delta result. Maybe it was because in this study the have OA on both knee that have higher stage that different from previous study where the patient OA staging is 1 and 2. Other than that the patient the duration and frequency of the therapy that received in both studies also different with this study that may affect the result in the end. In a previous study regarding ESWT, the patients did not receive sham treatment, which may have contributed to the insignificance of the results in this study, as sham treatment can have psychological effects on patients that may improve their functional outcomes.

This study has limitation, first the researcher did not use blinding techniques for researchers so that measurement bias could occur. Limitation of this study is that the outcome assessment was not blinded. The researcher who conducted the measurements was aware of the group allocation, which may introduce measurement bias.

CONCLUSION

Both groups showed significant improvement in knee functional scores after four weeks of intervention. Although the ESWT group showed greater improvement, no significant difference was found between the groups. These findings suggest that quadriceps set exercises contribute to functional improvement in knee osteoarthritis, while the additional benefit of ESWT requires further investigation in studies with larger samples and longer follow-up.

Conflicts of Interest

The authors declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article. The researchers were responsible for all costs related to the study.

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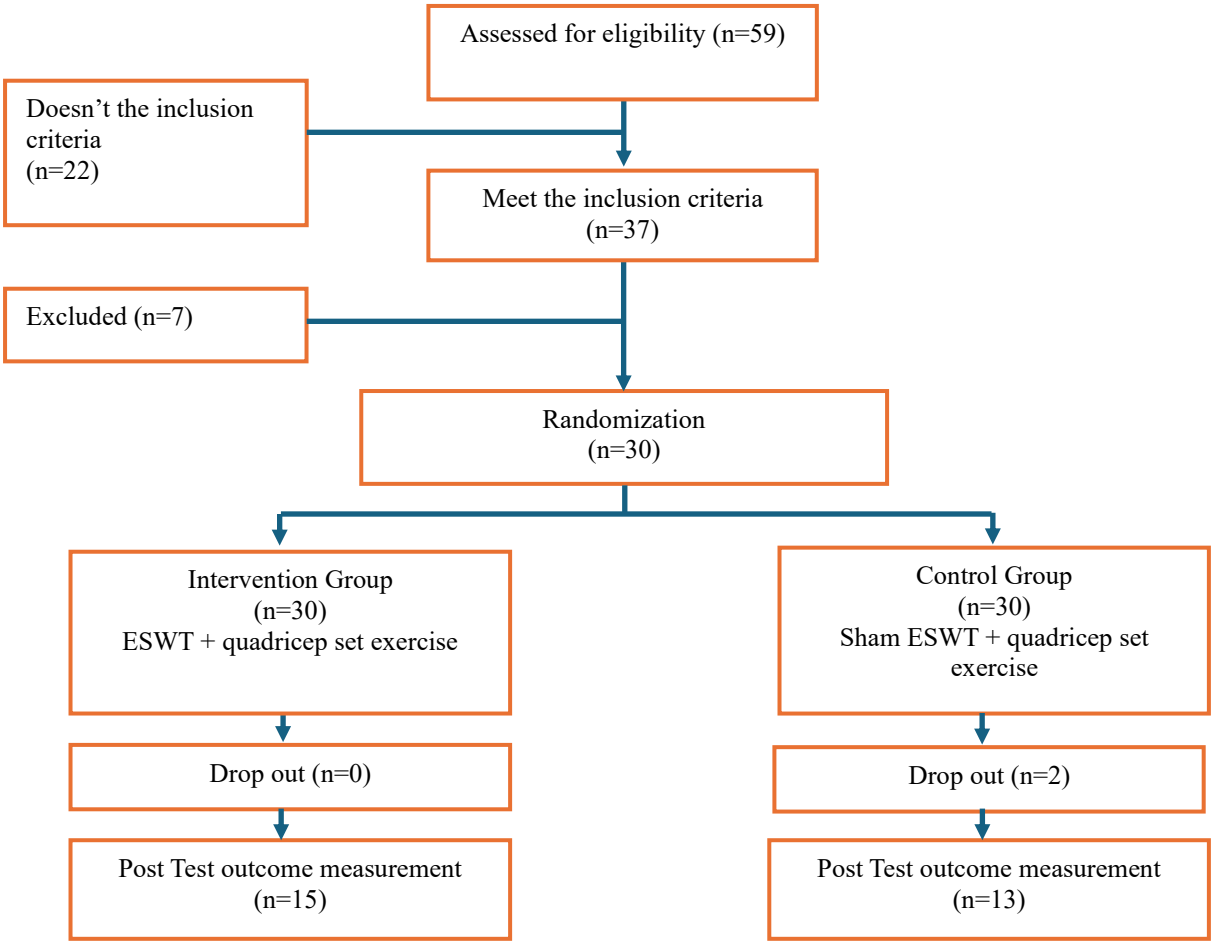

Figure 1. Flow diagram of the study

Table 1. Baseline Characteristic

Variabel	Group		p
	IG (n=15)	CG (n=13)	
Age	57,47 ± 5,57	58,69 ± 4,70	0,517‡
Education			
Elementary School	4 (50%)	4 (50%)	0,792‡
Secondary School	2 (50%)	2 (50%)	
High School	6 (60%)	4 (40%)	
Diploma	0 (0%)	1 (100%)	
Bachelor	2 (40%)	3 (60%)	
Master	1 (100%)	0 (0%)	
Moca-INA	28,13 ± 0,99	28,23 ± 1,09	0,828‡
Grading OA genu dekstra			
2	11 (57,9%)	8 (42,1%)	0,689¥
3	4 (44,4%)	5 (55,6%)	
Grading OA genu sinistra			
2	9 (45%)	11 (55%)	0,221¥
3	6 (75%)	2 (25%)	
NRS	3,07 ± 0,80	3,00 ± 0,82	0,825‡
Weight (kg)	60,13 ± 5,64	60,46 ± 7,60	0,897§
Height (cm)	152,33 ± 5,31	151,23 ± 6,56	0,744‡
BMI (kg/m^2)	25,95 ± 2,46	26,37 ± 2,18	0,637§

Table 2. The Western Ontario and McMaster Universities

WOMAC	Group		p
	IG (n=15)	CG (n=13)	
Pre treatment	18,07 ± 9,20	21,77 ± 10,83	0,337§
Post treatment	6,00 ± 6,37	11,54 ± 7,34	0,019‡*
p	<0,001¶*	<0,001¶*	
Delta	-12,07 ± 4,83	-10,23 ± 5,97	0,377§

REFERENCES

1. Kesehatan Politeknik Kesehatan Makassar M, Dwiya Lestari V, Durahim D, Ilma Amalia Jurusan Fisioterapi Poltekkes Kemenkes Makassar N. Different effects of progressive resistance exercise and knee strengthening exercise on increasing functional capabilities in case knee osteoarthritis in paccerakkang health center area. Media Kesehatan Politeknik Kesehatan Makassar. 2022;
2. Kolasinski SL, Neogi T, Hochberg MC, Oatis C, Guyatt G, Block J, et al. 2019 American college of rheumatology/arthritis foundation guideline for the management of osteoarthritis of the hand, hip, and knee. Arthritis and Rheumatology. 2020 Feb 1;72(2):220–33.
3. WHO. Osteoarthritis. WHO. 2023.
4. Vos T, Lim SS, Abbafati C, Abbas KM, Abbasi M, Abbasifard M, et al. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. The Lancet [Internet]. 2020 Oct;396(10258):1204–22.
5. Rosemann T, Laux G, Kuehlein T. Osteoarthritis and functional disability: results of a cross-sectional study among primary care patients in germany. BMC Musculoskelet Disord. 2007;8.
6. Divisi Reumatologi Departemen Ilmu Penyakit Dalam FKUI/RSCM. Rekomendasi IRA untuk diagnosis dan penatalaksanaan osteoartritis. 2014.
7. Holla JFM, Steultjens MPM, van der Leeden M, Roorda LD, Bierma-Zeinstra SMA, den Broeder AA, et al. Determinants of range of joint motion in patients with early symptomatic osteoarthritis of the hip and/or knee: an exploratory study in the check cohort. Osteoarthritis Cartilage. 2011 Apr;19(4):411–9.

8. Zhou G, Zhao M, Wang X, Geng X, Tian H. Demographic and radiographic factors for knee symptoms and range of motion in patients with knee osteoarthritis: a cross-sectional study in Beijing, China. BMC Musculoskelet Disord. 2023 Dec 1;24(1).
9. Al-Mahmood MR, Uddin MT, Islam MT, Fuad SM, Rahman Shah T. Correlation between goniometric measurements of range of motion and radiographic scores in osteoarthritis knee: an observational study among females. Medicine (United States). 2022 Aug 12;101(32): E29995.
10. Seifeldein GS, Haseib A, Hassan HA, Ahmed G. Correlation of knee ultrasonography and western Ontario and McMaster University (womac) osteoarthritis index in primary knee osteoarthritis. Egyptian Journal of Radiology and Nuclear Medicine. 2019 Dec 1;50(1).
11. Karsten S, Limena S, Phandu M. Translation, adaptation, and validation of western Ontario and McMaster universities osteoarthritis index (womac) for Indonesian. The Journal of Indonesian Orthopaedic & Traumatology. 2019 Dec 20;2(3):17–26.
12. Ko NY, Chang CN, Cheng CH, Yu HK, Hu GC. Comparative effectiveness of focused extracorporeal versus radial extracorporeal shockwave therapy for knee osteoarthritis—randomized controlled study. Int J Environ Res Public Health. 2022 Aug 1;19(15).
13. Israwan W. Effect of static and dynamic quadriceps exercise program on pain reduction in knee osteoartrose patients in dempo surgery. Journal for Quality in Public Health [Internet]. 2022;6(1):202–9.
14. Randita ABT, Wardhani IL, Andriati A, Wardani NK, Philothra PT, Subadi I, et al. Extracorporeal shock wave therapy as regenerative medicine in knee osteoarthritis: pre-experiment for matrix metalloproteinase-3 evaluation. Curr Rheumatol Rev. 2023 Sep 26;20(2):176–81.
15. Li W, Pan Y, Yang Q, Guo ZG, Yue Q, Meng QG. Extracorporeal shockwave therapy for the treatment of knee osteoarthritis: a retrospective study. Medicine 2018;97(27): e11418.
16. Anwer S, Alghadir A. Effect of isometric quadriceps exercise on muscle strength, pain, and function in patients with knee osteoarthritis: a randomized controlled study. Journal of physical therapy science 2014;26(5):745-8.
17. Rusfid FM, Uthradevi R, Usman A, James TT. The effect of multi-angle isometric quadriceps exercise on pain and dynamic balance after total knee arthroplasty– a randomised controlled trial. Asian Journal of Orthopaedic Research 2023;6(2):151-6.
18. Kisner C, Colby LA. resistance exercise for impaired muscle performance. in: kisner c, colby la, editors. therapeutic exercise: foundations and technique. 6th ed. Philadelphia: E.A. David Company; 2012. p. 179-99.
19. Choi IJ, Jeon JH, Choi WH, Yang HE. Effects of extracorporeal shockwave therapy for mild knee osteoarthritis: a pilot study. Medicine. 2023 Nov 17;102: e36117.
20. Naggar ME, Ghuiba K, Tabie AE, Abdelsalam MS, editors. Extracorporeal shock wave therapy and low-level laser therapy in treatment of knee osteoarthritis: a comparative study. The 21st International Scientific Conference Faculty of Physical Therapy; 2022; Cairo.