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Original Research

The Difference in the Effects of Open Kinetic Chain Exercise and Isometric Exercise on the Quadriceps Muscles in Reducing Pain in Patients with Knee Osteoarthritis

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ABSTRACT

Background: *Knee osteoarthritis causes a decrease in quadriceps muscle strength and pain during activities. Strengthening the quadriceps muscles through exercise effectively reduces pain and improves the quality of life of patients. The purpose of this study was to compare the effects of open kinetic chain (OKC) and isometric exercises on pain reduction in patients with knee osteoarthritis.*

Methods: *This study used a quasi-experimental two-group pre- and post-test design with 40 patients with knee osteoarthritis. Patients were randomly divided into two groups of 20 people. Group I performed OKC exercises and group II performed isometric exercises for 4 weeks (3 sessions/week). Pain was measured using the valid and reliable Visual Analog Scale (VAS). Data analysis used the Wilcoxon test for pre- and post-comparisons within each group and the Mann-Whitney test for differences between groups.*

Results: *OKC and isometric exercises significantly reduced pain in patients. The mean VAS reduction in the OKC group was 2.10 ± 0.60, while in the isometric group it was 1.20 ± 0.51. The difference in pain reduction between groups was significant ($p < 0.001$).*

Conclusion: *OKC exercise was more effective in reducing knee osteoarthritis pain than isometric exercise. It is recommended that OKC exercise be used as the primary intervention in knee osteoarthritis physiotherapy rehabilitation for optimal results. Further studies with larger samples and longer durations are needed.*

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INTRODUCTION

Increased life expectancy has led to an increase in the elderly population, resulting in an increase in degenerative diseases, one of which is osteoarthritis (Reece et al., 2012). Osteoarthritis is a degenerative joint disease that often occurs in weight-bearing joints such as the knee, causing pain and decreased functional ability (Huang et al., 2017). Joint pain is the main complaint that interferes with daily activities and the quality of life of sufferers (Hochberg et al., 2015).

Upper trapezius muscle spasm pain is quite commonly found as a musculoskeletal manifestation that interferes with productivity and work activities (Kalichman et al., 2016). This spasm occurs due to unconscious muscle contractions that cause limited movement and chronic pain (Dommerholt et al., 2010). Poor posture, particularly forward head posture in computer workers, increases the risk of this muscle spasm (Kaur & Kumar, 2018).

Therapeutic modalities such as dry needling (DN) and low-level laser therapy (LLLT) are options for managing myofascial pain, particularly upper trapezius muscle spasms (Agung et al., 2018). DN stimulates trigger points to relax muscles and improve blood circulation, while LLLT increases tissue oxygenation and suppresses inflammatory mediators (Motavalian et al., 2020; Clijsen et al., 2019). Previous studies have demonstrated the effectiveness of both in reducing musculoskeletal pain (Sacristán et al., 2022).

Previous research has been limited in directly comparing the effectiveness of DN and LLLT in reducing upper trapezius muscle spasm pain. In addition, the comparison methods used were inconsistent and the samples were limited (Hidayat & Oktavanti, 2020; Zuhri & Rustanti, 2022). Therefore, this study aims to provide more valid scientific information with a rigorous experimental design and representative samples.

The purpose of this study is to determine the difference in the effects of DN and LLLT on reducing upper trapezius muscle spasm pain so that it can be used as a reference for more effective and efficient clinical physiotherapy therapy in the management of myofascial pain patients in the field of musculoskeletal rehabilitation (Agung et al., 2018). The results of this study are expected to significantly improve the quality of intervention and patient outcomes.

MATERIALS AND METHOD

This study used a quasi-experimental design with a two-group pre- and post-test design. This design was chosen because it allows for a more accurate comparison of two types of treatment on the results measured before and after the intervention. The selection of this design also allowed researchers to assess the effectiveness of open kinetic chain (OKC) and isometric exercise interventions on pain reduction objectively in a group of knee osteoarthritis patients with similar characteristics.

The study was conducted at the Physiotherapy Clinic of Mitra Plumbon General Hospital, Cirebon, during the period of October 17 to November 12, 2022. This location was chosen because it has a sufficient number of knee osteoarthritis patients and facilities that support the implementation of therapy and measurements. The study period was adjusted to the availability of patients and therapy schedules so that all intervention procedures and pre- and post-test measurements could be conducted consistently.

The population in this study consisted of patients with knee osteoarthritis who were treated at the Physiotherapy Clinic of Mitra Plumbon Hospital. The sampling technique used was simple randomization by dividing patients based on their arrival number, where odd numbers were assigned to group I (OKC) and even numbers were assigned to group II (isometric). A total of 40 samples were divided into two groups, each consisting of 20 people. The inclusion criteria included patients aged 35–74 years with a diagnosis of knee osteoarthritis and a minimum pain score of 3 on the VAS scale. The exclusion criteria included a history of trauma or knee surgery in the last six months, cardiovascular disorders, acute inflammation, cognitive impairment, or knee joint contracture.

The independent variable in this study was the type of exercise (OKC and isometric), while the dependent variable was the pain level in patients with knee osteoarthritis. The measurement instrument used was the Visual Analog Scale (VAS), a subjective measuring tool that measures pain intensity on a scale of 0–10 cm. This instrument has a validity of 0.16–0.51 and reliability of 0.60–0.77 according to the results of Spearman's test conducted on patients with musculoskeletal pain (Alghadir et al., 2018). VAS was chosen because it is sensitive, easy to use, and is not influenced by the age or gender of the patient.

The research procedure included preparation, implementation, and measurement stages. The preparation stage included research permission, patient recruitment according to criteria, and provision of explanations and written consent (informed consent). The implementation stage included initial pain measurement (pretest), provision of exercises according to group, and re-measurement (posttest). Group I received OKC exercises in the form of active knee extension movements with light weights, 10 repetitions per session, three times a week for four weeks. Group II received isometric exercises in the knee extension position, held for six seconds per contraction, 10 repetitions per session, with a similar frequency. All interventions were performed by the same physiotherapist to maintain data consistency.

Data analysis was performed using SPSS software version 26.0. Data normality was tested using the Shapiro–Wilk test because the sample size was less than 50, and the results showed that the data distribution was not normal ($p < 0.05$). Therefore, non-parametric statistical tests were used: the Wilcoxon test to determine the difference between the pre- and post-tests in each group, and the Mann–Whitney test to compare the differences between groups. This study was conducted with full consideration of research ethics principles, such as respecting the dignity, autonomy, and privacy of each research subject by providing clear information regarding the objectives, process, risks, and benefits of the study.

RESULTS

Table 1. Characteristics of Research Subjects Based on Gender, Age, and Body Mass Index (n=40)

Characteristics	Group I (OKC)	Group II (Isometric)
Male (n, %)	1 (5%)	1 (5%)
Women (n, %)	19 (95%)	19 (95%)
Average Age (years) ± SD	54 ± 8.51	53 ± 8.07
Average BMI (kg/m²) ± SD	28 ± 5.62	28 ± 5.54

Table 1. Shows that most respondents were female (95%) in both groups. The average age in the OKC group was 54 years and in the isometric group 53 years, indicating that both groups had relatively comparable age characteristics. Similarly, the body mass index (BMI) between groups showed that the subjects had comparable baseline conditions, so that differences in results were not influenced by demographic factors.

Table 2. Mean Visual Analogue Scale (VAS) Pain Scores Before and After Intervention

Group	Initial VAS (Mean ± SD)	Final VAS (Mean ± SD)	Difference (Δ)
I (OKC)	5 ± 1.32	3 ± 1.01	2 ± 0.31
II (Isometric)	5 ± 1.21	4 ± 0.97	1 ± 0.24

Table 2 shows that before treatment, the average pain of both groups was equal at 5 cm on the VAS scale. After treatment, the average pain of group I decreased to 3 cm (a 40% decrease), while group II decreased to 4 cm (a 20% decrease). The difference in the mean reduction in pain indicates that OKC exercise is more effective than isometric exercise in reducing knee osteoarthritis pain.

Table 3. Statistical Test Results

Type of Test	Group	p-value	Conclusion
Wilcoxon (Within Groups)	OKC	<0.001	There is an effect
Wilcoxon (Within Groups)	Isometric	<0.001	There is an effect
Mann-Whitney (Between Groups)	-	0.021	There is a Difference

Table 3 shows that the Shapiro-Wilk test results indicate that the OKC group data are not normally distributed ($p < 0.05$), while the isometric group data are normally distributed ($p > 0.05$). Therefore, the non-parametric Wilcoxon test was used for analysis within groups and the Mann-Whitney test for comparisons between groups. The p-value of 0.021 indicates a significant difference between the two interventions in terms of pain reduction.

DISCUSSION

This study found that both OKC and isometric exercises were effective in reducing pain in patients with knee osteoarthritis. The results showed that the group performing OKC exercises experienced a greater reduction in pain compared to the isometric group. This indicates that both types of exercise can be used for pain intervention, but OKC has an advantage in terms of pain reduction effectiveness (Ng et al., 2022).

Analysis of previous studies supports these results, in which OKC exercises have a positive effect by better mobilizing the knee joint, stimulating pain reduction mechanisms and tissue repair in the quadriceps muscles (Prio et al., 2017; Carol et al., 2016). Isometric exercises have also been shown to increase muscle strength and joint stability, although they do not involve active joint movement, so their effectiveness is slightly lower than OKC (Huang et al., 2017; Kisner & Colby, 2016).

The implications of this study's findings suggest that physical therapists should consider OKC exercises as the primary option in knee osteoarthritis pain rehabilitation programs. In addition to reducing pain, OKC exercises also have the potential to improve

joint functionality by maximizing joint mobilization and optimal muscle activation. This approach is expected to enhance patients' overall quality of life (Kisner & Colby, 2016).

Limitations of the study include the relatively small sample size and the limited duration of the intervention to four weeks. In addition, patients' physical activity and consumption of other medications outside the exercise program could not be strictly controlled, which could potentially affect the final results of the study. These limitations need to be considered in the interpretation and generalization of the study results (Susilawati et al., 2015).

The recommendation from this study is to conduct a follow-up study with a larger sample and a longer duration to determine the long-term effects of OKC and isometric exercises. It is also important to control external variables that may affect pain, such as physical activity and other additional therapies. This aims to strengthen the validity of the results and improve the quality of rehabilitation interventions (Kisner & Colby, 2016).

Overall, this study contributes scientific evidence supporting the effectiveness of OKC exercises in reducing knee osteoarthritis pain. Physical therapists are encouraged to adopt this approach in clinical practice while applying these research findings as a basis for developing more optimal and patient-centered therapy protocols (Basu et al., 2020).

CONCLUSION

This study demonstrates that OKC quadriceps muscle exercises are significantly more effective in reducing pain in patients with knee osteoarthritis compared to isometric quadriceps muscle exercises. This reduction in pain is supported by the mechanism of joint mobilization and more optimal mechanical stimulation with OKC, thereby improving the condition of the knee muscles and joints. However, isometric exercises still have a significant positive impact on increasing muscle strength and joint stability. It is recommended that OKC exercises be prioritized in the rehabilitation program for patients with knee osteoarthritis for more optimal clinical results.

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