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Analysis of the Effectiveness of Ultrasound Combined with Wall Squat Exercise versus Ultrasound Combined with Instrument-Assisted Soft Tissue Mobilization on Functional Activity in Sub-Acute Knee Osteoarthritis

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ABSTRACT

Osteoarthritis (OA) is a degenerative joint cartilage disorder that often causes pain and limits functional activity in affected individuals. To evaluate the difference in effectiveness between wall squat exercise and instrument assisted soft tissue mobilization (IASTM) in improving functional activity in patients with sub-acute lutut osteoarthritis.This study used a two-group pre-test and post-test design. The sample was taken from sub-acute lutut osteoarthritis. patients at the Elderly Posyandu within the Trauma Center Health Center in Samarinda, using random assignment techniques. Patients were divided into two groups: the intervention group I received ultrasound therapy (US) and wall squat exercise, while intervention group II received US and IASTM. Each group consisted of 21 patients and received treatment three times a week for four weeks. Functional activity was measured using The Western Ontario and McMaster Universities Arthritis Index (WOMAC). Intervention group I showed a significant decrease in WOMAC scores from 32.33 ± 5.425 to 14.57 ± 3.218 ($p < 0.001$). Group II also showed a significant decrease, from 35.14 ± 4.453 to 25.43 ± 4.422 ($p < 0.01$). Group I experienced a greater reduction compared to group II ($p = 0.00$).The combination of US and wall squat exercise is more effective than the combination of US and IASTM in improving functional activity in patients with sub-acute lutut osteoarthritis.Patients receiving US and wall squat exercise showed a more significant improvement in functional activity. Based on the significant results, it is recommended that further research be conducted over a longer period to assess the long-term effectiveness of the interventions for osteoarthritis sub-acute lutut osteoarthritis.

Keywords: Osteoarthritis, Wall Squat Exercise, Instrument Assisted Soft Tissue Mobilization

1. INTRODUCTION

A sedentary lifestyle and excessive weight gain are significantly associated with the risk of osteoarthritis (OA), as confirmed by previous research, which highlights that low physical activity and overweight are major risk factors for OA (1). Excess weight exacerbates OA (2). Lack of physical activity leads to decreased muscle strength and joint stability, while increased mechanical load on the knee joint can trigger cartilage degeneration. OA degeneration of the knee has a significant impact on the functional activity of patients. When degeneration occurs in the knee joint, such as cartilage damage, osteophyte formation, and other structural changes, the joint pathomechanics are disrupted. This creates instability, increases friction, and causes mechanical imbalance within the joint. The direct effect of these changes is the disruption of normal or patokinetic movement patterns of the knee joint. Patients with sub-acute knee OA often experience reduced range of motion, stiffness, and discomfort during daily activities such as walking, standing, or climbing stairs. The inability to perform these activities normally or comfortably contributes to an overall decline in functional activity, which leads to a gradual reduction in functional ability.

Osteoarthritis is a degenerative disorder of the joint cartilage that results in pain and limits functional activities of patients. Additionally, OA is related to vascular flow and the accumulation of waste products that cannot be transported to lymphatic drainage systems. Sub-acute knee osteoarthritis is classified as a non-communicable disease caused by degenerative changes in the articular cartilage of the knee (3). OA is a chronic disease that is commonly observed and characterized by joint pain, stiffness, and swelling (4). OA is the most common form of arthritis, affecting approximately 302 million people worldwide and is a leading cause of disability among the elderly. The prevalence of OA increases with age, with 60-70% of cases occurring in individuals aged 50-69 years (5). This is supported by other studies indicating that globally, 9.6% of men and 18.0% of women over 60 years of age suffer from symptomatic OA (6). According to WHO data, the prevalence of OA in 2019 was 528 million people, with 73% of the affected population being over 55 years old and predominantly women at 60%..

The wall squat exercise is an example of a closed kinetic chain (CKC) exercise, where the feet remain in contact with the floor and the back remains pressed against the wall. During this exercise, despite the feet and back being stationary, the primary movement occurs at the knee and hip joints. In a wall squat, the body bends at the knees and hips to lower itself in a seated position, similar to a squat. The primary muscles of the legs, including the quadriceps, hamstrings, and gluteus, contract to support the body's weight and move the body up and down. Concurrently, the core muscles are also engaged in maintaining stable posture. This process stimulates sensory feedback involved in proprioception, as the body actively monitors joint position and movement. Therefore, wall squat exercises play a role in enhancing knee joint proprioceptive ability and the overall body (7). Previous research supports this finding, indicating that wall squat exercises can improve joint stability by activating knee muscles, enhancing proprioceptive reflexes, and increasing functional activity in knee OA patients (8). Other studies have also found that performing wall squat exercises over a two-week period leads to improved functional activity in patients with sub-acute knee OA(9). The combination of US and wall squat exercises represents a physiotherapy intervention that can be used for sub-acute knee OA cases to enhance patient functional activity. Use of US before wall squat exercises can relax the muscles and soft tissues around the knee, thereby increasing the effectiveness of the exercise by reducing knee joint pain.

Instrument-Assisted Soft Tissue Mobilization (IASTM) is a physiotherapy modality used to mobilize soft tissues under pressure. IASTM involves the use of a metallic instrument applied with pressure to stimulate soft tissues, remove scar tissue and adhesions resulting from injuries, and enhance blood perfusion to the affected area, thereby accelerating the healing process. The goal of IASTM in OA is to mobilize soft tissues to reduce adhesions and muscle tension. IASTM can also be applied along lymphatic pathways, with pressure directed towards nearby lymph nodes to facilitate waste removal through lymphatic drainage. Research on IASTM applied to the hamstring muscle has shown that it can reduce muscle tension and pain in futsal players (10). Pressure from IASTM results in tissue mobilization and mechanical stimulation, leading to tissue remodeling with increased oxygen and nutrient supply from the blood. Pressure directed from nearby nodes helps remove waste through the lymphatic pathway, eventually reaching the largest node, the thoracic duct, for further processing and drainage (11). IASTM pressure causes fascia elongation and reduces tension around the joint, affecting sensitive areas, such as blood vessels and nerves, thus enhancing joint mobility (12).

The combination of US and IASTM represents a modern physiotherapy intervention that utilizes the thermal effects of US and light pressure from IASTM for soft tissue mobilization and reducing muscle adhesions, which can alleviate muscle tension. Research on IASTM is still limited and studies combining IASTM with US are relatively new. Applying US before IASTM can help increase blood circulation and nutrient flow to tissues, potentially accelerating healing and recovery in sub-acute knee osteoarthritis. This combination also has the potential to reduce the muscle tension. This study is highly relevant for understanding the differential effects of combining US with wall squat exercises versus US with IASTM in improving functional activity in individuals with sub-acute knee osteoarthritis. These findings could provide valuable information for physical therapy practitioners in selecting the best intervention methods to improve the quality of life of individuals with sub-acute knee osteoarthritis.

2. METHOD

This study used a two-group pre-test and post-test design. This study included patients with OA at the Elderly Posyandu in the Samarinda Trauma Center Health Center working area, using a random assignment technique, from a sub-acute knee, grade I and grade II knee OA by orthopedic surgery, and assistance from physiotherapy. Patients were divided into two groups: treatment group I received ultrasound therapy (US) and wall squat exercises, while treatment group II received US and IASTM. Each group consisted of 21 patients who received treatment three times a week for four weeks. Functional activity was measured using The Western Ontario and McMaster Universities Arthritis Index .

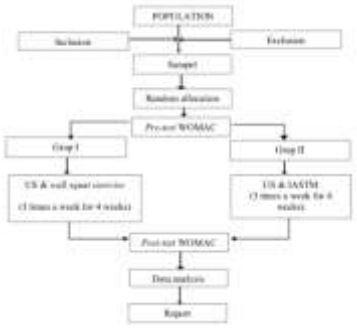

Fig 1. Research Flowchart

3. RESULTS AND DISCUSSION

Table 1. Subject Characteristic

Subject Characteristics	Group I		Group II	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Overweight	20	47,6	19	45,2
Obestity type 1	1	2,4	2	4,8
OA Grade 1	19	45,2	16	38,1
OA Grade 2	2	4,8	5	11,9
	Mean ± SD N= 21		Mean ± SD N= 21	
Age	61,81		62,05	
Pre-test	32,33 ± 5,425		35,14 ± 4,453	

Based on Table 1, there were 42 participants, all of whom were classified as elderly, with ages ranging from 60 to 70 years. Additionally, the Body Mass Index (BMI) of the study subjects was predominantly in the overweight category, with 39 out of 42 samples falling into this category. Furthermore, the majority of subjects had grade 1 osteoarthritis. According to the WOMAC pre-test scores, Group I had an average score of 32.33 ± 5.42, while Group II had an average score of 35.14 ± 4.45.

Table 2. Normality Test Shapiro-Wilk

	Shapiro Wilk test
	Group I
Pre-test	0,13
Post-test	0,15
	Shapiro Wilk test

Based on Table 2, The total WOMAC scores for both groups had a p-value > 0.05 in the normality test using the Shapiro-Wilk test, indicating that the data were normally distributed before the intervention. Additionally, the p-value for the data homogeneity test using Levene's test was 0.170, indicating that the variance in the total WOMAC scores between Group I and Group II was homogeneous before the intervention.

The results of the normality and homogeneity tests met the criteria for parametric analysis. Therefore, the researcher chose to use parametric statistical tests: the paired sample t-test to compare the data before and after the intervention for each group (Treatment Group I and Treatment Group II), and the independent t-test to assess the effectiveness between the two sample groups. Subsequently, hypothesis testing was conducted using the Pearson Correlation test. The results of the hypothesis tests are shown in table below.

Table 3. Comparison Test Pretest and Post-test

	Pretest WOMAC Mean ± SD	Posttest WOMAC Mean ± SD	p value
Group I	32,33± 5,42	14,57± 3,21	0,00
Group II	35,14 ± 4,45	25,43 ± 4,42	0,00

Tabel 3. shows the results of hypothesis tests I and II related to the improvement of functional activity in patients with sub-acute knee osteoarthritis. The increase in functional activity in Group I (intervention with US and wall squat exercise) showed a p-value of 0.00 ($p < 0.05$). In Group II (intervention with US and IASTM), the p-value was

also 0.00 ($p < 0.05$). The interventions in both treatment groups had a significant effect on improving functional activity in patients with sub-acute knee osteoarthritis.

Tabel 4. Comparison between Groups I and II

	Group I Mean ± SD	Group II Mean ± SD	p value
Pre-test	32,33± 5,425	35,14 ± 4.453	0,07
Difference	17,76 ± 2,644	9,71± 0,956	0,00
Post-test	14,57 ± 3,218	25,43 ± 4,422	0,00

Comparative testing showed that before the intervention, there was no significant difference between treatment groups I and II 0.07, indicating that both groups had similar WOMAC scores at the start of the study ($p > 0.05$). After the intervention, a significant difference in the change in WOMAC scores was observed between the two groups. The intervention using ultrasound (US) and wall squat exercises was more effective in improving the condition of patients with sub-acute knee osteoarthritis thant the combination of US and Instrument-Assisted Soft Tissue Mobilization (IASTM), as evidenced by the significant reduction in WOMAC scores in Treatment Group I.

The research sample represents the target population, which includes all knee osteoarthritis (OA) patients in the Elderly Posyandu in the Trauma Center Puskesmas area of Samarinda for the year 2024. The average age of the participants was 61 years, which falls into the elderly category. Previous studies have shown that OA frequently occurs in the elderly, causing pain, decreased function, and disability and reducing the functional activity of those affected, particularly in individuals over 60 years of) (13). The incidence of OA in Indonesia is predominantly among individuals aged $\geq$60 years, with a prevalence of 65% in the Indonesian population (14).

Based on BMI, the study subjects were predominantly classified as overweight, with 39 of 42 individuals falling into this category. This finding is consistent with previous research indicating that overweight and obesity are major risk factors for OA, although they are modifiable(15). Other studies also mention that being overweight is a modifiable risk factor for OA, with a risk nearly three times higher than that in individuals with anormal body weight (16).

The characteristics of OA grade in this study showed that 35 individuals had grade 1OA. These data are consistent with previous research that explains the increase in symptoms associated with greater knee pain, stiffness, and physical disability in patients (17). Other studies mentioned that a higher BMI is associated with more severe radiological findings of OA grade, which leads to increased knee pain (18).

This study indicates that the combination ultrasound (US) and wall squat exercises is more effective in improving functional activity in patients with sub-acute knee osteoarthritis than the combination of US and Instrument-Assisted Soft Tissue Mobilization (IASTM). In Treatment Group I, which received US and wall squat exercises, the average WOMAC score before the intervention was 32.33, which decreased to 14.57 after the intervention. This demonstrates a substantial improvement in functional activity, with the paired sample t-test showing a p-value of 0.00, indicating a significant effect of this intervention on enhancing functional activity in patients with sub-acute knee osteoarthritis.

The combination of US and wall squat exercises provided a greater synergistic effect than the combination of US and IASTM. US utilizes high-frequency sound waves to increase local temperature, improve tissue metabolism, reduce soft tissue stiffness, and enhance blood circulation and oxygen distribution in the muscles (19). Wall squat exercises, as isometric exercises, enhance muscle strength, flexibility, and proprioception by stimulating mitochondrial biogenesis and muscle cell regeneration and increasing ATP production for stronger and more sustained muscle contractions (7).

This exercise also improves knee joint stability through effective muscle contraction, without changes in muscle length (20). The combination of US and IASTM is effective in improving functional activity through different mechanisms. US accelerates tissue healing and enhances local blood circulation, whereas IASTM focuses on soft tissue mobilization and adhesion reduction (21). This study showed that while IASTM can enhance flexibility and functional activity, it is less effective than wall squat exercises in improving muscle strength and knee joint stability(12). The combination of US and wall squat exercises is superior in increasing muscle strength and flexibility and improving the quality of life of patients with sub-acute knee osteoarthritis. Wall squat exercises stimulate physiological adaptations by increasing mitochondrial biogenesis and ATP production, supporting stronger and more efficient muscle contractions and improving proprioception and joint stability. This process involves more direct muscle strength enhancement, greater mobility, and pain reduction than the benefits obtained from the combination of US and IASTM. Thus, the combination of US and wall squat exercises is superior in enhancing functional activity in patients with sub-acute knee osteoarthritis compared to the combination of US and IASTM.

4. CONCLUSION

Based on this study, it can be concluded that the intervention combining ultrasound (US) and wall squat exercises significantly improves functional activity in patients with sub-acute knee osteoarthritis (OA). Additionally, the combination of US and Instrument-Assisted Soft Tissue Mobilization (IASTM) enhances functional activity in these patients. However, the combination of US and wall squat exercises demonstrated superior effectiveness compared to US and IASTM in improving functional activity in individuals with sub-acute knee OA.

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