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Effectiveness of Neuromuscular Taping Application and Combination of Ultrasound Therapy Plus Exercise Therapy Protocol to Reduce Pain and Functional Disability in Elderly with Knee Osteoarthritis

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Abstract:- Knee Osteoarthritis causes pain and movement disorders, joint stiffness, and a lack of proprioception, as well as decreased quadriceps muscle strength, increasing functional disability, and affecting the functional quality of life. Cost-effective and safe method for treating and preventing knee osteoarthritis with Neuromuscular Taping (NMT), Ultrasound therapy and exercise therapy protocols supervised by physiotherapists. The aim of this research is to reduce pain as measured by the VAS scale, joint stiffness as measured by the goniometer (ROM) and functional disability as measured by the WOMEC. Experimental research method with pre and post test one group design. Research was conducted from August to September 2023, at the FIT Sport and Rehabilitation Centre Pekanbaru, RIAU. The sample in this study was all 10 patients with knee osteoarthritis. Participants' demographic data and Visual Analogue Scale (VAS) results, degree of range of motion (ROM), Western Ontario and McMaster Universities Arthritis Index (WOMAC) scores were used as outcome measures. Data was collected before and after the four-week treatment period. Safety and side effects were monitored throughout the study. The average results show a large effect on VAS pre and post with a mean of 3.30 ± 1.34 with a significant value (P < 0.005) and WOMAC pre and WOMAC post with a mean of 27.70 ± 17.01 with a significant value (P < 0.001), so the conclusion of this finding is that giving intervention Neuromuscular Taping combination Ultrasound therapy and exercise therapy protocol for 4 weeks 3 times a week showed a significant effect in reducing pain scores and reducing functional disability in cases of knee osteoathritis.

Keywords:- *Knee Osteoarthritis, Ultrasound, Exercise Therapy, Physiotherapy, Neuromuscular Taping (NMT).*

I. INTRODUCTION

Osteoarthritis is a degenerative disease that occurs during the ageing process and affects people over 45 years of age and more women than men. problems that occur in the joints in carrying out their functions [1]. Osteoarthritis is chronic and non-inflammatory, and there is erosion of joint cartilage and osteophytes on the joint surface. Almost 70% of those aged 50 years and older have joint complaints that are characterised by damage to the joint structure [2]. Generally, this disease can occur in the wrists and most often occurs in the knees because their function is to always support the body's weight, but it does not rule out the possibility that it can occur in the hips and back [3]. WHO (World Health Organisation) added osteoarthritis as one of four muscle and bone conditions that are a problem for individuals, with significant treatment costs. They estimate that 9.6% of men and 18% of women over the age of 60 suffer from osteoarthritis, and this will continue to increase due to increasing life expectancy, obesity, and smoking [4]. The prevalence of osteoarthritis based on the Osteoarthritis Research Society International (OARSI) (2016) saw an increase in OA by 73% in 2013 and is ranked as the third fastest increasing condition related to disability, behind dementia and diabetes mellitus. In Indonesia, it reaches 5% of people aged < 40 years, 30% at age 40–60 years, and 65% at age > 61 years [5]. Osteoarthritis sufferers in Riau from Basic Health Research data (RISKESDAS) saw a decrease in the prevalence of joint disease at ages > 15 years from 11.9% in 2013 to 7.3% in 2018, while the prevalence in Riau did not change from 2013 to 2018, namely 7.1% (Ministry of Health, 2018) [6]. OA affects 13.9% of adults aged 25 years and over and 33.6% (12.4 million) of those over 65 years of age. It was estimated that there were 26.9 million adults in the United States in 2005. It is now estimated that half of all adults will experience symptomatic OA in their lifetime, and this number will increase to two out of three obese adults [7]. With more than 34% of adults aged 20 years and older in the United States meeting criteria for overweight, 33.8% meeting criteria for obesity, and 5.7% categorised as severely obese, rates of knee OA are predicted to increase exponentially. The

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financial costs of OA care are estimated at $2600 per capita out-of-pocket expenditures and $5700 total costs per person, for a total estimated annual national cost of $15.5–$28.6 billion per year. This includes 11.1 million outpatient visits and 632,000 joint replacements annually [8].

Knee OA is one of the five leading causes of disability among non-institutionalised adults. Some degree of mobility limitation is experienced by 80% of OA patients; 25% cannot carry out main activities of daily living (ADL); 11% of adults with knee OA require personal care assistance; and 14% require assistance for routine needs [9]. The cause of osteoarthritis cannot be ascertained, but there are factors that are at risk for osteoarthritis, such as old age, obesity, trauma to the joints, genetic abnormalities in the joint cartilage, and pressure on the joints during heavy activities that burden the knees [7]. The main symptoms most commonly experienced by osteoarthritis sufferers are pain and stiffness in the joints. Pain occurs due to excessive use of the joint. Meanwhile, stiffness can occur because the pain that is felt makes the sufferer not carry out movement or activity in the joint. The emergence of the above can occur at some point in the morning when you just wake up or in the afternoon after resting. [10]

Signs and symptoms of osteoarthritis include crepitus, pain, limited range of joint movement, Q-angle valgus and varus deformity, joint stiffness, and muscle weakness (Utomo, 2015). Joint pain is pain that occurs in the joint area and around the joints as a result of an inflammatory process or occurs idiopathically [11].

Based on the results of magnetic resonance imaging (MRI), the source of pain in osteoarthritis sufferers is joint inflammation (synovitis), joint effusion, and bone marrow edema. Bone growth (osteophytes) is also a sign of pain. When osteophytes develop, neurovascular innervation penetrates the bone base to the cartilage and towards the osteophytes that are undergoing growth (Winangun, 2019). These signs and symptoms will reduce the elderly's endurance and balance, worsen walking patterns, decrease mental health, depression, decreased cardio-vascular and respiratory function, and decrease daily functional activities [12].

Physiotherapy strategies are needed in treating knee osteoarthritis to reduce pain, stiffness, and functional disability. The recommended strategy is a conservative non-pharmacological strategy by applying NeuroMuscular Taping, a technique that uses elastic adhesive tape on the skin, providing a therapeutic effect that directs long distances through reflex pathways. can reduce pain and facilitate lymphatic drainage through skin fold formation and muscle movement to achieve biomechanical therapeutic effects. Muscles are an important part of the action of neuromuscular taping, which affects veins, lymphatic circulation, and body temperature. Ultrasound therapy is a modality used in the field of physiotherapy that has high sound waves, namely >20,000 Hz. In physiotherapy, several choices of megahertz are used, namely in the range of 0.5–5 MHz. The ultrasound dose is set within 1 MHz to a frequency of 3 MHz. aims to increase blood circulation and speed up the healing process of inflammation. The exercise therapy protocol supervised by physiotherapists is an intervention or physiotherapy action that focuses on movement exercises or physical activities, both active and passive, that are systematic, planned, structured, and repetitive with correct movement patterns to restore musculoskeletal function to normal and improve fitness and functional ability [13].

The aim of this study was to assess the effectiveness of the application of neuromuscular taping and a combination of ultrasound therapy and exercise therapy protocols to reduce pain, stiffness, and functional disability in elderly people with knee osteoarthritis.

II. RESEARCH METHOD

This research design uses experimental research with a pre-test and post-test one-group design, without a control group. The research was conducted from August to September 2023 at the FIT Rehabilitation Centre Pekanbaru (RIAU).

The sample in this study was all 10 patients with knee osteoarthritis. The sampling technique uses a total sampling technique, namely a sampling technique by taking all members of the population as respondents, or the selected sample of 10 participants. The inclusion criteria in this study were patients aged 38 to > 65 years who experienced knee pain following clinical and radiological assessment, elderly patients with chronic knee pain throughout the day for ≥ 3 months, radiological tibiofemoral OA (Kellgren-Lawrence grade 2–3 as evaluated by a radiologist and orthopaedic doctor), stiffness in the morning < 30 minutes, crepitus, tenderness, enlarged ones or knees, and not being hot to the touch. Exclusion criteria in this study were: acute knee pain, previous knee surgery, other connective tissue diseases affecting the knee, serious neurological or psychiatric disorders, steroid or hyaluronic acid injection therapy during the previous 3 months, sciatica pain, use of anticoagulant drugs, use of a pacemaker, and previous electroacupuncture treatment [14]. Samples selected to be research subjects were given a mentor regarding the research programmeme to be carried out, were willing to take part in the research programmeme, and were asked to fill out informed consent [8].

III. RESEARCH PROCEDURE

The demographic and clinical characteristics of all participants were recorded. Age, gender, weight, height, BMI, visual analogue scale (VAS) pain intensity, ROM (geniometer), and WOMEC The research was conducted for 4 weeks and 3 times a week. The examination and instruments used in this research are:

A. Inspection and Measurement Methods with VAS

The visual analogue scale (VAS) is a pain assessment tool that uses a 10 cm line table with scale readings (0-10 cm) and a range of scale meanings (0-1 cm with no pain interpretation, 1-3 cm with mild pain interpretation, 3-6 cm with moderate pain interpretation, 7-9 cm with severe pain interpretation, and 9-10 cm with very severe pain

interpretation. Visual analogue scale (VAS) pain intensity before intervention 1 week and 4 weeks after intervention The determination of the VAS score is done by measuring the distance from the end of the line indicating no pain to the point indicated by the patient [15].

B. Measurement Using WOMAC

Measuring the functional degree of the knee is an assessment of the patient's disability and an indicator of the success of the action that has been taken. One way to assess the functional level of the knee is to use the Western Ontario and McMaster Universities Arthritis Index (WOMAC), which is an index to assess the condition of patients with osteoarthritis of the knee. A total of 24 questions consisting of pain, stiffness, and physical and social function are evaluated using WOMAC. The measuring tool is in the form of a questionnaire containing 5 questions regarding pain, 2 questions related to joint stiffness, and 17 questions related to physical activity. The lower the total score produced, the greater the improvement in functional ability. The interpretation of the total WOMAC score includes: Mild, 24-48 = moderate, 48-72 = severe, and 72-96 = very severe [16].

C. Measurement Using a Goniometer

Knee joint stiffness can be measured by assessing the range of motion of the knee joint. Measurements are carried out using a tool, namely a goniometer. The goniometer is a parameter used in evaluating joints and soft tissue around the joints. Referring to the International Standard Orthopaedic Measurement (ISOM) criteria, normal knee joint (active movement) S = 0o–0o–90o (passive motion) S = 10o-0o-160o [16].

D. Intervention Phase

- *Method for installing elastic therapeutic taping using the NMT technique*

Preparing the patient: position the patient with the legs flexed at 110º; draw a circle line on the patella with a body marker or eyebrow pencil. Preparing for installation, prepare the tape, then measure the tape with a length of 30 cm and 25 cm. Then cut out 3 fan-shaped taping strips with a width of 1 cm each. Do this on both pieces of tape. To apply the tape, clean the patient's knee with water or a wet tissue. Place the taping double fan on the front knee, and place one fan on the back knee. Type: double fan Quantity: 3 strips Size: 30 cm 2 and 25 cm 1 [17].

- *Implementation of therapeutic ultrasound*

The patient is in a supine position on the bed. Position the patient as comfortably as possible. Patients are asked to remove clothing that covers or hinders the therapy process. Provide education about the effects and benefits of ultrasound. The therapist's position is as comfortable and clean as possible. Determine the intensity to be used, namely 1 watt/cm (low current), and ensure that the current used is continuous. The transducer is placed on the area to be treated for 5–10 minutes. The transducer is moved, and the movement must be in the same direction [18].

- *Implementation of Exercise Therapy*

Training Protocol consists of 4 weeks of training, with 3 days per week. This programme was designed based on the recommendations of the American Geriatrics Society. All sessions were supervised by a trained physiotherapist (first author) [19].

The exercise therapy protocol for knee osteoarthritis patients in grades 2–3 is: warm up for 10 minutes with flexibility and mobility exercises to train the hip, knee, and ankle joints while walking and sitting on the floor. 2. Muscle strengthening is carried out for 20 minutes using isometric exercises for the quadriceps (quadriceps), hamstring muscle strengthening exercises, and isotonic exercises lying on your side for the hip and pelvic muscles. 3. Balance and stabilisation exercises are carried out for 10 minutes of walking forward, walking backwards, stepping sideways, walking on toes, and walking on heels. 4. Muscle stretching is carried out for 5 minutes by stretching the quadriceps muscles, hamstring muscles, and gastrocnemius muscles. 5. Cooling down is carried out for 5 minutes at a slow pace [12].

IV. RESULTS

Participant characteristics in terms of age, weight, and height Gender, body mass index.

Table 1: Demographic Data of Participants in the Intervention Neuromuscular taping combination ultrasound therapy and exercise therapy protocol.

Variabel (N=10) Category	**Mean ± SD**	**Minimum; Maximum**	***P-Value***
Gander: Male (2 participants) Female (8 participants)	8.60 ± 0.84	2;8	0.000
Age (years)	57.80 ± 10.20	42; 72	0.602
Body Weigh (kg)	68.80 ± 10.20	55; 85	0.243
Height (cm)	159.40 ± 5.89	147;169	0.234
BMI	26.96 ± 3.61	22; 33.20	0.734

Table 1 shows the characteristics of a sample of 10 people (N = 10) with NMT interventions in ultrasound therapy and exercise therapy protocols. It was found that the mean gander was 8.60 ± 0.84, with the minimum gander in males being 2 participants and the maximum gander in females being 8 people. Mean age: 57.80 ± 10.20, with a minimum age of 42 years and a maximum age of 72 years; mean body weight: 68.80 ± 10.20, with a minimum body weight of 55 kg and a maximum body weight of 85 kg; mean height: 159.40 ± 5.89, with a minimum height of 147 cm and a maximum height of 169 cm; and mean body mass index (BMI): 26.96 ± 3.61, with a minimum BMI of 22 and a maximum BMI of 33.20. Table 2: Shapiro-Wilk statistical analysis test.

Table 2: Shapiro–Wilk Statistical Analysis Test

Varibes	Shapiro-Wilk test	
N=10	Mean± SD	Sig
VAS Pre	5.90 ± 1.28	>0.234
VAS Post	2.60 ± 0.84	>0.172
WOMAC Pre	45.70 ± 20.07	>0.294
WOMAC Post	18.00 ± 8.57	>0.322
ROM Pre	127.50 ± 9.79	<0.003
ROM Post	131.50 ± 6.26	<0.000

Table 2 shows that the decision to test the hypothesis first uses the results of the data normality test using the Shapiro Wilk test where the data is less than 50. For all pre-test and post-test variables in the data group, if the significant value is P<0.05, then the data is not normally distributed, and then analyse the hypothesis using a non-parametric test with the Wilcoxon Signed Ranks Test. If the significant value is P > 0.05, then the data is distributed. Normally, a t-test will be carried out. Table 3: Hypothesis analysis pre- and post-treatment Neuromuscular taping combination Ultrasound therapy and exercise therapy protocol

Table 3: Hypothesis Analysis Pre and Post Treatment Neuromuscular Taping Combination Ultrasound Therapy and Exercise Therapy Protocol

N=10	Mean± SD	Minimum; maximum	P-Value
VAS Pre and VAS post	3.30± 1.34	4.00 ; 8.00 1.00: 4.00	<0.005
WOMAC pre and WOMAC Post	27.70± 17.01	23.00: 80.00 6.00 : 37.00	<0.001
ROM Pre ROM post	4.75± 9.50	110 : 135 120 : 135	>0.228

Table 3 explains that according to the Wilcoxon Signed Ranks Test, the neuromuscular taping combination ultrasound therapy and exercise therapy protocol VAS Pre and VAS P-Value treatment scores were <0.005 (P<0.05). The results of these values indicate that there is a significant difference in pain reduction for knee osteoarthritis patients before and after intervention. Pre- and post-WOMAC scores had a value of P <0.001 (P<0.05). The results of these values state that there is a significant difference in the reduction of functional disability before and after the intervention. Pre- and post-ROM scores were >0.228 (P > 0.05).

V. DISCUSSION

Based on the demographic data of the participants, intervention, neuromuscular tapping combination, ultrasound therapy, and exercise therapy protocol, The mean gander is 8.60 ± 0.84, with the minimum gander in males being 2 participants and the maximum gander in females being 8 people. This finding shows that women are more likely to suffer from knee osteoarthritis than men because in women there is a decrease in the hormone oestrogen and excessive physical activity on the knees. Physical activity: continuous repetition of joint movements can predispose to osteoarthritis, but proper movement of the knee joint and muscles around the knee can strengthen and stabilise the joint, thereby reducing the risk of osteoarthritis [13]. Injury also increases the risk of genital osteoarthritis. Injuries that increase the risk of genu osteoarthritis are meniscus tears or anterior cruciate ligament injuries. Mean Age The mean age is 57.80 ± 10.20, with a minimum age of 42 years and a maximum age of 72 years. These findings show that age is the strongest risk factor. The ageing process will reduce the number of chondrocytes in joint cartilage and will correlate directly with the degree of cartilage damage. The prevalence and severity in women are greater than in men. Research shows that hormones play a role in the mechanism of osteoarthritis. The mean body weight was 68.80 ± 10.20 with a minimum body weight of 55 kg and a maximum body weight of 85 kg, and the mean body mass index (BMI) was 26.96 ± 3.61 with a minimum BMI of 22 and a maximum BMI of 33.20. These findings indicate that some participants are obese because obese people have a 2.96 times higher risk of developing osteoarthritis than people with normal bodies. Obesity increases the risk of osteoarthritis by several mechanisms, such as increasing joint load, especially on weight-bearing joints, and less physical activity, ultimately eliminating the ability and strength of the muscles around the joints. In genus osteoarthritis, obesity causes weakness of the muscles around the knee joint and increases the incidence of arthroplasty [1].

VAS, WOMAC, and ROM scores before and after showed a statistically significant decrease. Referring to the evaluation table of final therapy results based on research conducted by the author using neuromuscular tapping, ultrasound therapy, and protocol exercise therapy to reduce pain and stiffness and decrease functional disability in cases of knee osteoarthritis grades 1-3, the results of the distribution of subjects were mean VAS. Pre 5.90 + 1.28, minimum score 4.00 and maximum score 8.00, and VAS Post mean 2.60 + 0.84, minimum score 1.00 and maximum score 4.00. The findings of this study show a significant decrease. Mean WOMAC Pre 45.70 + 20.07, minimum score 23.00 and maximum score 80.00, WOMAC Post 18.00 + 8.57, minimum score 6.00 and maximum score 37.00. These findings indicate a significant reduction in functional disability. Mean ROM Pre 127.50 + 9.79 Minimum score 110 and Maximum score 135, ROM Post 131.50 + 6.26 Minimum score 120 and Maximum score 135. This finding shows a slight, significant increase because participants with grade 1–3 knee osteoarthritis experienced movement pain during passive movement full knee flexion [16].

The results of parametric statistical tests (paired t-tst) show that the VAS and WOMAC results increased significantly. Total VAS Pre and VAS Post with a mean of 3.30 ± 1.34 with a significant value (P<0.005) and WOMAC Pre and WOMAC Post with a mean of 27.70 ± 17.01 with a significant value (P<0.001), then the Neuromuscular Taping Intervention combination ultrasound therapy and exercise therapy protocol was given for 4 weeks 3 times per week and showed a significant effect in reducing pain scores and reducing functional disability in cases of knee osteoarthritis. The results of the non-parametric statistical test (Wilcoxon

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Signed Ranks Test) ROM Pre and ROM Post had a mean of 4.75 ± 9.50. Minimum score 120 and maximum score 135 have a significant value (P> 0.228). This finding shows that there is a slight and significant difference in the pre- and post-scores in reducing stiffness [20]. Neuromuscular tapping (NMT) with a decompression technique will form folds in the skin, which results in lifting the skin and increasing space in the skin, which improves blood circulation, thus providing an effect that can relieve pain and normalise muscle tension [17].

Based on research (Rieke et al., 2014), ultrasound is the effect of sound waves that pass through a medium that vibrates the tissue molecules in the knee joint, increasing tissue fluid exchange and affecting the mobility of the knee joint tissue, which is called micromassage. Ultrasound is able to reduce pain due to several possible causes, including the recovery of inflammation, the removal of waste products, or changes in the permeability of cell membranes to sodium, which can change electrical activity or the pain threshold [21].

Then, to increase pain reduction, neuromuscular tapping (NMT) is given. Neuromuscular tapping (NMT) with decompression techniques will form folds in the skin, which results in lifting of the skin and increasing space in the skin, which improves blood circulation, thus providing an effect that can relieve pain and normalise muscle tension [17].

Based on research (L. Ogura et al., 2021), an exercise therapy protocol is a method or technique for strengthening muscles in which optimal isometric and isotonic contractions are carried out on antagonistic and antagonistic muscle groups, followed by relaxation, aimed at reducing pain and increasing passive range of motion so that stiffness is reduced. Lack of activity in muscles can cause weakness and atrophy. Quadriceps muscle weakness can increase the risk of knee osteoarthritis. The quadriceps are the largest muscle group that passes through the knee joint and have the greatest potential to absorb energy and stress on the knee joint. This muscle plays an important role in the process of walking, standing, and climbing stairs. The patient is in the process of walking, standing, and climbing stairs. Genu osteoarthritis sufferers will reduce knee movement to reduce pain, which causes the quadriceps muscles to experience weakness and atrophy. This exercise can produce co-contractions (simultaneous agonist-antagonist contractions). Co-contraction causes the muscles to be able to stabilise the joints better, thus affecting the quality of the movements produced. Pressure on the joints will stimulate the receptors in the joints and increase joint congruence, which is also very helpful for stability. Multiple muscle contractions will really help produce synergistic movements in accordance with the stages of normal movement. A study by Ogura found significant benefits with a 4-week physiotherapy programme [9].

VI. CONCLUSION

This study showed more improvement in the pain scale with VAS and functional disability with the WOMAC score. However, the ROM score was significantly lower because participants experienced movement pain at the end of the ROM. The conclusion shows that the application of neuromuscular taping and a combination of ultrasound therapy and exercise therapy protocols is relatively safe and provides a greater effect in reducing pain, stiffness, and functional disability in elderly people with knee osteoarthritis.

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