

Effectiveness of massage therapy continued exercise therapy against pain healing, ROM, and pelvic function in people with chronic pelvic injuries

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Abstract

This study aims to test and compare the effectiveness of massage therapy followed by exercise therapy against pain healing, range of motion (ROM), and pelvic function in people with chronic pelvic injuries. This study is a pre-experimental study with a multiple group pretest and posttest design. The treatment intervention in this study with massage therapy was continued with Yoga exercise therapy, theraband, proprioceptive neuromuscular facilitation (PNF), and core stability exercise (CSE). The sample in this study was 96 people with chronic pelvic injuries (more than three weeks). Instruments used include pain measurement instruments with visual analogue scales, goniometry to measure the range of motion (ROM), as well as pelvic functional instruments using (Harris Hip Score and Oxford Hip Score). Data analysis using Wilcoxon signed-rank test and Kruskal Wallis In general massage therapy followed by exercise therapy can reduce pain levels in people with pelvic injuries from 5.3 to 2.5 (52.4%), can increase ROM Flexion from 91.0 to 104.5 (16.8%), ROM Extension from 33.7 to 43.7 (37.3%), ROM adduction from 37.5 to 47.5 (33.9%), Importation ROM from 55.3 to 67.3 (24%), Internal Rotation ROM from 34.9 to 44.6 (30.7%), and Rotation External ROM from 36.9 to 43.6 (21.7%). Pelvic function after treatment increased from 86.7 to 93.7 (8.9%). Thus, massage therapy continued with exercise therapy can reduce pain very effectively, increase ROM effectively, and improve pelvic function quite effectively. For the decrease in Pain, the CSE group reached the highest percentage (92.3%), then successively followed by the Theraband, Massage, PNF, and Yoga groups (58.3%). For Flexion ROM, the Theraband group experienced the highest increase (29.1%), while PNF experienced the highest increase for both Extensions (91.7%), Adduction (76.4%), Abduction (67.8%), Internal Rotation (67.9%), and External Rotation (82.4%). Thus it can be concluded that massage therapy followed by exercise therapy can reduce pain very effectively because massage therapy and exercise therapy can increase muscle tone, improve blood circulation and increase endorphins released by the body, resulting in decreased pain. Massage therapy followed by exercise therapy can increase ROM effectively because of the process of changing muscle lengths so that it stimulates the neuromuscular mechanism in ROM. Massage therapy followed by exercise therapy can improve pelvic function quite effectively because of an increase in the recovery of the function of the pelvic muscles, an increase in ROM in the hip joint, and a reduction in hip pain. This has resulted in a very high recovery rate for chronic pelvic injury patients.

Keywords: massage therapy, exercise therapy, pain healing, ROM, pelvic function, chronic pelvic injury

Introduction

Injury is a disorder that occurs in any part of the body that causes pain, heat, red discolouration, swelling, and reduced Range of Motion (ROM) in muscles, tendons, ligaments, joints, or bones that occur due to overuse or accidents (Rahmaniar, 2019). There are three types of injury factors, namely muscle fatigue, previous injuries, and muscle imbalance (McCall et al., 2015) Injury can result in reduced ability to function in the body (Nirmalasari et al., 2020). One of the most common injuries is pelvic injuries because pelvic injuries are pain that is felt in the lower abdomen (abdominal area), pelvic area, or perineum (the area between the rectum and scrotum or vagina) and is influenced by several causes such as muscle tension, tendons or tendons. ligaments, injuries or fractures, sports hernias, bursitis, osteitis pubis, and hip-related diseases (Harrington, 2021) as well as high-intensity exercise (Candela et al., 2019)

Pain is defined as an unexciting sensory and emotional experience adrift with actual or potential tissue destruction (Reavey & Vincent, 2022). Chronic pain due to tissue destruction heals when the tissue heals. However, in a state of chronic pain, adjusting as well as increased regulation in the central nervous system. Chronic pelvic pain (CPP) without the presence of violence is a presumption that is at risk of stimulation in the pelvic area of both men and women that lasts intermittently or continuously for 6 months or more (Bradley et al., 2017; Harrington, 2021). Pelvic pain can affect many systems in the body, listed nerves, endocrine, urinary, reproductive, gastrointestinal, and immune systems.

The pelvis has joint space. ROM in the hip joint, namely: Femoral-on-pelvic hip kinematics. With the knee flexed, the mean ROM of flexion of the femur at the hip joint is about 120°. With the knee in the extended position, the average femur flexion ROM at the hip joint is limited to about 70-80°. ROM extension of the femur at the hip joint is approximately 20° from the neutral position. The average hip abduction ROM is about 40°, while the average hip adduction ROM is about 25° (Al-Muqsih, 2017).

If the pelvis is injured, it will inhibit the Range of Motion (ROM). Obstacles to the pelvic joint must be quickly given a crackdown as a healing effort so as not to cause negative consequences that continue to be severe. The attempted cure efforts against pelvic pain barriers can be pharmacological and non-pharmacological treatments (Thorborg & Hölmich, 2013). Pharmacological treatment is the treatment of using drugs to heal muscle pain and joint pain. The opposite of non-pharmacological treatment is a treatment that is tried using various healings, such as acupuncture, shiatsu, heat healing, cold healing chiropractic, massage, and others.

Currently, an efficient and cost-effective method is needed to treat disorders of the musculoskeletal system. Almost everyone in some part of life will experience this problem. Musculoskeletal disorders in the form of osteoarthritis, rheumatoid arthritis, injuries, and syndromes result from daily life, where these musculoskeletal disorders occur due to several factors due as poor eating habits that lead to obesity or malnutrition, spending long hours in one working position. Many factors can ultimately cause problems with musculoskeletal disease, one of which is the hip joint. The hip joint is one of the most important joints in the body, because the hip supports the body for activities such as walking and moving, so a healthy and strong hip joint is needed. If the hip joint is not strong, it can cause disruption and even injury to the hip. To overcome this, proper and effective massage therapy is needed. The effectiveness of massage in the therapy of obturator nerve dysfunction as a complication of hip joint phalloplasty (Zuzda et al., 2022). Massage therapy, as a stand-alone treatment, reduces pain and improves function compared to no treatment in several musculoskeletal conditions (Bervoets et al., 2015).

Massage therapy has been shown to have beneficial effects on a variety of conditions including prenatal depression, premature infants, term infants, autism, skin conditions, pain syndromes including arthritis and fibromyalgia, hypertension, autoimmune conditions including asthma and multiple sclerosis, immune conditions including HIV and cancer. breasts, ageing problems including Parkinson's and dementia, massage therapy also provides more stimulation of pressure receptors, which in turn increases vagal activity and reduces cortisol levels (Field, 2016). Society tends to sort out non-pharmacological treatments in overcoming its special musculoskeletal barriers to the pelvic joints because it avoids other consequences that can be caused by drugs. One form of non-pharmacological treatment that people try it with a healing period such as Topurak (Ambardini & Kushartanti, 2016).

Topurak manipulation is a mixture of compressive manipulation meaning the suppression of trigger point points on the surface of the body, clock/tapotement means hitting certain muscle parts, and movement/stretching means moving the scope of movement of the joints. Topurak manipulation is tried by patting on trigger points for the process of muscle softening so that it can reduce stiffness or muscle tension. Clock or tapotement to improve muscle softening so that the scope of movement of the joints increases and pain will decrease (Rohim & Kushartanti, 2017). The movements that patients try with instructions from treatment can restore the joints to the correct position, as well as stretch stiff muscles so that they become more relaxed. The advantages of Topurak manipulation can relax muscles, reduce pain, and actively hook patients so that they are more comfortable because the patient carries out outmatches the stiffness and pain experienced (Ambardini & Kushartanti, 2016).

Topurak manipulation for shoulder subluxation repositioning is known to have the power to reposition the shoulder joint with increased ROM marked, reduce pain due to shoulder subluxation, and be efficient in shoulder repositioning (Rohim & Kushartanti, 2017). Manipulation of Topurak for the treatment of pain and neck muscle tension is also known to have the power to treat pain and neck muscle tension which is characterized by increasing range of movement (ROM), shrinking the pain scale, and increasing the body. On the contrary, topurak manipulation has not been tried research previously in the treatment of chronic pelvic wounds so it is not yet known its usefulness.

So far there have been many pharmacological and surgical healing options that can be tried to suppress pelvic injury constraints. Recent application guidelines for pelvic injury enforcement from the American College of Physicians and the American Pain Society show that if pelvic injuries do not improve with pharmacological treatment and standard self-care, nonpharmacological care should be considered (Maher et al., 2017). Therefore, close to 40% of patients with pelvic injuries tell using complementary medicine as well as alternatives such as massage, reflexology, and acupuncture (Allegrì et al., 2016). Research also shows that in many problems CPP can receive a manual therapy approach (Chaitow, 2007).

Other alternative modalities include hypnosis, biofeedback, relaxation, massage, and traction treatments; and pelvic wound rehabilitation exercises listed as Yoga-based exercises, exercises with theraband, Proprioceptive Neuromuscular Facilitation (PNF) exercises, and Core Stability Exercise (CSE). Exercise is a process of increasing training skills that fit theory and practice, using procedures and provisions of application sourced from a scientific approach, using principles that are planned and orderly, so that the purpose of the exercise can be achieved in time (Nasrulloh et al., 2020, 2021; Nugroho et al., 2021). Exercise therapists are a meaningful part of a multidisciplinary team that helps cure chronic pelvic soreness (Bradley et al., 2017). Yoga,

PNF, Theraband and CSE exercise therapy are the recommended types of therapy for chronic pelvic wound problems (Ferber et al., 2015; Kim & O'Sullivan, 2013; Lempke et al., 2018; Pauline & Rintaugu, 2011). Research proves that exercise therapy can universally correct the muscles of the back support that tend to weaken in this obstacle. The exercise is recommended considering that this exercise aims to strengthen and revise the shape of the togok body. In addition, research also shows that exercise has the potential to increase muscle strength, joint flexibility, and balancer in patients with chronic pelvic injuries. The exercise can also reduce the assumption of pain, increase the pain threshold and increase the pelvic use. Until now, scientific facts about the usefulness of the exercise after mass therapy for pelvic injury suppression have not been widely studied and therefore the purpose of this research is to systematically take into account the fact of the usefulness of these exercises in healing pelvic injuries about the revision of use, pain shrinkage and improvement in the quality of life of people with pelvic injuries.

Materials & methods

This study is a pre-experimental study with a multiple group pretest and posttest design. The treatment intervention in this study with massage therapy was continued with Yoga exercise therapy, theraband, proprioceptive neuromuscular facilitation (PNF), and core stability exercise (CSE). The sample in this study amounted to 96 people obtained incidentally. The inclusion criteria in this study were non-specific chronic pelvic injury sufferers (more than three weeks), had the capacity and willingness to perform prescribed exercises, and were willing to be the subject of a study marked by the signing of Informed Consent. Exclusion criteria are patients with pelvic injuries caused by fractures, malignancy, neurological deficits, or kidney failure (specific pelvic injuries), and patients taking analgetic and anti-inflammatory drugs for the past 7 days.

The pain instrument uses the Visual Analogue Scale. Instrument Range of Motion (ROM) is a measurement of the scope of motion of the joint using a goniometer. Instruments used to assess pelvic function include the Harris Hip Score and the Oxford Hip Score. The social demographic data of the study subjects were analyzed descriptively. Functional capacity data, pain, and living quantities are processed with non-parametric statistics because all instruments produce ordinal data. In this study, Wilcoxon Signed Rank was used to measure the effects of each post-natal exercise to reduce pain, improve the range of motions (ROM) and increase the functional capacity of the pelvis. Kruskal Wallis was conducted to compare effective levels of yoga-based exercises, PNF, Theraband, and CSE to reduce pain, improve range of motions (ROM) and increase pelvic functional capacity.

Result

Chapters of research results and discussions will be presented sequentially, including (1) Results; Research Data Normality Test, (2) inferential statistical analysis test with Wilcoxon Signed Rank Test to show significant differences in function data, pain, flexion, extensions, adduction, deduction, production, internal rotation and external rotation in the control group, CSE, yoga, theraband and PNF, and (3) Different tests with Kruskal Wallis are used to compare pretest, posttest, and difference (percent) between the treatment group and the control group, In full it will be presented as follows: Normality Test

Table 1. Normality Test Results of Research Data

		Total (n=96)	Control (n=20)	CSE (n=20)	PNF (n=18)	TheraBand (n=20)	Yoga (n=18)
Pelvic function	Pretest	<0.001	0.169	0.025	<0.001	0.002	0.038
	Posttest	0.001	0.006	<0.001	<0.001	<0.001	0.696
	Delta	<0.001	0.067	0.085	<0.001	0.006	0.188
	Delta%	<0.001	0.044	0.024	<0.001	0.002	0.442
Pain	Pretest	<0.001	0.055	0.012	0.189	0.285	0.024
	Posttest	<0.001	0.002	<0.001	0.043	<0.001	0.013
	Delta	<0.001	0.035	<0.001	0.173	0.077	0.635
	Delta%	<0.001	0.013	0.001	0.208	0.149	0.485
Flexion	Pretest	<0.001	0.913	<0.001	0.044	0.372	0.19
	Posttest	<0.001	0.626	0.034	0.807	0.232	0.88
	Delta	<0.001	0.222	0.014	0.032	0.013	0.067
	Delta%	<0.001	0.004	<0.001	<0.001	<0.001	0.026
Extension	Pretest	<0.001	0.007	<0.001	0.513	0.325	0.224
	Posttest	0.014	0.098	<0.001	0.4	0.471	0.035
	Delta	<0.001	0.06	0.152	0.675	0.159	0.208

	Delta%	0.001	0.01	0.019	0.292	0.003	0.574
Adduction	Pretest	0.01	0.481	<0.001	0.101	0.897	0.665
	Posttest	<0.001	0.288	<0.001	0.813	0.146	0.32
	Delta	<0.001	0.204	0.375	0.024	0.658	0.162
	Delta%	<0.001	0.05	0.395	<0.001	0.005	0.412
Abduction	Pretest	<0.001	0.123	<0.001	0.896	0.074	0.144
	Posttest	0.002	0.213	<0.001	0.387	0.522	0.716
	Delta	0.2	0.228	0.14	0.143	0.295	0.897
	Delta%	0.102	0.074	0.097	0.015	0.009	0.107
Internal Rotation	Pretest	0.026	0.012	0.012	0.342	0.572	0.953
	Posttest	0.153	0.66	0.001	0.451	0.438	0.255
	Delta	0.004	0.768	0.531	0.748	<0.001	0.679
	Delta%	<0.001	0.016	0.592	0.029	<0.001	0.058
External Rotation	Pretest	<0.001	0.448	0.012	0.893	0.466	0.018
	Posttest	<0.001	0.613	<0.001	0.077	0.69	0.176
	Delta	0.026	0.307	0.062	0.783	0.071	0.534
	Delta%	0.001	0.623	0.254	0.91	0.002	0.437

Table 1, shows the results of the normality test. The data tested for normality include a pretest, posttest, delta, and delta % in all data observed, namely function, pain, flexion, adduction, deduction, abduction, internal rotation, and external rotation for each treatment group. The results of the normality test showed that there was a normal distribution of data, and most of the data were not distributed normally. Based on these results, research data is not eligible for analysis using parametric analysis, so data analysis uses non-parametric statistical analysis.

The different tests with Wilcoxon Signed Rank Test were used to compare pretests and posttests between the treatment group and the control group. The test results are different from Wilcoxon Signed Rank Test are as follows:

Table 2. Pretest and Posttest Different Test Results with Wilcoxon Signed Rank Test

	Total	Control	CSE	Yoga	Thera	PNF
Pelvic function	<0.001	<0.001	<0.001	0.012	<0.001	<0.001
Pain	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Flexion	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Extension	<0.001	<0.001	<0.001	0.008	<0.001	<0.001
Adduction	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Abduction	<0.001	<0.001	<0.001	<0.001	0.002	<0.001
Internal Rotation	<0.001	0.003	0.003	0.011	<0.001	<0.001
External Rotation	<0.001	0.001	<0.001	0.052	<0.001	<0.001

Table 2, shows the results of the Wilcoxon Signed Rank Test analysis on the data of each treatment group. The results of the Wilcoxon Signed Rank Test showed significant differences in data on function, pain, flexion, extension, adduction, abduction, internal rotation, and external rotation in the control group, CSE, yoga, theraband, and PNF. The results of the analysis found that there was insignificant data, namely external rotation data in the yoga group ($p = 0.052$), meaning that there was no significant difference between the pretest and posttest of rotational external movements in the yoga groups. Difference Test between Groups (Kruskal Wallis Difference Test). The different tests with Kruskal Wallis were used to compare pretests, posttests, and differences (percent) between the treatment group and the control group. The test results are different from Kruskal Wallis are as follows:

Table 3. Mean Rank and Test are Different from Kruskal Wallis.

		Control	CSE	Yoga	Theraband	PNF	Kruskal Wallis (H)	df	P
Pelvic function	Pretest	57.7	36.6	55.4	71.7	18.8	41.3	4	<0.001
	Posttest	50.5	68	20.3	70.4	28.6	51.6	4	<0.001
	Delta	40.6	69.1	19.6	38.8	74.1	49.6	4	<0.001
	Delta%	41.5	66.7	20.4	38.2	75.6	48	4	<0.001
Pain	Pretest	45	76.2	32.9	34.2	53	32.2	4	<0.001
	Posttest	54	30	53.3	43.5	63.7	17.4	4	0.002
	Delta	57.9	12.4	66.9	57.2	50.2	46.8	4	<0.001
	Delta%	54.3	23.3	61.2	47.7	58.3	23.7	4	<0.001
Flexion	Pretest	48.3	42.5	78.3	34.9	40.7	27.8	4	<0.001

Extension	Posttest	45.4	33	80.7	36.1	50.8	34.6	4	<0.001
	Delta	42.8	36.6	45	56.7	62.5	11.1	4	0.026
	Delta%	43	40.9	35.1	60.2	63.5	15.2	4	0.004
	Pretest	36.7	80.1	43.6	58.9	19.8	52	4	<0.001
	Posttest	33.5	74.3	27.8	66	37.9	43.5	4	<0.001
	Delta	43.7	37.6	33.8	58.2	69.9	21.8	4	<0.001
Adduction	Delta%	47.1	31.3	37	52.9	75.8	28.6	4	<0.001
	Pretest	51.4	60.5	36.7	52.3	39.7	9.4	4	0.051
	Posttest	43	51.2	42.8	41.4	65.2	9.6	4	0.048
	Delta	41.9	43.1	51.4	39.7	68.7	13.6	4	0.009
	Delta%	42.6	39.3	55.9	39.6	67.7	14.9	4	0.005
	Pretest	52.6	42.8	66	47	34.5	13.1	4	0.011
Abduction	Posttest	59.4	26.3	61.1	38.5	59.6	25	4	<0.001
	Delta	58.2	27.2	44.6	39.3	75.6	33.8	4	<0.001
	Delta%	56.5	29.8	41.3	40	77	32.6	4	<0.001
	Pretest	48.7	71.7	61.4	39.3	19.8	25.3	4	<0.001
	Posttest	43.9	50.3	48.3	47.6	52.9	8.2	4	0.086
	Delta	43.3	26.4	38.7	57.3	78.8	27.4	4	<0.001
Internal Rotation	Delta%	43	25.2	37.8	58.4	80.2	29.8	4	<0.001
	Pretest	52.4	68.6	48.3	46.7	24	39.2	4	<0.008
	Posttest	41.7	50.8	37.1	52.7	60.4	1.1	4	0.893
	Delta	41	35.7	37.4	53.8	76.4	38.9	4	<0.001
	Delta%	41.9	33.5	37.3	54.5	77.1	43.3	4	<0.001

Kruskal Wallis test analysis results on pelvic function data, pain, flexion, extensions, adductions, and deductions showed that there were differences in data at the time of pretest, post-test, delta, and delta percent data between the control groups, CSE, yoga, theraband, and PNF. Internal rotation data showed differences in internal rotation data at the time of pretest, but there was no difference in internal rotation posttest between the control group, CSE, yoga, theraband, and PNF ($p = 0.086$). Kruskal Wallis test analysis results on external rotation data showed that there were differences in external rotation data at the time of pretest, but there was no difference in external post-test rotation between the control groups, CSE, yoga, theraband, and PNF ($p = 0.893$).

Discussion

Based on the results of the study obtained, in general, Massage Therapy followed by Exercise Therapy can reduce the level of pain in people with chronic pelvic injuries from a score of 5.3 to 2.5 (by 52.4%). Decreased pain in people with pelvic injuries is due to being given massage therapy or Topurak manipulation which is carried out continuously so that it can have a positive effect on healing due to pelvic injuries. Massage topurak is one type of massage with compression manipulation (stocking), hit (tapotement), and motion (Stretching) that can be useful in muscle loosening, reducing pain, and repositioning joints to their original position (Ambardini & Kushartanti, 2016). When the trigger point is pressed or palpable, the stimulated muscle contracts and produces local pain. Tapotement aims to facilitate blood circulation, increase muscle tone, accelerate the supply of nutrients in tissues, and facilitate metabolism (Setiawan, 2020). Movement at this stage is done by asking the patient to move the pelvis according to the movement instructed with the breadth according to the pain and stiffness felt by the patient. Movement is done with the aim, if there are joints in the wrong position, it can restore the joint to its original position. Massage can also increase endorphins leading to decreased sensitivity to pain, relieving the mind, and increasing pain thresholds. While the use of exercise therapy is one of the efforts that can be done in injury rehabilitation with the main goal of achieving a 100% cure rate (Ambardini & Kushartanti, 2016).

Massage therapy followed by exercise therapy in people with pelvic injuries can also increase ROM Flexion from a score of 91.0 to 104.5 (by 16.8%), ROM Extension from the score of 33.7 to 43.7 (by 37.3%), ROM Adduci from a score of 37.5 to 47.5 (by 33.9%), ROM Production from a score of 55.3 to 67.3 (by 24%), internal ROM Rotation from a score of 34.9 to 44.6 (by 30.7%), and External ROM Rotation from a score of 36.9 to 43.6 (21.7%). Overall massage therapy followed by exercise therapy can increase ROM because that massage has physiological effects that can improve ROM, strength, coordination, balance, and muscle function to improve athletes' physical performance while reducing the risk of injury to athletes, while the exercise therapy carried out is one of the treatment efforts in wound healing or rehabilitation whose implementation involves optimizing ROM (Range of Motion) both actively and passively. In this case, it is reinforced by previous research that the combination of massage frirage therapy and exercise therapy is effective in rom recovery, pain, and pelvic injury movement function of patients (Hernowo & Ambardini, 2019).

The goal of exercise therapy is rehabilitation to overcome impaired function and movement, prevent complications, reduce pain, and train joint movements. Rehabilitation treatment in injury patients includes physical therapy, which consists of various types of exercises; Muscle isometric exercises, as well as ROM (Range Of Motion) exercises, are active and passive (Damping, 2012).

Pelvic function in pelvic injury patients improved after treatment, which increased from a score of 86.7 to 93.7 (by 8.9%). This is a positive effect of giving massage therapy treatment followed by exercise therapy,

which has a positive impact to increase range of motion (ROM) to optimize motor performance and rehabilitation. Exercise therapy is very effective at increasing ROM, specifically through the process of short-term muscle changes to stimulate neuromuscular mechanisms that will increase ROM (Sharman et al., 2006). With the increase in ROM in the joints and the reduction of pain, it will result in improved pelvic function in patients with pelvic injuries, so the recovery rate of pelvic injury patients is very large.

Types of Exercise Therapy that are given to people with pelvic injuries include yoga practice therapy, Proprioceptive neuromuscular facilitation (PNF) therapy, Theraband Exercise Therapy, and Core Stability Exercise (CSE). Yoga is a type of exercise that is suitable for people with pelvic injuries because this type of exercise is a type of exercise that aims to increase the strength of the body's supporting muscles including the spine and improve posture and flexibility. To choose and design this exercise protocol it is necessary to note several things, namely the type, components, and modifications of yoga, the frequency of exercises, instructor qualifications, exercises at home, and support facilities (Field, 2011). Conceivably, all these elements can have therapeutic benefits for physical and mental health as well, so it is important to decide which of these (naï.e., attitude and behaviour, posture, Breathing exercises, interiorization, and concentration/meditation) should be included in the yoga protocol for certain conditions (Chang et al., 2016). Yoga exercises for pelvic injuries usually include breathing exercises, posture exercises, relaxation, and meditation (Chang et al., 2016).

Proprioceptive neuromuscular facilitation (PNF) is a stretching technique that aims to maximize muscle flexibility and involves a series of contractions and relaxations with stretching forced during the relaxation phase (Millner et al., 2022). PNF exercises are very effectively used to improve ROM, particularly with short-term changes in ROM (Sharman et al., 2006). PNF is a stretching technique utilized to improve muscle elasticity and has been shown to have a positive effect on the active and passive range of movement (Hindle et al., 2012). PNF is an exercise in providing stimulation to proprioceptors to increase the need for neuromuscular mechanics so that an easy response can be obtained by processes in which the response of neuromuscular mechanisms is made easier or easier (Wahyudin & W, 2008). Stretching with PNF is a method of training flexibility that can reduce hypertonus, allowing muscles to relax and lengthen. It is generally regarded as one of the most effective forms that serve muscle stretching (Diana Victoria et al., 2013). PNF is used to improve muscle elasticity and increase passive and active range of motion (ROM) (Hindle et al., 2012; Millner et al., 2022). So it can be concluded that PNF is a stretching technique that can be used by the clinical environment to increase the range of movement (ROM) actively and passively to optimize rehabilitation for injuries.

The PNF technique has wide application in treating people with neurological and musculoskeletal conditions, often used in rehabilitating the knees, shoulders, hips, and ankles (Smedes et al., 2016). PNF stretching is used as a warm-up exercise to maintain and maintain ROM (Hindle et al., 2012). In doing this stretch, the muscles will fight the energy of the partner in the form of muscle contractions isometrically. After the muscle is stretched to the point of maximum flexibility (pain limit), then the perpetrator holds with isometric contractions. The increasing isometric strength will cause the addition of strain on the tendon therefore the organ tendon Golgi gets a harder stimulus. This causes the stimulation of the organ's tendon golgi to reach its excitatory threshold. When isometric contractions last longer and are stronger, the muscle tension also increases, due to increased pushing and resistance. This increased muscle tension will one day cause stress to reflect and make the partner who encourages the loss of resistance from the person concerned, so that it can encourage further to expand the movement of the joints, meaning that it can increase the area of joint movement (Giriwijoyo & Sidik, 2013). PNF exercises are very well used to practice limited movement due to stiffness in the joints, balance disorders, and slow-motion rhythms (Wahyudin & W, 2008). This is what causes muscle lengthening can be even more possible. In addition, the inhibition effect is a protective mechanism to prevent muscle tearing or the release of tendons from attachment to the bone.

Theraband therapy is one form of exercise therapy in the form of rubber that serves to recover injuries and helps strengthen muscle function. Theraband is a thin rubber force or tube used as a healing medium to rehabilitate injuries and improve strength, functional, and joint mobility. This method is often used by physiotherapists for the recovery of injuries to the ankle. Theraband has a size covering thin, medium, and thick according to the needs used. Theraband therapy is widely used by therapists to help recovery in patients who have injuries as well as in people with back injuries. Applying the exercise process to a person must pay attention to the needs of the client or patient because each patient who has an injury has different characteristics.

Core stability was developed from the idea of neutralizing the pelvis. The core is a group of torso muscles that surround the spine and abdomen. Abdominal, gluteal, hip girdle, paraspinal, and other muscles work together to provide spinal stability. Core stability is an important motor control for the initiation of body movements according to the needs of the activity. Core stability was essential for the balance of the spine, pelvis, and kinetic chains. Sports medicine uses core stability exercise to improve performance and prevent injuries and is used for low back pain healing exercise therapy (Akuthota et al., 2008). Core stability training has beneficial effects on trunk function, standing balance, and mobility (Haruyama et al., 2017). Core stability training was an exercise that uses the ability of the trunk, lumbar spine, pelvic, hip, and abdominal muscles, and small muscles along the spine. An 8-week core stability training program enhances functional movement patterns and dynamic postural control in collegiate athletes (Bagherian et al., 2019). The muscles work together to form a force aimed

at maintaining the spine by the alignment of the body that is symmetrical and becomes more stable. When the spine is strong and stable it makes it easier for the body to move effectively and efficiently. When the body moves effectively and efficiently, it can reduce the risk of injury, improve sports skills such as strength, speed, and function and provide support to the body when performing all dynamic movements.

Core stability training focuses on pelvic lumbo stability which refers to the ability of the back muscles and abdominal muscles to control the position and movement of the midsection. If these structures are maintained or kept in optimal alignment, the lower limbs' muscles and joints can function efficiently. Today many well-known fitness programs such as pilates, yoga, and tai chi follow the principles of core stability exercises. The first stage of core stability training begins with learning to activate the abdominal muscles. It is very important to activate the transverse muscles of the abdomen, external obliques, and internal obliques for the initial stage (Akuthota et al., 2008). After activation of the transverse abdominus muscle, core stability training is enhanced by curl-up exercises, side bridge (side plank), and quadruped position by raising the arms or legs. When core stability exercises both in the supine position, supine with the knee bent, or in the quadruped position, the pelvis should not be lifted and the spine is maintained in a neutral posture. Diaphragmatic breathing rhythms are also maintained under normal circumstances (Akuthota et al., 2008). According to (Kibler et al., 2006), the benefits of a strong core are: (1) Improving strength and balance, (2) Lower back injuries, and (3) Maximizing balance and movement of the upper and lower extremities. Another opinion according to (Hibbs et al., 2008), the benefits obtained from core stability exercises are: (1) Reduce the risk of injury, (2) Injury rehabilitation program, (3) Stabilize the spine, (4) Improve athlete performance.

Conclusions

From the results of the above research, it can be concluded that massage therapy followed by exercise therapy can reduce pain very effectively, can increase ROM effectively, and improve pelvic function quite effectively. For the reduction in pain, the CSE group reached the highest percentage of 92.3%, then successively followed by the Theraband, Massage, PNF, and Yoga groups by 58.3%. For the range of motion (ROM) Flexion, the Theraband group experienced the highest increase of 29.1%, while PNF experienced the highest increase both for Extensions by 91.7%, Adduction by 76.4%, Abduction by 67.8%, Internal Rotation by 67.9%, and External Rotation by 82.4%. Thus it can be concluded that massage therapy followed by exercise therapy can reduce pain very effectively because massage therapy and exercise therapy can increase muscle tone, improve blood circulation and increase endorphins released by the body, resulting in decreased pain. Massage therapy followed by exercise therapy can increase ROM effectively because of the process of changing muscle lengths so that it stimulates the neuromuscular mechanism in ROM. Massage therapy followed by exercise therapy can improve pelvic function quite effectively because of an increase in the recovery of the function of the pelvic muscles, an increase in ROM in the hip joint, and a reduction in hip pain. This has resulted in a very high recovery rate for chronic pelvic injury patients.

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