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The effectiveness of manipulative therapy in reducing pain and improving range of motion in patients with shoulder injuries

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Abstract
Shoulder injury is one of the most prevalent musculoskeletal injuries. The objective of this research was to investigate the effectiveness of manipulative therapy in reducing pain intensity and enhancing shoulder range of motion among individuals with shoulder injuries. This study employed a pre-experimental research design known as the one-group pretest-posttest design. The population of interest for this research comprises patients with shoulder injuries who seek treatment at the Physical and Manipulative Therapy Clinic, Health and Sport Center in Universitas Negeri Yogyakarta. The sampling method employed in this study was purposive sampling, which involved selecting a sample size of 23 subjects. The pain level of the shoulder joint was measured using the Numeric Rating Scale (NRS), while the range of motion of the shoulder joint was measured using a goniometer. The measurements were conducted both before and after the treatment. The manipulative therapy treatment utilized in this study consisted of massage techniques such as effleurage, friction, petrissage, and tapotement, as well as stretching and mobilization. The data analysis technique employed in this study involved quantitative descriptive analysis, and the hypothesis testing was conducted using the Wilcoxon Signed Rank Test. The results of this study indicated that manipulative therapy was effective in significantly reducing the pain level of the shoulder joint ($\alpha = 0.000$) with an effectiveness of 65.61%. Additionally, manipulative therapy was found to significantly improve the range of motion, specifically flexion by 26.67%, extension by 34.52%, abduction by 25.03%, adduction by 13.30%, medial rotation by 33.16%, and lateral rotation by 16.56% with an overall significant probability value of $p = 0.000$. manipulative therapy, thus, is recommended for reducing pain and increasing range of motion in shoulder injury.

Keywords: Manipulative therapy, shoulder injury, pain

Introduction
Human beings as biopsychosocial creatures engage in activities driven by their needs, leading to individuals undertaking diverse activities [1]. Movements that occur during activities can lead to injuries, typically affecting muscles, tendons, ligaments, joints, and bones [2]. Research in India revealed that shoulder injuries have the highest prevalence rate, reaching 72.2% [3], while research in Iran indicated that shoulder injuries ranked as the third highest prevalence rate at 41.5% [4]. According to the Basic Health Research in 2018, it was recorded that 44.7% of injuries occur at home and in the surrounding environment [5]. The results of the research indicate that shoulder injuries are not only experienced by athletes undergoing training programs but also individuals with busy activities, high mobility, and frequent heavy lifting, who are also at risk of experiencing shoulder injuries. Shoulder injuries often occur because the head of the joint enters the socket joint less than half of its depth and is only supported by the ligaments and muscles around the shoulder [6].
The shoulder joint is the most freely movable joint compared to other joints. The shoulder joint allows movement along three main axes: transverse, longitudinal, and sagittal[7]. The shoulder consists of soft tissues that surround the framework. The bones composing the shoulder joint are as follows: (1) The scapula, which is a flat triangular bone that forms the shoulder girdle (shoulder blade) with 17 muscle attachments.

The posterior aspect of the scapula contains the glenoid, which forms half of the primary shoulder joint. (2)
The clavicle, or collarbone, serves as a supportive structure connecting the upper extremity skeleton to the axial skeleton anteriorly and articulates with the sternum medially. (3) The humerus, the long bone of the upper arm, has a proximal part called the head or caput, which articulates within the shoulder joint[8]. The shoulder consists of four main joints, namely the glenohumeral (GH) joint, acromioclavicular (AC) joint, sternoclavicular (SC) joint, and scapulothoracic (ST) joint [9].
The following are the ranges of motion in the shoulder joint: [10]:

Table 1: Range of Motion in the Shoulder Joint

Movement	ROM (Degree)
Flexion	180º
Extension	60º
Abduction	170º -180º
Adduction	30º -50º
Medial Rotation	80º -90º
Lateral Rotation	90º

The pathophysiology of injury begins when cells undergo damage, leading to the release of chemical mediators that stimulate inflammation. These mediators include bradykinin, prostaglandins, histamine, and leukotrienes. These chemical mediators cause vasodilation of blood vessels and attract immune cell populations to the site of injury, a process known as inflammation. Over time, this inflammation gradually decreases as the regeneration process of the damaged cells or tissues occurs [11].
Manipulative therapy is generally defined as a therapy that extensively employs manual techniques. It focuses on the structures and systems within the body, such as bones, joints, soft tissues, circulatory and lymphatic systems, as well as nerves, with the aim of facilitating the body's natural healing processes. Some of the physiological effects of manipulative therapy include:

1. Reducing swelling in the chronic phase.
2. Alleviating pain through the mechanism of pain stimulus inhibition (gate control).
3. Enhancing muscle relaxation.
4. Improving range of motion (ROM), strength, coordination, balance, and muscle function.

Massage is widely used in sports medicine and offers various benefits, especially for injured athletes. It has diverse therapeutic effects, including accelerating the inflammatory process and mobilizing contracted fibrous tissue (inflammation control), increasing blood flow, and providing pain relief and muscle relaxation [12]. Massage or kneading is a part of manipulative therapy that involves applying pressure and movements. Massage helps individuals relax and alleviate pain. Besides massage, there is another crucial component in restoring the function of musculoskeletal and other affected tissues, known as exercise therapy. Types of exercise therapy include mobilization. Mobilization is a fundamental component of rehabilitation that can accelerate tissue healing, ultimately supporting movement function or mobility. Mobilization can be used to improve joint range of motion (ROM). Mobilization can take the form of passive range of motion exercises, assisted range of motion exercises, active-assisted range of motion exercises, active exercises, and stretching exercises. In the field of medicine, massage is one of the approaches used to alleviate pain, rehabilitate, and enhance the physical performance of patients [13]. The pressure stimulation during massage manipulation follows neural pathways that are faster than the nerves that transmit pain signals. As a result, massage performed with sufficient pressure intensity triggers stimuli that interfere with the transmission of pain signals to the brain, effectively "closing the gate" of pain perception before it can be processed in the brain [14]. The evidence regarding the effectiveness of massage therapy in improving pain and range of motion is stil limited. The objective of this research, thus, was to investigate the effectiveness of manipulative therapy in reducing pain intensity and enhancing shoulder range of motion among individuals with shoulders injury.

Method

This study was a pre-experimental research with a one-group pretest-posttest design to measure the effectiveness of manipulative therapy at the Physical and Manipulative Therapy Clinic, Health and Sport Center Universitas Negeri Yogyakarta (HSC UNY). The study adopted a quantitative descriptive approach to describe the outcomes of manipulative therapy effectiveness.
The population of this study consisted of patients who visit the Physical and Manipulative Therapy Clinic, HSC UNY, with complaints of shoulder pain and limited shoulder range of motion. The sampling technique used was purposive sampling, which involves selecting samples based on specific criteria. The inclusion criteria for this study included experiencing shoulder dislocation injury, being between the ages of 20 and 60, and being willing to participate as research subjects. The exclusion criteria for this study were patients with frozen shoulder and patients with a history of degenerative diseases. The total sample size was 23 individuals.
The instruments used in this study involve tests and measurements. The assessment of pain level is conducted using the Numeric Rating Scale (NRS), which measures pain on a scale ranging from 0 to 10. The number 0 represents no pain at all, while the number 10 indicates the most severe pain. The measurement of the shoulder range of motion includes the assessment of flexion, extension, adduction, abduction, medial rotation, and lateral rotation using a goniometer. The pre and post-test measurement were compared using Wilcoxon signed rank test. The effectiveness was measured by dividing the differences between pre and post test data, divides by pre-test multiplied by 100%.

Results and Discussion

This study was conducted to determine the effectiveness of manipulative therapy in reducing pain levels and improving range of motion in shoulder injuries. The study included a total of 23 subjects, with 11 males and 12 females. The highest number of shoulder injury cases occurred in the age range of 51-60 years, with 12 individuals. The second highest number of cases occurred in the age range of 41-50 years, with 5 individuals. Additionally, there were 3 individuals each in the age ranges of 31-40 years and 20-30 years who experienced shoulder injuries.
Housewives are the most prevalent subjects experiencing shoulder injuries. This is consistent with the Basic Health Research in 2018, which recorded that 44.7% of injuries occurred at home and in the surrounding environment[5]. Activities carried out at home and in the surrounding environment are often unmeasured and can lead to shoulder injuries.

Based on the pain scale data obtained from 23 subjects with shoulder injuries, there was an increase of 3 individuals in the category of no pain. The majority of the pretest data showed 14 individuals, which decreased to only 1 individual. In the mild category, there was an increase from 2 individuals to 15 individuals. The research findings regarding the pain scale revealed an average pretest pain scale of 6.83, with a standard deviation of 1.99. Meanwhile, the posttest results yielded an average of 2.35 with a standard deviation of 1.82. The average results indicate a decrease in pain scale by 4.48. By calculating the effectiveness formula, it was obtained that the effectiveness of manipulative therapy in reducing pain scale is 65.61%. This condition indicates that manipulative therapy is effective in reducing pain scale by 65.61%.

The description of the results regarding shoulder range of motion can be seen in Table 2 below:

Table 2: Description of Shoulder Range of Motion

Shoulder Range of Motion (ROM)	Statistics	Pretest	Posttest	Effectiveness
Flexion	Mean	127,48	161,48	26,67%
	SD	36,37	32,65	
Extension	Mean	26,96	36,26	34,52%
	SD	14	14,46	
Abduction	Mean	117,96	147,48	25,03%
	SD	34,07	32,52	
Adduction	Mean	40,52	45,91	13,30%
	SD	3,63	2,5	
Medial Rotation	Mean	50,87	67,74	33,16%
	SD	14,97	17	
Lateral Rotation	Mean	65,91	76,83	16,56%
	SD	14,63	14,79	

The average results were then calculated using the effectiveness formula. The findings indicate that manipulative therapy can improve flexion range of motion by 26.67%, extension by 34.52%, abduction by 25.03%, adduction by 13.30%, medial rotation by 33.16%, and lateral rotation by 16.56%.

The results of the Wilcoxon Signed Ranks Test for the pain scale indicate that the significance probability value is 0.000 < 0.05, indicating a significant influence of manipulative therapy on reducing pain scale and improving shoulder range of motion in cases of shoulder injuries.

The results of the Wilcoxon Signed Ranks Test for flexion, extension, abduction, adduction, medial rotation, and lateral rotation range of motion reveal a significance value of 0.000 < 0.05. This indicates a significant influence of manipulative therapy on improving shoulder range of motion in cases of shoulder injuries.

The reduction in pain scale reported by the research subjects is attributed to the manipulations provided in this study, which included massage and repositioning through stretching and joint mobilization. Adams *et al*. (2010) investigated the impact of massage on pain management, and their findings showed a decrease in the average pain scale from a pretest mean of 5.18 (SD: 2.01) to a post-massage mean of 2.33 (SD: 2.10). Massage significantly improves range of motion (ROM) [15]. Specifically, massage demonstrated a significant effect in improving shoulder flexion by 18.21% and shoulder abduction by 22.07%. *Massage* has shown a significant influence in enhancing range of motion (ROM) [15]. Techniques such as effleurage, petrissage, and friction. Effleurage reduces edema and enhances muscle relaxation by facilitating lymphatic gland flow. Petrissage is performed with the aim of increasing muscle mobility, by rotating the area between muscle and skin after grasping the soft tissue. Friction involves deep pressure on the soft tissue of the skin using the thumb, placing it on the bone or on the muscle fascia. This technique smoothens scar tissue and loosens deep adhesions in tendons, ligaments, joint capsules, and others.

Simply put, this condition can occur due to massage manipulation performed on the muscles surrounding the injured area, including triceps, biceps, deltoids, trapezius, pectoralis major, supraspinatus, infraspinatus, teres minor, teres major, rhomboideus major, and rhomboideus minor. In the management of massage manipulation, several techniques are employed, namely effleurage, friction, petrissage, and tapotement, which generally impact the smooth circulation of blood and lymph, leading to increased oxygen supply and subsequently inducing relaxation and comfort in the subject. This can trigger endorphins, capable of reducing pain sensation. In the gate control theory, massage also plays a role in blocking pain sensations by interacting with receptors present in the skin. Among these receptors are Pacinian corpuscles, which receive strong pressure impulses (friction, petrissage, and tapotement), and Merkel discs, which receive impulses from light touch and gentle pressure (effleurage). These receptors then transmit signals to thickly myelinated Aβ nerve fibers, which conduct impulses faster than the Aδ and C afferent nerve fibers responsible for carrying pain impulses. As a result, the pain messages are not processed by the brain, and the thickly myelinated Aβ fibers block or close the gate first. Consequently, the sensation of pain can be reduced.

In addition to massage manipulation, the HSC UNY Physical and Manipulative Therapy Clinic employs exercise therapy, which includes stretching movements and joint mobilization to reposition and enhance the range of motion of the shoulder joint. Stretching is beneficial for reducing muscle stiffness and increasing joint flexibility and soft tissue suppleness, thereby enhancing the range of motion of the shoulder joint. Additionally, joint mobilization triggers muscle contractions in spastic muscles, leading to the release of endogenous opioids and stimulating the secretion of endorphins from the pituitary gland, which can effectively alleviate pain [16].

Joint mobilization promotes movement between capsular fibers, resulting in increased interstitial fluid levels and interfiber distance. Mobilization also selectively stimulates the synovial tissue to stretch, causing a gradual rearrangement of collagen fibers with a reduction in cross-linking and the development of a parallel fiber configuration within the newly formed collagen tissue. Furthermore, mobilization can break adhesions within the joint capsule and synovial folds while increasing the length of capsule fibers. These responses are believed to have mechanical effects, resulting in an increased range of arthrokinematic motion in a joint [17].

Conclusion

Based on the results and discussions presented earlier, the conclusions drawn from this study are as follows: (1) Manipulative therapy can reduce the pain scale in patients with shoulder injuries, (2) Manipulative therapy can improve the range of motion in the shoulder joint of patients with shoulder injuries, (3) Manipulative therapy is effective in reducing the pain scale by 65.61% and increasing the range of motion in flexion by 26.67%, extension by 34.52%, abduction by 25.03%, adduction by 13.30%, medial rotation by 33.16%, and lateral rotation by 16.56%.

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