EFFECTIVENESS OF MANUAL THERAPY ADDED TO CONVENTIONAL PHYSIOTHERAPY PROTOCOL IN PATIENTS WITH SURGICALLY TREATED PROXIMAL HUMERAL FRACTURES

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ABSTRACT

Proximal humerus fractures are the third most common fractures in adult patients. In developed economies, there is a tendency to increase the number of these fractures due to the aging population. Physical therapy is recognized as an important component in the management regardless of the fracture type or treatment protocol.

The purpose of this blind, randomized study was to compare the effectiveness of two physical therapy interventions on the shoulder range of motion and function after surgical treatment of proximal humerus fracture: 1) supervised therapeutic exercise only (Control group – CG), 2) supervised therapeutic exercise with manual soft tissue mobilization and massage (Experimental group – EG). Ninty-six subjects diagnosed with proximal humerus fracture treated operatively were randomly assigned to one of these two groups. The rehabilitation included four phases, in each of which the patients underwent ten procedures.

Shoulder range of motion was assessed with a universal goniometer for flexion, extension abduction, internal rotation and external rotation. International SFTR method of measuring and recording joint motion was used. The results were analyzed with the statistical program SPSS Statistics 19. At the end of the study, we found statistically significant better results in the EG in flexion (152.8° ± 22.3°), abduction (145.3° ± 24.2°), external (61.1° ± 11.8°) and internal (75.3° ± 11.6°) rotations, compared to CG: flexion (140.7° ± 22.0°), abduction (130.6° ± 24.4°), internal (51.8° ± 15.6°) and external (63.5° ± 14.1°) rotations with statistical significance ($p < 0.05$). The extension showed improvement in both study groups, within the EG results being 52.9° ± 15.9° and in the CG 49.9° ± 5.5° - with no statistically significant difference between them. The DASH (Disabilities of the Arm, Shoulder, and Hand) scale was used for functional assessment of upper extremity.

We established that the application of manual soft tissue mobilization with massage in the postoperative rehabilitation of patients with proximal humerus fractures leads to more effective restoration of shoulder joint function.

Keywords: *Proximal humerus fractures, physiotherapy.*

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INTRODUCTION

Proximal humerus fractures are common, particularly among older adults (Hajcsar et al., 2000). They are the third most common fractures in adult patients (Karl et al., 2015). These fractures are more common in postmenopausal women with osteoporosis and in the elderly. There are differences in trauma mechanism in women and men, as well as in different age groups (Passaretti et al., 2017). The majority of proximal humerus fractures are minimally displaced and can be treated nonoperatively. Controversy remains regarding the optimal care of displaced fractures with potential treatment options of non-operative management, percutaneous fixation, open reduction internal fixation

and different types of arthroplasty (Handoll et al., 2012). The treatment of unstable fractures depends of fracture pattern, bone quality and individual characteristics of patients (Schumaier, Grawe, 2018; Howard et al. 2018). Currently, the gold standard for proximal humeral fractures fixation are angular stable implants providing greater fracture stability in cases with osteoporotic bone (Totev, Dimitrov, 2014).

There are a number of protocols concerning proximal humerus fractures. They are designed for a specific type of fracture with specific type of treatment. Most of the protocols are based on the experience of certain clinics (http://fraserortho.com; https://www.nbt.nhs.uk). Another part of the protocols includes the basic principles, without specific details (https://surgeryreference.aofoundation.org). This does not reduce their therapeutic value. Results from the application of specific protocols have also been published (Hodgson, 2006; Handoll et al. 2015).

The effect of applying different types of soft tissue mobilization and massage techniques in shoulder pathologies is considered by a number of authors, but there is no single rehabilitation protocol. Different researchers use different rehabilitation methods and combinations of them but the reported results are diverse (Yeun, 2017; Dolder, et al., 2010).

PURPOSE AND OBJECTIVES OF THE STUDY

The purpose of the study was to compare the effectiveness of two physical therapy methods on the shoulder range of motion and function after surgical treatment of proximal humerus fracture.

APPLIED METHODOLOGY

For the period 2009 – 2020, in the clinical bases for practical training of students from the Department of Physical Medicine, Rehabilitation, Occupational Therapy and Sports of Medical University – Pleven, kinesitherapy was applied to 96 patients with proximal humerus fracture treated operatively.

Procedure

Participants were randomly assigned to one of two intervention groups according to the block randomization method: Control Group, exercise only; Experimental Group, exercise and manual soft tissue mobilization and massage. Block randomization was used to ensure that an equal number of patients were assigned to each treatment group. Block randomization works by randomizing participants within blocks in such a way that an equal number is assigned to each treatment groups. A planned enrollment of 96 participants, 48 per study group, were randomly assigned to two intervention parts. As an example, subject #1 had an equal chance of drawing an envelope assigning him/her to Control Group “A” or Experimental Group “B”. If he/she drew “A,” the card was removed. Subject #2 then had a chance of drawing an envelope with group A or B from the remaining envelopes. Blocked randomization offers a simple means to achieve balance between study groups and to reduce the opportunity for bias and confounding. Once the baseline examination was completed, a second investigator blind to the baseline examination opened the randomisation envelope indicating the patient’s treatment group assignment that corresponds to the patient’s unique identification number. Each subject was informed of his/her treatment protocol but remained blinded to other group assignments to avoid subject bias.

Owing to the nature of this study, it was not possible to blind the patient or the physician providing the intervention to the treatment received. One physical therapist with 10 years of clinical experience performed the pre- and post-treatment assessment measurements.

This assessor was blinded to group assignment and the intervention protocols. Patients were instructed not to discuss the treatment received with the phsician when reporting for their follow-up appointments, unless medically necessary. The study was conducted in accordance with patient protection requirements (according to the Helsinki Declaration) and with signed patient's informed consent for participation in the scientific study.

In the control group (48 patients) a traditional for the clinic kinesitherapy treatment was applied, including mainly therapeutic exercises.

In the experimental group (48 patients) the applied kinesitherapy methodology included therapeutic exercises and manual soft tissue mobilization techniques combined with massage.

Description of the kinesitherapy methodology

The aim of kinesitherapy in both groups of patients was maximum functional recovery of the operated upper limb and independence in the daily living activities.

Kinesitherapy was applied in four periods:

First period: 1-3 postoperative weeks (POW) or immediately after removal of the immobilization. During this period there was still no stable bone fusion and given the age of patients and bone quality, despite the fixed fracture, we applied therapeutic exercises with maximum sparing of the involved area. We trained patients with immobilization to perform isometric contractions for the immobilized muscles and ideomotor exercises. For patients without immobilization, we applied carefully dosed pendular exercises. The kinesitherapy program in all patients included active exercises for immobilization-free joints of the affected upper limb, breathing exercises and active exercises for the healthy upper limb.

Second period: 4 – 5-6 POW or the first and second post-mobilization week. During this period, we also provided maximum protection of the operated area from biomechanical efforts. We expanded the therapeutic program to include: cryotherapy combined with massage in the shoulder area; drained massage in the forearm and shoulder area; passive, active-assisted and active exercises for the shoulder muscles in painless range of motion (initially from a relaxed starting position and later in an antigravity position) postisometric relaxation for muscles with increased tone and techniques for proprioceptive neuromuscular relief.

Third period (moderately protective): 7-8 POW or third and fourth post-mobilization weeks. We expanded the applied active-assisted, self-passive and active exercises for the shoulder in open and closed kinetic chain (without weight bearing) and gradually increased their dosage. We included isometric exercises and training in daily living activities.

Fourth period (minimally protective): 9-10 POW or 5-6 post-mobilization weeks. We included exercises against dosed resistance (with gradual progression from 0.1 kg. to 0.5 kg.) – criteria for the inclusion of resistance was the presence of clinical and radiological evidence for bone fusion and lack of pain when overcoming resistance.

In EG patients we additionally included manual soft tissue mobilization techniques combined with massage to increase the range of motion in the shoulder:

- caudal mobilization of the shoulder, combined with massage along the course of trapezius muscle *(p. descendens)* and levator scapulae muscle.
- mobilization of the scapula, combined with a massaging of rhomboideus major and minor muscles, serratus anterior muscle, and subscapularis muscle.
- techniques for increasing abduction in the shoulder:

- elevation of the arm (initially in the plane of the scapula, gradually passing into the frontal plane), combined with compression on the lateral edge of the scapula simultaneously with a sliding massaging motion.
- passive abduction of the shoulder, caudal mobilization of the humeral head and sliding massaging movement on the ventral and dorsal aspects of the shoulder.

- techniques increasing external rotation in the shoulder joint – passive elevation, external rotation, caudal mobilization of the humeral head and longitudinal massage along the muscles around the shoulder joint.
- techniques for increasing the flexion in the shoulder joint – dorsal mobilization of the humeral head with elevation of the upper limb in the sagittal plane and sliding massaging movements.
- techniques for increasing the internal rotation in the shoulder joint – passive internal rotation in the shoulder joint, combined with traction along the axis of the limb and sliding massage movements along the muscles of rotator cuff.

When performing the techniques, the treated area was mobilized in a certain direction, degree and pace, allowing simultaneous, effective impact on all massaged tissues. The main idea of our methodology is based on the knowledge that the neurophysiological stimulus of massage and the neurophysiological stimulus of passive movements have a relationship arising from their common point of impact on peripheral receptors located in the musculoskeletal system (Lewit, 1981).

Clinical and radiological follow-up of patients was performed by an orthopedic surgeon. Shoulder range of motion was assessed by universal goniometer for flexion, extension, abduction, internal rotation and external rotation. International SFTR method of measuring and recording joint motion (S is sagittal plane, F is frontal plane, T is transverse plane, R is rotation) was used. The SFTR method of recording joint motion and position as a part of internationally accepted neutral-zero method provides an objective system avoiding confusion of language and terminology.

The collected data was statistically processed with SPSS software, version 18.0, SPSS Inc. Chicago, IL, USA, and the following values were found: *minimum, maximum, mean, SD, and one sample paired t-test to compare pre- and post- treatment results of the group.* The unpaired *t*-test was used to compare pre- and post-treatment results between the two groups, at a confidence level of $p \leq .05$.

RESULTS AND ANALYSIS

Patients' characteristics

The demographic characteristics of the patients at baseline are presented in Table 1.

Table 1. *Baseline demographic characteristics.*

Characteristic	Experimental Group (n=48)	Control Group (n=48)
Gender, n (%)		
Male	10 (20.8)	12 (25.0)
Female	38 (79.2)	36 (75.0)
Age (years)		
n	48	48
Mean (*SD*)	59.6 (12.4)	62.7 (14.98)
Median (min., max.)	59.6 (37.84)	62.7 (19.86)

The mean age of patients was 61.1 ± 13.7 years (EG 59.6 ± 12.4; CG 62.6 ± 14.9). The sample was dominated by women - 74 (77.01%), compared to men - 22 (22.9%). There were no marked differences between EG and CG. Baseline fracture data at randomization are shown in Table 2.

Table 2. *Baseline fracture data at randomization.*

Characteristic	Experimental Group (n=48)	Control Group (n=48)
Affected shoulder, n (%)		
Left	26 (54.2)	27 (56.3)
Right	22 (45.8)	21 (43.7)
Shoulder dominance, n (%)		
Yes	14 (29.2)	16 (33.3)
No	34 (70.8)	32 (66.7)
Injury mechanism, n (%)		
Fall/trip from standing height or less	40 (83.3)	44 (91.7)
Fall downstairs/steps or from a height/ΠΤΠ	3 (6.3)	3 (6.3)
Other	5 (10.4)	1 (2)
Missing	0	0
Types of fractures according to the Neer classification		
3 Neer two part: surgical neck	36 (75.0)	29 (64.0)
4 Neer two part: greater tuberosity	1 (2.1)	0 (0)
5 Neer two part: lesser tuberosity	7 (14.6)	11 (22.9)
8 Neer three part: surgical neck+greater tuberosity	1 (2.1)	6 (12.5)
9 Neer three part: surgical neck+lesser tuberosity	2 (4.2)	2 (4.2)
10 Neer three part: anterior dislocation + greater tuberosity	1 (2.1)	0 (0)

The treatment groups appeared to be balanced for these characteristics, including Neer category.

The methods of surgical treatment were determined by a trauma surgeon, according to the indications for operative treatment. Perioperative management including anaesthesia, analgesia, antibiotic and thromboembolism prophylaxis followed local guidelines. The use of painkillers and other medications was in accordance with the surgeon‘s prescriptions. Analgesic therapy included non-steroidal anti-inflammatory drugs in both groups of patients. No significant intergroup and intragroup differences were observed concerning painkillers.

The duration of sling immobilisation is shown in Table 3.

Table 3. *Duration of post-surgical sling immobilisation.*

Characteristic	Experimental Group (n=48)	Control Group (n=48)
Post-surgical immobilisation		
Mean (SD)	11.2 (4.8)	12.1 (4.95)
Median (min., max.)	10 (0.21)	10 (5.25)

In 95 (98.96%) patients postoperative immobilization was applied (average of 11.2 days in EG patients and average 12.1 days in CG patients).

The duration of immobilization after surgery varies from 0 to 4 weeks. Of the 96 patients included in our study, four (4.2%) were immobilized for three or more weeks, twenty-seven (28.1%) were immobilized for up to 1 week, sixty-four (66.7%) between one and three weeks, and one (1.04%) was without immobilization. No statistically significant intergroup and intragroup differences were observed in terms of immobilization ($p > .05$). The onset of rehabilitation is determined by clinical and radiographic signs of bone heal-

ing or usually 4 weeks after surgery. Until bone union is evident, stress-free exercises are applied concerning the fracture area, starting from 2-3 postoperative day.

After removal of the immobilization, we found a significant limitation of the range of motion in the shoulder joint in both groups of patients ($p \leq .05$) compared to a healthy shoulder joint. One-way ANOVA analysis indicated no statistically significant differences between the groups on age, and baseline pretreatment scores. Chi square analyses indicated no statistically significant differences between the two groups on gender, involved shoulder, or hand dominance.

The therapeutic exercises and soft tissue mobilization treatment technique decrease pain, increase function, and enhance activities of daily living in patients.

After the rehabilitation course, we found a statistically significant improvement in shoulder range of motion in both groups. In Table 4 we are presenting the comparison of the average values of the final range of motion of in the two groups.

Table 4. *Comparison of the final results of the shoulder range of motion (in degrees) between the both groups – means (±SD).*

Values (4th visit)	CG (n=48)	EG (n=48)	*p*
Flexion	140.7° (±22.0)	152.8° (±22.3)	.009
Abduction	130.6° (±24.4)	145.3° (±24.2)	.004
Internal rotation	51.8° (±15.6)	61.1° (±11.8)	.001
External rotation	63.5° (±14.1)	75.3° (±11.6)	.000
Extension	49.9° (±5.5)	52.9° (±15.9)	.217

When analyzing the range of motion in flexion, abduction, external and internal rotation, we found that at the end of the study, patients in the experimental group were with statistically significantly better results ($p < .05$). Analyzing the extension there was an improvement in both groups, but there was no statistically significant difference between the results. The methodology applied by us, combining soft tissue mobilization techniques with massage, shows an immediate positive effect on the range of motion in the shoulder joint. When analyzing flexion, it is evident that 53% of patients in the experimental group achieved over 149º, compared to 39% of the control group. In abduction, 38% of the patients from the experimental group achieved abduction over 149º, compared to 25% from the control group. Sixty-four percent of the experimental group and 50% of the control group achieved external rotation over 54º. Eighty percent of the patients in the experimental group and 68% of the patients in the control group achieved internal rotation over 59°. The maximum follow-up period for patients was 14 weeks after the trauma, and given the observed trends, it is expected that increasing of range of motion will continue after this period.

The DASH (Disabilities of the Arm, Shoulder, and Hand) scale is used for functional assessment of upper extremity. This questionnaire has been developed to measure disability and symptoms related to upper extremity musculoskeletal disorders. This 30-item questionnaire includes 21 physical function items, 6 symptom items, and 3 social function items. There are also two optional 4-item modules: one intended for athletes and musicians, and the other for working populations (Angst et al. 2011; Kennedy et al. 2011).

The DASH questionnaire, together with its short form (QuickDASH), is the most wide-

spread instrument for shoulder assessment. However, it is region specific, i.e., specific to the arm, not just to the shoulder.

Using the DASH scale, we assessed upper extremity function in both study groups at each stage of the study.

Table 5. *DASH results*

Values	CG (n=48)	EG (n=48)
1th visit		
Mean (*SD*)	68.750 (8.131)	64.931 (8.271)
Std. Error Mean	1.174	1.194
2nd visit		
Mean (*SD*)	51.302 (10.953)	44.750 (12.335)
Std. Error Mean	1.581	1.780
3th visit		
Mean (*SD*)	31.667 (10.584)	26.146 (11.805)
Std. Error Mean	1.528	1.704
4th visit		
Mean (*SD*)	19.462 (10.692)	13.392 (11.882)
Std. Error Mean	1.543	1.715

At the beginning of the study, both groups had significant functional deficits in all items of the scale. The values of the total assessment in the first visit were greater than 40 (EG - 64.9 ± 8.2, CG 68.8 ± 8.1), which means extremity disability. In the analysis, we found an improvement in all studied factors at each subsequent visit in both groups.

The overall score of EG patients at the end of the study was 13.4 and 19.5 in the control group. The results in patients from the EG were statistically significantly better than those in CG (p = .010). With a score below 15, the limb is fully functional in performing the various activities examined by the DASH scale. This gives us reason to evaluate the effect of our program as excellent in terms of functional recovery of patients.

DISCUSSION

In the literature reviewed by us, there are few studies evaluating the effect of massage, combined with mobilizing soft tissue techniques in treatment of shoulder pathologies. According to Kostov (2018) the application of a methodology involving active kinesitherapy combined with soft tissue mobilization techniques and massage, has a positive effect on the condition of periarticular tissues and muscles around the shoulder. As a result of trauma, surgery and immobilization, histological and biochemical changes occur in these tissues, leading to pain, reduced mobility, intra- and extra-articular adhesions. Post-mobilization changes are also observed in the muscles – loss of strength, muscle hypotrophy and shortening.

The application of manual soft tissue mobilization techniques, combined with massage in EG patients, leads to improved trophies of the per articular tissues and stimulates reparative processes. These techniques combine the effect of a healing massage performed on a small area, with passive mobilization. The emphasis of the massage effect is on muscle insertions, tendons and ligaments. With deeper techniques, joint capsule can be reached and engaged. Massage techniques also affect the skin and subcutaneous tissue, although as a "secondary object". The results obtained by us confirm the statement of other authors that the application of these techniques leads to improved elasticity and function of musculoskeletal structures, reduces pain and improves range of motion (Dolder et al., 2010).

The application of a combination of manual soft tissue mobilization with massage in patients with shoulder fractures allows improving the therapeutic results and reducing the time for functional recovery.

The most common complication observed in a study by Robinson et al. (2019) including surgically treated patients with fractures of the proximal humerus, followed up for mean period of two years are shoulder contractures – present in 23.6% of patients. When analyzing the results of a study by Bertoft et al. (1984) comparing two methods of rehabilitation in patients with proximal humerus fractures, we see that range of motion recovers most significantly by about ten weeks after trauma, then continues to increase throughout the one-year follow-up period. At the end of the study period flexion and abduction are statistically significant decreased from the norm ($p < .05$). The results of this study are similar to ours.

The application of adequately dosed stress and muscle load leads to an increase in their strength and does not disrupt the recovery process. Physical activity is a factor that stimulates bone healing, and the early inclusion of properly dosed exercises leads to an earlier and complete recovery of patients‘ motor function and their return to normal life (Kostov, 2018). Painless exercises, applied by us against dosed resistance after 9-10 POW, have a positive effect.

This study has some strengths and limitations. The strengths of the present study include: prospective study design, random assignment of patients, and one evaluator. Various limitations of the present study include: small sample size, short treatment period, no long term follow up. The importance of many factors (the use of medications, comorbidities, individual characteristics, etc.) cannot be evaluated. This can be a potential source of bias. Further research is needed to find out effectiveness of manual soft tissue mobilization and massage with larger sample size and longer follow up.

CONCLUSIONS

This study has documented that the soft tissue mobilization treatment technique reduces pain, increases range of motion, improves outcomes and function in patients with proximal humerus fractures after surgical treatment.

This technique would appear to be an effective adjunct to traditional physiotherapy treatment for proximal humerus fractures.

The comparative analysis of two groups showed the kinesitherapy method with a soft tissue mobilization treatment technique to be more efficient for the functional recovery of the patients.

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