

PHYSICAL THERAPY FOR PATIENTS WITH POSTTRAUMATIC ELBOW CONTRACTURES

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Purpose: to develop and explain a modern program of physical therapy for people with posttraumatic elbow contractures during the late post-operative period using rating scales for the separate categories of International Classification of Functioning, Disability and Health (ICF) to assess the effectiveness of rehabilitation.

Material and methods: the study involved 17 patients aged 28 to 50 years. The control group (CG) – 9 people (4 women, 5 men) and main group (MG) – 8 people (3 women, 5 men) were selected. The program of physical therapy in MG patients included ultrasound therapy with immediate follow-up mobilization techniques for the elbow joint in addition to conventional means. Goniometry, manual muscle testing, questionnaires Quick Disability of the Arm, Shoulder and Hand Outcome Measure (QuickDASH), Patient-rated elbow evaluation (PREE), were defined as rating scales according to literature review.

Results: only 8 categories were identified, they were most significant for patients, and the corresponding ratings of the categories were established. After MG patients rehabilitation assessments of category b710 Functions of joint mobility

according to the results of goniometry improved from $2,8\pm 0,2$ to $1,9\pm 0,2$ c.u., $p<0,001$, for patients of CG - from $2,9\pm 0,2$ to $2,4\pm 0,6$ c.u., $p<0,05$, with a significant difference between the comparison groups, $p<0,05$. Also, assessments of category d445 "The using of the hand and arm" according to the PREE function scale for patients of MG had positive changes: from $3,5\pm 0,5$ to $2,4\pm 0,5$ c.u., compared with CG - from $3,5\pm 0,5$ to $3,0\pm 0,2$ c.u., $p<0,05$, $p<0,001$, with a significant difference between MG and CG, $p <0.05$. The average duration of the late postoperative period of the MG was $21,62\pm 2,28$ days, of the CG – $27,11\pm 2,52$ days with the difference between groups, $p<0,05$.

Conclusions: the most significant categories of IFC for the elbow contracture, their rating scales have been identified. Based on the significant differences of two IFC categories assessments (b710 "Joint mobility functions", d445 "Use of hand and arm", $p<0,05$) and reducing the duration of the rehabilitation period ($p<0,05$), the benefits of developed physical therapy program were proved by.

Keywords: posttraumatic elbow contracture, physical therapy.

Introduction

Elbow joint (EJ) fractures are rated at 5 – 6% within skeletal injuries structure, however, the frequency of posttraumatic elbow stiffness (PTES) and treatment of postsurgical complications concerning elbow injury has not been specified yet [2, 5, 11]. Research has proved that unsatisfactory treatment results cause 33-44% of PTES cases, and revision is required for 26-55% of patients [1, 6, 9, 31]. Thus, relatively high level of PTES, mean age (mostly more than 45 years old) can adversely affect a considerable part of the active patient population [8, 22, 25].

Currently the best evidence-based physical therapy (PT) for postoperative patience suffering PTES protocol is undiscovered and varies depending on intervention, hospital, moreover, rehabilitation outcome measures are not defined. Using ICF in rehabilitation will be instrumental not only in unifying the term of type and severity of functional impairment (disability) but also improve the quality of rehabilitation procedures planning when making up individual rehabilitation program.

Unfortunately, ICF Core Sets for individual diseases and injuries specify the qualification categories, but do not indicate the specific research methods that should be used. [10, 24, 30, 31].

Therefore, the development and verification of the modern PT program for people suffering PTES, using evidence-based rehabilitation means and efficacy evaluation methods based on ICF categories using rating scales, are relevant.

Connection of the study with scientific programs, plans, topics. The study has been carried out according to “Rehabilitation technologies joint and ligamentous apparatus pathology”, the initiative topic of the research for 2019-2021 (state registration number 0120U104881).

Purpose of the study has been to develop and verify the modern PT program for people suffering PTES at the late postoperative stage using rating scales for ICF categories to evaluate rehabilitation efficacy.

Material and Methods of the research

The research involved 17 patients aged 28 to 50 years, who underwent rehabilitation treatment at “Fortis” Medical Health Center (clinical site of KhSAPC). The control group (CG) including 9 people (4 women, 5 men) and main group (MG), consisting of 8 people (3 women, 5 men) have been selected using random numbers method. Inclusion criteria have been the following: flexion-extension arc of the elbow $<100^\circ$ or stiffness $>30^\circ$ compared to the healthy limb, a history of elbow injury along with posterior approach surgical treatment of EJ, posterior splinting for 3-4 weeks, informed written consent. Exclusion criteria: EJ instability, polytrauma, inability to restore movement according to postoperative radiography, inflammatory diseases of EJ. In terms of general characteristics MG and CG have been congenerous.

In addition to currently accepted kinesitherapy (active and passive exercises to increase range of motion, stretching, postisometric muscle relaxation, proprioceptive-neuromuscular facilitation techniques, simple strengthening exercises for elbow muscles, scapula mobilization and exercises for its “core” muscles, exercises for the rotator cuff muscles, radiocarpal joint and wrist), daily home exercises, wearing night

static elbow brace in maximum extension position, the developed PT program for MG patients included ultrasound therapy (UST) followed by immediate mobilization techniques for the EJ. The patients of the CG had UST along with therapeutic massage of the shoulder and forearm [3, 16, 33].

3 Mhz ultrasound ("Biomed") has been applied for anterior and posterior surfaces of EJ during 3 min. for each area at 1.4 W/cm². Continuous mode, lability technique, contact (special gel), every other day, 8 procedures. It was followed by immediate elbow joint mobilization (MG) or massage of the shoulder and forearm (CG) during 15-20 minutes [15, 33].

Mobilization has been measured depending on patients' evaluation. The patients subjectively determined the level of tolerable pain and assessed the pressure, therewith have taken into account defensive tissue reaction, muscle spasm and contraction. III and IV grades of Maitland's mobilization have been applied at the late postoperative stage [4].

To improve flexion, the following joint mobilizations has been performed: distraction, anterior glide. To improve extension - distal radial glide has been done. Each rhythmic or oscillatory mobilization has been performed for at least 30 seconds with 3 repetitions [33].

According to the literature subjective and objective rating scales have been designated: goniometry [4], manual muscle testing [18], Quick Disability of the Arm, Shoulder and Hand Outcome Measure (QuickDASH) [10, 29], Patient-rated elbow evaluation (PREE) [27,28], that have been used to assess rehabilitation efficacy and severity of impairment (dysfunction), activity and participation according to ICF.

Mathematical statistics methods. Descriptive statistics has been used for the general characteristics of the values. The calculation of the average duration of the late postoperative stage has been carried out from the date of arriving at a stiffness diagnosis (5-8 weeks post surgery) and until reaching 30° to 130° range of flexion - extension of the EJ. To test the differences between groups over time, nonparametric statistics has been used due to the small number of observations, the Wilcoxon rank sum test – for related sets, Mann-Whitney test – for independent ones. $p < 0,05$ value

has been considered significant. Statistical analysis has been performed using SPSS statistical computer program, 16.0 version [21].

Results of the research

Resulting from the research, the categories specific for the patients suffering PTES from the Brief ICF Core Sets for Hand Conditions have been selected as follows: body functions (b280 Sensation of pain, b710 Mobility of joint function, b730 Muscle power function) and activity and participation (d520 Caring for body parts, d550 Eating, d430 Lifting and carrying objects, d445 Hand and arm use, d850 Remunerative employment). All respondents among the patients participating in the study, complained about b710 Mobility of joint function, b730 Muscle power function, d430 Lifting and carrying objects, d445 Hand and arm use, $52,94 \pm 12,48$ % noted the presence of the category b280 Sensation of pain, $88,23 \pm 8,05$ % had problems with d520 Caring for body parts, $29,41 \pm 10,60$ %, d550 Eating, $76,47 \pm 10,60$ % - d850 Remunerative employment. Other categories from the Core Set were not significant for the people from the MG and CG, no one identified those impairments.

Each category has been qualified according to the appropriate scale (Table 1).

The aim of rehabilitation of patients suffering PTES according to ICF is to restore: the functions of the operated EJ (at the level of structure), the ability of self-care (at the level of activity), professional activity (at the level of participation).

Over 4-week time of the study, the efficacy evaluation of the late postoperative stage has been assessed based on the results of achieving goals and tasks of rehabilitation (Table 2-3). The aim "To restore hand functions" corresponded to 4 ICF categories, 2 of which have improved significantly: b710 Mobility of joint function and d445 Hand and arm use ($p < 0,05$).

Table 1

Rating scales for ICF categories depending on the aim of rehabilitation

Objective	ICF category	Assessment instrument
To restore hand functions	b280 Sensation of pain	<ul style="list-style-type: none"> • PREE scale(pain) • 50-39 points (4 – complete problem); • 38 -26 points (3 – severe problem); • 25 -13 points (2 – moderate problem); • 1-12 points (1 – mild problem); • 0 points (0 – no problem).
	b710 Mobility of joint function	Goniometry (4 grades of flexion-extension stiffness)
	b730 Muscle power function	<ul style="list-style-type: none"> • Manual muscle testing • 0 = no contraction is present (4– complete problem); • 1 = trace of contraction that is contraction without movement (4– complete problem); • 2 = prominent muscle contraction and ability to make movement without help, without gravity (3 – severe problem); • 3 = full range of motion in antigravity position (2 – moderate problem); • 4 = full range of motion against moderate pressure along full range of motion (1 – mild problem); • 5 = full range of motion against strong pressure (0 – no problem).
	d445 Hand and arm use	<ul style="list-style-type: none"> • PREE scale (functions) • 50-39 points (4 – complete problem); • 38 -26 points (3 – severe problem); • 25 -13 points (2 – moderate problem); • 1-12 points (1 – mild problem); • 0 points (0 – no problem).
To ensure self-sufficiency in everyday life	d520 Caring for body parts d550 Eating d430 Lifting and carrying objects	<ul style="list-style-type: none"> • QuickDASH • 100-74 % (4 – complete problem); • 75 -49 % (3 – severe problem); • 50 -26 % (2 – moderate problem); • 1-25% (1 – mild problem); • 0 % (0 – no problem).
To return to work	d850 Remunerative employment	<ul style="list-style-type: none"> • QuickDASH (supplementary section) • 100-74 % (4 – complete problem); • 75 -49 % (3 – severe problem); • 50 -26 % (2 – moderate problem); • 1-25% (1 – mild problem); • 0 % (0 – no problem).

Table 2

Evaluation of achieving the set goal “To restore hand functions” at the late postoperative stage for patients with PTES in comparison groups

Rating scales and ICF categories	MG, M±m (n=8)		CG, M±m (n=9)		p, between comparison groups
	in the beginning	in 4 weeks	in the beginning	in 4 weeks	
PREE scale (pain), c.u.	23,0±6,0	20,25±7,1	23,2±5,5	20,5±5,9	>0,05
b280 Sensation of pain c.u.	2,2±0,5	1,7±0,6	2,2±0,6	1,8±0,9	>0,05
Goniometry (extension), c.u.	96,25±6,25	143,75±12,18**	95,55±6,17	110,00±8,89*	<0,05
Goniometry (flexion), c.u.	86,25±5,35	45,55±4,01**	85,26±5,11	61,12±4,87*	<0,05
Goniometry (pronation), c.u.	16,21±1,13	50,15±6,17**	15,33±1,27	30,15±3,49*	<0,05
Goniometry (supination), c.u.	10,23±1,24	43,75±3,44**	11,33±1,11	25,45±2,81*	<0,05
b710 Mobility of joint function, c.u.	2,8±0,2	1,9±0,2**	2,9±0,2	2,4±0,6*	<0,05
MMT flexion, c.u.	4,0±0,2	4,1±0,2	3,8±0,5	3,9±0,6	>0,05
MMT extension, c.u.	3,1±0,4	3,4±0,6	3,2±0,5	3,3±0,4	>0,05
b730 Muscle power function, c.u.	3,1±0,4	3,4±0,5	3,1±0,4	3,2±0,3	>0,05
PREE scale (functions), c.u.	37,75±2,87	25,37±3,47**	37,89±4,81	32,22±5,48*	<0,05
d445 Hand and arm use, c.u.	3,5±0,5	2,4±0,5**	3,5±0,5	3,0±0,2*	<0,05

* - significant difference between the values of related options over time, $p < 0,05$;

** - significant difference between the values of related options over time, $p < 0,001$

The aim “To ensure self-sufficiency in everyday life” corresponded to three ICF categories, two of which have undergone positive changes in both comparison groups (Table 3).

Table 3

Evaluation of achieving the set goal “To ensure self-sufficiency in everyday life” at the late postoperative stage for patients with PTES in comparison groups

Rating scales and ICF categories	MG, M±m (n=8)		CG, M±m (n=9)		p, between comparison groups
	in the beginning	in 4 weeks	in the beginning	in 4 weeks	
QuickDASH, %	62,2±2,5	56,8±5,0	58,3±5,1	55,4±4,7	>0,05
d520 Caring for body parts, c.u	4,3±0,6	2,4±0,7*	4,1±0,8	2,5±0,7*	>0,05
d550 Eating, c,u	2,2±0,6	1,5±0,5*	2,2±0,7	1,4±0,5*	>0,05
d430 Lifting and carrying objects, c.u	3,6±0,9	3,2±0,6	4,1±0,4	3,4±0,4	>0,05

* - significant difference between the values of related options over time, $p < 0,05$

The aim “To return to work” is derivative for person’s participation in social life and is essential for rehabilitation. The category d850 Remunerative employment has improved greatly during the study period in both groups ($p < 0,05$), but without considerable difference between them (Table 4).

Table 4

Evaluation of achieving the set goal “To return to work” at the late postoperative stage for patients with PTES in comparison groups

Rating scales and ICF categories	MG, M±m (n=8)		CG, M±m (n=9)		p, between comparison groups
	in the beginning	in 4 weeks	in the beginning	in 4 weeks	
QuickDASH (supplementary section), %	67,9±18,1	50,0±12,5*	72,9±15,2	46,9±13,4*	>0,05
d850 Remunerative employment, c.u.	3,00±0,75	2,25±0,62	3,22±0,69	2,12±0,74*	>0,05

* - significant difference between the values of related options over time, $p < 0,05$

Moreover, the average duration of the late postoperative recovery stage was 21,62±2,28 days for MG patients (9,75±0,75 kinesitherapy sessions and 7,0±1,0 UST interventions plus joint mobilization), 27,11±2,52 days for CG patients (11,88±1,06 kinesitherapy sessions and 7,6±0,69 UST plus massage of the limb) with a significant difference between the duration of the period of physical therapy, $p < 0,05$.

Conclusions / Discussion

ICF classification includes more than 1400 categories limiting its usage in clinical practice [20,31]. ICF Core Sets may serve as a base scheme and operational instrument for effective classification and description of the patient's functions. ICF Core Sets consist of minimal number of categories, but as many as necessary to describe patient's level of functioning. 117 ICF categories have been included into Comprehensive ICF Core Set for Hand Conditions. Based on the results of the survey only 8 categories, which in many cases are significant for the patients suffering elbow stiffness, have been selected from the Brief ICF Core Set for Hand Conditions (23 categories).

Goniometry (4 grades of elbow stiffness) [4], MMT (using 6 point scale) [18], QuickDASH (having 5 grades) and PREE scales, which are recommended as valid for the use of ICF categories evaluation, can be used to qualify the categories [28].

Pursuant to learning the literature [12, 13, 33] and analyzing functional changes associated with postoperative stiffness, UST followed by mobilization techniques along with the use of the evidence-based means of rehabilitation for PTES, have been included into PT program at the late postoperative stage. It is soft tissues mobilization techniques that have the following effects: pain management, blood flow increasing, mobility improvement, anti-inflammatory response triggering, incarnation. Clinically, scar tissue and fibrosis cause pain, muscle spasm and joint stiffness. Improving elasticity and stretching property of tissue that occurs after using UST which decreases tissue scarring and fibrosis, increases range of motion and reduces pain, and thus is clinically relevant.

The results obtained in this research are coherent with findings of the other studies. The possibility of using UST in terms of evidence-based therapeutic effect on

pain, muscle spasm and other joint stiffness has been proven [7, 13, 26]. An additional point is that attention has been paid to the results of scientific publications [13, 19] on the effective use of therapeutic exercises to increase range of motion during the 20-minutes period after applying UST, as this timespan has shown favorable physiological results. Furthermore, the combination of UST and joint mobilization has been efficient for posttraumatic stiffness of upper extremity joints based on the results of case series [13]. Joint mobilization has been performed immediately after the ultrasonic treatment, as the heat is quickly dissipated through the thermal conductivity from the area through the vascular system. Skeletal muscles temperature rise decreases rapidly within the first 10–15 minutes after finishing UST [19, 23]. F. Kaltenborn [17] believed that a greater range of motion in the hypomobile joint is obtained during mobilization rather than during basic stretching. Stretching triggers only angular components (i.e. flexion, extension), while joint mobilization engages auxiliary components, the most important of which is glide. Kaltenborn created the theory that the full range of passive motion in the synovial articulation is possible subject to the existence of so-called auxiliary joint movements: gliding, rolling, traction, compression. These are non-physiological low-amplitude movements that are beyond the volitional control of the patient, which can be performed only by a physical therapist [12, 15].

Indications for joint mobilization are pain, muscle spasm, blocking, joint laxity and functional stiffness.

Therefore, the most significant ICF categories for elbow stiffness, their rating scales have been specified. Based on rating scales and ICF categories qualification, the advantages of including UST followed by immediate elbow joint mobilization within the physical therapy program have been proved according to significant differences in the two ICF categories (b710 Mobility of joint function, d445 Hand and arm use, $p < 0,05$) and reduction in the duration of the rehabilitation period ($p < 0,05$).

Directions for future research in this area lie in the fact that the obtained results have an effect within a relatively short period of time and require longer testing.

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