CLINICAL SCIENCE

PHYSICAL TREATMENT OF POSTTRAUMATIC ELBOW CONTRACTURES IN CHILDREN – OUR EXPERIENCE

Marija Gocevska[1], Erieta Nikolikj Dimitrova[1], Valentina Koevska[1], Biljana Mitrevska[1], Cvetanka Gjerakaroska Savevska[1], Biljana Kalchovska[1], Maja Manoleva[1], Lazar Todorovic[2]

[1] *University Clinic for Physical Medicine and Rehabilitation; Ss. Cyril and Methodius University in Skopje, Faculty of Medicine, Republic of North Macedonia*

[2] *Clinic of Pediatric Surgery, Skopje; Ss. Cyril and Methodius University in Skopje, Faculty of Medicine, Republic of North Macedonia*

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***Correspondence:** Marija Gocevska, University Clinic for Physical Medicine and Rehabilitation; Ss. Cyril and Methodius University in Skopje, Faculty of Medicine, Republic of North Macedonia. E-mail: marija_sarevska@yahoo.com

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Abstract

The most common complications of elbow trauma are contractures and neurovascular injuries. The complications can be a result of the initial injury, but they can also be a result of a surgical treatment. In addition to orthopedic treatment of elbow fractures, physical therapy and rehabilitation play a significant role in treatment of posttraumatic contractures. The aim of this study was to determine the effects of physical therapy and rehabilitation of posttraumatic elbow contractures in children. Materials and Methods: This was a retrospective cross-sectional study conducted in the University Clinic for Physical Medicine and Rehabilitation, Skopje in the period 01.01.2021 – 01.07.2022. A total of 52 children were included, at the age between 2 and 13 years who had a posttraumatic elbow contracture, limited range of motion, pain and/or limitations in accomplishing daily activities. Depending on the clinical finding, children underwent a relevant physical therapy (kinesitherapy, functional therapy, electrotherapy, thermotherapy, hydrotherapy and magnetotherapy) in duration of three weeks. For assessing the effects of the rehabilitation therapy, the range of motion of the elbow and forearm was examined along with the Flynn's scale in all children, prior to and after completion of the physical treatment. Results: Applied physical treatment resulted in a significant improvement in all analyzed movements such as: elbow flexion (p=0.00001), elbow extension (p=0.00001), forearm pronation (p=0.00001), forearm supination (p=0.0000) and Flynn's scale (p=0.0000). After completion of the rehabilitation treatment, excellent results were registered in 41 (85%) children, moderate in 10 (19.23%) and favorable in 1 (1.92%). Conclusion: Timely and adequate application of physical therapy and rehabilitation can significantly improve the final outcome in treatment of posttraumatic elbow contractures in children. A combination of different physical procedures adequately applied and personalized can significantly improve the range of motion of the elbow.

КЛИНИЧКИ ИСПИТУВАЊА

ФИЗИКАЛЕН ТРЕТМАН НА ПОСТРАУМАТСКИ КОНТРАКТУРИ НА ЛАКОТ КАЈ ДЕЦА – НАШЕ ИСКУСТВО

Марија Гоцевска[1], Ериета Николиќ Димитрова[1], Валентина Коевска[1], Билјана Митревска[1], Цветанка Ѓеракароска-Савевска[1], Билјана Калчовска[1], Маја Манолева[1], Лазар Тодоровиќ[2]

[1] *Универзитетска клиника за физикална медицина и рехабилитација; Универзитет „Св. Кирил и Методиј" во Скопје, Медицински факултет, Скопје, Република Северна Македонија*

[2] *Универзитетска клиника за детска хирургија; Универзитет „Св. Кирил и Методиј" во Скопје, Медицински факултет, Република Северна Македонија*

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***Кореспонденција:** Марија Гоцевска, Универзитетска клиника за физикална медицина и рехабилитација, Скопје; Универзитет „Св. Кирил и Методиј" во Скопје, Медицински факултет, Република Северна Македонија.

E-mail: marija_sarevska@yahoo.com

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Извадок

Најчестите компликации на траумата на лактот се контрактури и невроваскуларни повреди. Компликациите може да бидат резултат на иницијална повреда, но може да бидат и резултат на хируршки третман. Покрај ортопедскиот третман на фрактури на лактот, физикална терапија и рехабилитација играат значајна улога во третманот на посттрауматски контрактури. Целта на оваа студија беше да се утврдат ефектите од физикална терапија и рехабилитација на посттрауматски контрактури на лактот кај децата. Материјали и методи: Ова беше ретроспективна студија на пресек спроведена на Универзитетската клиника за физикална медицина и рехабилитација, Скопје во периодот 01.01.2021 – 01.07.2022 година. Вклучени се вкупно 52 деца, на возраст меѓу 2 и 13 години кои имале посттрауматска контрактура на лактот, ограничен опсег на движења, болка и/или ограничувања во извршувањето на секојдневните активности. Во зависност од клиничкиот наод, на децата им беше извршена соодветна физикална терапија (кинезитерапија, функционална терапија, електротерапија, термотерапија, хидротерапија и магнетотерапија) во времетраење од три недели. За проценка на ефектите од терапијата за рехабилитација, опсегот на движење на лактот и подлактицата беше испитувана и Флиновата скала кај сите деца, пред и по завршувањето на физичкиот третман. Резултати: Применетиот физикален третман резултираше со значително подобрување на сите анализирани движења како што се: флексија на лактот (p=0,00001), екстензија на лактот (p=0,00001), пронација на подлактицата (p=0,00001), супинацција на подлактицата (p=0,0000's) и Флинова скала (p=0,0000). По завршувањето на рехабилитационит третман, одлични резултати се забележани кај 41 (85%) дете, умерени кај 10 (19,23%) и поволни кај 1 (1,92%). Заклучок: Навремената и адекватна примена на физикална терапија и рехабилитација може значително да го подобри крајниот исход во третманот на посттрауматски контрактури на лактот кај децата. Комбинацијата на различни физички процедури соодветно применети и персонализирани може значително да го подобри опсегот на движење на лактот.

Introduction

Elbow fractures account for about 16% of all skeletal injuries in childhood. Supracondylar humerus fractures are the most common fractures in children and they comprise about 60% of all pediatric fractures; the largest number of these fractures occur in children in their first decade of life.[1] The incidence of elbow fractures in children is variable and depends on many factors, and is opposite to the relatively small incidence of elbow fractures in adults. Elbow fracturesare usually a result of trauma. Falling from a height is the cause of 70% of cases.[2] The largest number of supracondylar fractures in children happen due to fall on an outstretched hand, and hence, this mechanism is frequently named with the acronym FOOSH.[3] It means that the extended elbow suffers a severe compression, especially the distal humerus. Flexion injury hasa direct impact on the olecranon of the flexed elbow. Immature bone is subject to twisting, but absorbs a lot of energy before breaking. In childhood, there is a much higher percentage of cartilage than in adulthood, and consequently this percentage diminishes as the child grows. Therefore, there are significant differences in bone fractures between children and adults.[4,5]

The impact of different factors related to injury as well as therapeutic intervention on bone, soft-tissue and other structures in the elbow area can cause posttraumatic elbow contracture as a recognized sequelae in these injuries. Posttraumatic elbow fractures with different range of motion can happen even after adequately realized orthopedic treatment.[6]

Elbow fractures are manifested with clear and obvious deformities to hidden and barely seen radiological changes. Complications in elbow injuries can be a result of the initial trauma, but they can also be a result of the surgical treatment. The most common complications of elbow trauma are angulation deformities and neurovascular injuries.[7,8] The incidence of complications primarily depends on the severity of the injury, and can be reduced by prompt and adequate treatment. Early diagnosis and treatment significantly improve the clinical outcome.

In addition to the orthopedic treatment in elbow fractures, physical therapy and rehabilitation also play an important role in treatment of posttraumatic elbow contractures and their related complications.9 For management of pain and swelling and prior to initiation of kinesiotherapy, several forms of physical procedures can be used. Different physical agents are applied, and they influence on physiological and functional regeneration of tissues, creation of biologically active materials, improvement in circulation and cellular metabolism. They are combined with kinesitherapy, hydro-kinesitherapy, functional therapy and thermotherapy. Various heat procedures (paraffin therapy) act on pain relief; they reduce the increased muscle tonus and improve elasticity and extensibility of fibrous tissue around the elbow. From phototherapy modalities infra-red and ultraviolet rays are used, and from electrotherapeutic procedures the following are applied: interferen-

tial currents, diadynamic currents, electrophoresis with drugs and galvanic current.

The goal of the physical treatment in elbow fractures is complete bone consolidation, achievement of painless and full range of motion by eliminating the present contracture, improvement in muscle strength and stability of the joint. By application of physical therapy and rehabilitation, onset of deformities is prevented and children can return to their daily activities.

The aim of this study was to determine the effects of physical and rehabilitation treatment of elbow contractures in children.

Materials and methods

This was a retrospective cross-sectional study conducted in the University Clinic for Physical Medicine and Rehabilitation in Skopje in the period 01.01.2021 - 01.07.2022. The sample consisted of 52 children with posttraumatic elbow contracture, limited range of motion, pain, reduced stability in the joint and/or limitation in performing daily activities. Following primary surgical/conservative intervention, children were treated on an outpatient basis at the University Clinic for Physical Medicine and Rehabilitation in Skopje.

Inclusion criteria for participation in the study: age from 2 to 13 years, regardless of gender, with limited range of motion of the elbow in any angle, limited range of motionof the adjacent joints, damage to the nerve structures, regardless of previous treatment by ansurgery doctor. Exclusion criteria: blood vessels lesion, open fractures and age >13 - <2.

Anamnestic data comprised: age, gender, side of injury, type of fracture, time elapsed from injury to initiation of rehabilitation therapy.

Physical therapy was started after removal of cast immobilization, with/without removal of osteosynthetic material. Children included in the study were examined by a Physiatrist, and physical therapy in duration of three weeks was recommended. Depending on the clinical finding, children were involved in a relevant physical therapeutic program.

All children underwent kinesitherapy and functional therapy, and therapeutic choice for the other procedures of physical therapy (interferential currents, diadynamic currents, electrophoresis with KJ, galvanic currents, magnetotherapy, cryotherapy, paraffin therapy and hydrotherapy) was recommended in line with the clinical and radiographic findings. Kinesitherapy consisted of active, active-assisted, active and active exercises with individual resistance that was progressively increased depending on the clinical finding. Having in mind the age of the child and local finding, functional therapy included different techniques and activities to increase the range of motion of the joint, to improve the muscle strength and to improve the functional status. Therapeutic program was individually adapted in line with the results obtained during therapy. At the same time, we educated and trained the parents to implement the exercises with their children at home.

Parameters for assessment of the rehabilitation treatment effects were: range of flexion and extension of the elbow, pronation and supination of forearm on the side of the elbow fracture. Plastic goniometer with a minimum deviation of 1o was used. Measurements were done in all children prior to and after completion of the physical treatment.

The range of motion of the elbow on admission and after completion of therapies was also assessed with the Flynn's four-degree scale for each patient as follows: a) grade/score 3 = full range of motion of the elbow or limitation of 5o; b) grade 2 = limitation of the range of motion of 5 to 10o; c) grade 1 = limited amplitude of motion of 10-15o; d) grade 0 = poor therapeutic result with limited range of motion of more than 150.[10]

Statistical analysis

Data obtained were analyzed with the SPSS software package, version 22.0 for Windows. Qualitative series were analyzed with the coefficients of relations, proportions and rates, and quantitative series with measures of central tendency (average/mean, mediana, minimal and maximal values), as well as with measures of dispersion (standard deviation). Shapiro-Wilk W test was used for determination of the normal distribution of frequency of the examined variables. Pearson Chi-square test was used for determination of the association between certain attributive dichotomous features. Difference test was used to compare the proportions. Wilcoxon Signed Ranks test was used for analysis of numerical variables between two measurements. To define the statistical significance, a two-way analysis was used with a level of significance of $p<0.05$.

Results

The study included 52 children with posttraumatic elbow contracture, 39 (75%) were boys and 13 (25%) were girls and the ratio between genders was 3:1, with a significant female preponderance (Difference 50% [(31.32-63.81) CI 95%]; p=0.0001).

The mean age of the entire group was 6.72±2.72 years with min/max of 2/12 years, and 50% of them were at the age <6.5 years for median (IQR)=6.5 (5-9). The mean age of boys was 6.41±2.59 years with min/max 2/12 years and median (IQR) = 6 (5=9). The mean age of girls was 7.77±2.95with min/max 4/12 years and median (IQR) = 8 (5-10). There was no significant difference between genders and age (Mann-Whitney U Test: Z=-1.405; p=0.1599).

The most frequent type of fracture was supracondylar, found in 30 children (57.69%), and the rarest was the fracture of the medial condyle, found in only one child (1.92%). There was no significant percentage difference in the frequency of previous surgical/conservative treatment and in the affected left/right hand, for consequently p=0.6961 vs. p=0.4345. Only 6 (11.54%) children with elbow contracture suffered from involvement of a peripheral nerve (Table 1).

Table 1. General and clinical parameters

General parameters	N (%)	p
Gender		
boys	39 (75%)	p=0.0001*
girls	13 (25%	
Type of fracture		
supracondylar	30 (57.69%)	-
olecranon	3 (5.67%)	
radial head	5 (9.61%)	
proximal forearm	2 (3.85%)	
lateral condyle	11 (21.15%)	
medial condyle	1 (1.92%)	
Treatment		
surgical	25 (48.07%)	p=0.6961
conservative	27 (51.92%)	
Hand		
left	24 (46.15%)	p=0.4345
right	52 (53.85%)	
Peripheral nerve lesion		
no	46 (88.46%)	p=0.0001*
yes	6 (11.54%)	
Affected peripheral nerve		
n.medianus	1 (16.67%)	
n.radialis	2 (33.33%)	
n.ulnaris	3 (50%)	
1 Difference test; *significant for p<0.05		

The average number of days from injury to rehabilitation in all children was 28.54±9.86 days with min/max of 15/60 days, and in 50% of children with <28 days for median (IQR)=28 (20.5-30). This period was 28.05±8.75 vs. 30±12.93 in boys vs. girls, respectively, without a significant difference between genders (Mann-Whitney U Test:Z=-0.032; p=0.9747).

The number of rehabilitation days after posttraumatic elbow contracture ranged from minimum 10 to maximum 20 days. On average, rehabilitation lasted 16.15±2.55 days, without a significant difference between genders (Mann-Whitney U Test: Z=-0.063; p=0.9494). In 75% of children the rehabilitation length was <20 days.

In children with posttraumatic elbow contracture, after completed rehabilitation compared to the condition prior to its initiation, there was a significant improvement in all analyzed movements such as: elbow flexion (p=0.00001), elbow extension (p=0.00001), forearm pronation (p=0.00001), forearm supination (p=0.00000) and Flynn's scale (p=0.00000) (Table 2).

Table 2. Comparison of movements prior to/after rehabilitation of posttraumatic elbow contracture

Intergroup comparison	Comparison of movements at two time points after posttraumatic elbow fracture					P
	Number (N)	Mean± SD	Min/Max	Median (IQR)	Mean Rank	
Elbow flexion						
before treatment	52	105.38±12.-5	35/145	110 (95-120)	0.00	Z=-6.105; p=0.00001*
after treatment	52	130.19±15.53	85/165	135 (120-140)	25.00	
Elbow extension						
before treatment	52	-24.33±19.45	-70/0	-20 (-40-10)	0.00	Z=-5.991; p=0.00001*
after treatment	52	0.19±1.39	0/10	0 (0-0)	24.00	
Forearm pronation						
before treatment	52	71.63±19.91	10/90	80 (52.5-90)	0.00	Z=-4.471; p=0.00001*
after treatment	52	83.94±7.69	50/90	85 (80-90)	15.00	
Forearm supination						
before treatment	52	77.88±13.98	30/90	82.5 (70-90)	0.00	Z=-4.487; p=0.00001*
after treatment	52	86.35±6.27	50/90	90 (85-90)	13.50	
Flynn scale						
before treatment	52	0.56±0.78	0/3	0 (0-0)	0.00	Z=-.001; p=0.00001*
after treatment	52	2.77±0.47	1/3	3 (3-3)	26,00	
Wilcoxon Signed Ranks Test*significant for p<0.05						

The additional analysis showed that none of the children with posttraumatic elbow contracture who underwent physical treatment experienced exacerbation in movements after treatment compared to pre-treatment. Unchanged condition before/after physical treatment was registered in 3 children in elbow flexion, 23 children in forearm pronation, 26 children in forearm pronation and in 1 child with unchanged score on Flynn's scale (Table 3).

Table 3. Changes in movements after physical treatment in children with posttraumatic elbow contracture

Determined change	Comparison of movements at two time points after posttraumaticelbow fracture				
	before/after Flexion - elbow	before/after Extension - elbow	before/after Pronation–forearm	before/after Supination - forearm	before/after Flynn scale
	after<before - 0 after>before - 49 after=before - 3	after<before - 0 after>before - 47 after=before -5	after<before - 0 after>before -29 after=before -23	after<before - 0 after>before -26 after=before -26	after<before - 0 after>before - 51 after=before - 1
SIgn Test					

Table 4. Analysis on Flynn's scale of mobility before/after rehabilitation treatment

Flynn scale score	Before treatment N (%)	After treatment N (%)
3 = excellent	1 (1.92%)	41 (85%)
2 = good	6 (11.54%)	10 (19.23%)
1 = favorable	14 (26.92%)	1 (1.92%)
0 - unsatisfactory	31 (59.61%)	-
Total		

Prior to physical treatment, unsatisfactory range of mobility was determined in majority of children with posttraumatic elbow contracture – 31 (59.61%). After completion of the rehabilitation treatment, excellent results were registered in 41 (85%) children, good in 10 (19.23%), and favorable in 1 (1.92%). There was no unsatisfactory mobility in none of the children after physical therapy (Table 4).

Discussion

Although the elbow is one of the most stable joints in the human body, posttraumatic contractures to elbow area are common. Posttraumatic elbow contractures that appear as a sequelae of elbow trauma in pediatric population are of different degrees of limitation in the elbow joint. These contractures can be a result of the injury type, diagnostic examination, modalities of treatment, and they certainly pose a significant therapeutic problem. After accomplishment of orthopedic and surgical treatment, physical therapy and rehabilitation play an important role in improvement of the elbow range of motion and overall functional improvement in patients.[11] The application of kinesitherapy, functional therapy in combination with the other physical procedures has a favorable impact on the outcome in treatment of posttraumatic contractures.[12]

Elbow fractures in children happen in their first decade of life, most often in children aged 3-10 years, withthe peak incidence in the 5- to 8-year-olds.[13,14] In our investigation, the mean age of children with elbow contracture was 6.72±2.72, which was in agreement with literature data.

In our sample, 75% of children with posttraumatic elbow contracture were boys, and in all patients the injury was a result of a fall on the elbow area, which was in correlation with the results presented by other authors.[15,16] In the literature, fall has been reported as a cause of supracondylar fractures in 90% to 95% of children. Contracture in the elbow area can also appear secondary as a consequence of a surgical intervention, manipulation of fractured fragments and prolonged physical therapy.[17]

Therefore, the success of treatment depends on various factors including the choice of physical modalities as well as the response of the tissue to physical therapy.

Many authors have reported their results with regards to treatment of elbow fractures, but without precise presentation of the ratio between the time when injury happened and start of rehabilitation. However, all authors have agreed that there is certain limitation in the elbow range of motion after removal ofcast immobilization. In our sample, the average number of days from injury to rehabilitation was 28.54 days, and the average length of outpatient treatment was 16.15 days. The limitation of this study was no long-term follow-up when there still might be a certain degree of elbow contracture in spite of the applied physical therapy and rehabilitation. A very small number of authors have reported on the dynamics of regaining range of motion of the treated elbow.[18,19,20,21] Orthopedic surgeons recommend physical therapy after removal of the immobilization in elbow fractures.[22,23] Contrary to this, some authors consider physical therapy not necessary after treatment of supracondylar humerus fractures.[24] Other authors advise physical therapy only in case of severe limitation in the elbow range of motion, in which the range of motion is unsatisfactory after certain postoperative period.[25]

In his study, Keppler assessed the effects of physiotherapy in improving the range of motion of the elbow after supracondylar humerus fractures in children. He examined 51 patients who had been surgically treated. One of the conclusions in his study was that physical therapy enabled a more rapid returnof normal elbow range of motion in the first 20 weeks after trauma.[18]

The incidence of specific nerve injuries varies in the literature. Primary lesions are a direct result of the trauma, whereas the secondary lesions appear during surgery, management of fractured fragments and onset of edema in the adjacent tissue.[26] In general, it is considered that the most common are median nerve injuries (28%-60% of all nerve injuries), followed by radial and ulnar lesions.[27,28] In our investigation, peripheral nerve lesion was encountered in 11.54% of children and the prevailing was ulnar nerve injury.

The final result of treatment of elbow contractures with physical therapy in children included in our study was excellent. After completed rehabilitation compared to the condition prior to its initiation, a significant improvement in the elbow range of motion was observed in all movements (flexion, extension, pronation and supination). Also, regarding the Flynn's scale excellent results were achieved in 85% of children. There were no unsatisfactory results. These results are similar to those of treatment outcome in supracondylar elbow fractures in studies with long-term follow-up.[29,30]

Our results also showed that kinesitherapy, functional therapy and hydro-kinesitherapy in combination with the other physical agents appropriately adjusted to the time period that corresponds to the clinical findings can be of substantial importance in treatment and outcome of treatment of posttraumatic elbow contractures in children. Elbow frac-

tures might cause functional morbidity and restricted range of motion, hence great attention should be paid to these fractures when establishing the diagnosis and conducting the treatment. Prompt diagnosis and appropriate orthopedic treatment as well as timely and adequately applied physical procedures within the overall treatment can significantly improve the final outcome of treatment.

A combination of various physical procedures adequately applied and adjusted can significantly improve the range of motion of the elbow.

Conclusion

Any delay in rehabilitation of an elbow fracture can cause disability and can have a negative impact on further mental and physical development of a child. Therapeutic approach to posttraumatic elbow fractures should be personalized and adequately adjusted, employing huge patience of all the involved parties.

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