

RADIOGRAPHIC ASSESSMENT IN THE TREATMENT OF SUPRACONDYLAR HUMERUS FRACTURES IN CHILDREN

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ABSTRACT

Introduction: Supracondylar humerus fractures are the most common fractures of the humerus at the elbow in children. The key role belongs to the age and immaturity of the humerus region. Treatment, even today represents the problem of bone and joint surgery. Gartland classification divides these fractures into four types. Analysis of radiographic parameters will serve as an indicator for treatment selection. **Goal:** To demonstrate the role of radiographic evaluation by measurement of

default radiographic parameters and indicate the choice of treatment for supracondylar fractures of type I and II by Gartland. **Material and methods:** The study included 60 children aged 4-14 years, divided into two groups, first with initial radiographic analysis and the second one without radiographic analysis. All were treated at the Primary Health Care Center Novi Travnik and Nova Bila Hospital from 2009 to 2011. Analysis was performed using methods of descriptive statistics to calculate the mean and standard deviation, Student's t-test and Chi-square test. **Results:** In patients from first

group hospitalization, immobilization duration, as well as physical treatment was shorter and more frequently surgical treatment was applied (manual reduction with K-wire fixation) with statistically significant difference ($p = 0.042$). **Conclusion:** Radiographic evaluation is one way to choose methods of fracture treatment. The incidence of complications is low, with excellent outcome of treatment and a faster return of children to their daily activities.

Key words: Gartland type I and II supracondylar fracture, Kirschner wires.

1. INTRODUCTION

Supracondylar humerus fractures are the most common fractures of the distal end of the humerus in children accounting for about 60% of all fractures in the elbow.

Fractures during growth period by its etiology, mechanism of injury and healing, differ significantly from the fracture at the adulthood (1, 3). Most of these fractures occur in children under the age of 10 years and usually between 5-8 years of age.

Favorable conditions for the occurrence of fractures allow increased looseness of the collateral ligament laxity structures, immaturity of bone material in the humerus region and the specific relationship of bone structures in the elbow joint.

The frequency with respect to gender shows that these fractures were twice as common in boys than in girls, while in relation to the side

are more likely to occur in the left elbow on the nondominant side (3, 7, 18).

In most cases supracondylar humerus fractures in children resulting from falls on the outstretched hand, when the extensional type fracture occurs in approximately 97% of cases, while in 3% the flexion type occurs most often by fall on the bent elbow.

There are many classifications of supracondylar fractures. As a criterion in all classification attempts are taken two features: the size of dislocation of the distal fractured fragment and the position of the fracture line. The most common is the Gartland classification (1959), which after radiographic analysis provides us guidance in selecting treatment options. It divides fractures on:

- I type – without dislocation;
- II type – with the dislocation of fragments that are still in contact

(intact posterior cortex, dislocations in single plane);

- III type – complete dislocation of fragments with no cortical contact (the most common type with 50%).
- If there are clinical signs of neurovascular lesions, or in case of open fracture, then this is classified as a fracture – type IV (1, 3, 5).

For diagnostic and therapeutic procedures with the trauma of the distal end of the humerus in children we should not forget the ossification map of this region. There are six ossification centers in the elbow joint. It should be noted that at the time of birth the distal humerus is completely made of cartilage. Ossification cores are gradually appearing in a specific order. The order of appearance is shown by mnemonic abbreviation: CRITOL (Capitulum, Radius, Internal or medial epi-

condyle, Trochlea, Olecranon, Lateral epicondyle). Age of occurrence is variable, but generally the sequence is at age of 1, 3, 5, 7, 9, 11 years (3, 4, 7, 10, 11, 12, 13, 14, 15, 16). Diagnosis of fractures of the distal humerus in children is a clinical and radiological. It is based on: history, clinical examination and radiographs, whereas methods: ultrasound, CT, MRI, color-Doppler, angiography, EMG is useful as an additional diagnosis of multifragment fractures in suspected vascular injury and in assessing damage to nerve structures (3, 14, 17, 18, 19, 20, 21, 22.).

In history, essential is information on the mechanism of injury, as well as information about disorders and pain. Clinical findings consist of examination, palpation, testing the functions and neurology-circulatory status, along with registration and exclusion of associated injuries and illness at admission. Cubital region has three fat pads and during palpation of cubital region we should pay attention to the movement of fat pads, which with swelling of the region and palpatory tenderness indicate an occult fracture, but not visible on x-ray and without other clinical signs of fracture (2, 3, 12, 13).

For X-ray imaging are made standard projections: AP image with the extended elbow, forearm in neutral position; lateral projection, the elbow in flexion if possible up to 90°.

In the analysis of X-ray images is necessary to point out some characteristics of the angles, which are used to estimate the position of fragments: Baumann angle (Figure 1.), AHL (anterior humeral line) (Figure 2.), humerotrochlear angle (Figure 3.) (3, 7, 12, 19) (.

Complications arise as a result of trauma, iatrogenic during repositioning or during the surgery. They are divided into two basic groups: a) those that lead to deterioration of the lower extremities function, b) those who leave the cosmetic consequences. Deterioration of function leads to injury of neurological and circulatory structures, while the major cosmetic problem is cubitus varus or valgus.

Posttraumatic elbow contracture occurs as distinct consequences of

these fractures and is characterized by varying degrees of restrictions of movement in the elbow (6, 7, 12, 15, 21, 22).

In daily clinical work, but also in literature, we face numerous methods of treating supracondylar fractures. Treatment can be conservative and surgical. Each of these methods has the same goal—to keep the fragments in corrected position through conservative (manual reposition, immobilization by splint and traction) and by surgical techniques (open surgical reduction and fixation with Kirschner wires or manual reduction and transcutaneous Kirschner wire fixation of the fragments). Manual reduction and transcutaneous Kirschner wire fixation is increasingly considered the method of choice (3, 6, 8, 10, 11, 24).

In addition to the conservative and surgical treatment of supracondylar fractures important place and role in the treatment have physical therapy with the use of different passive and active therapeutic procedures depending on clinical findings, in order to achieve better functional and aesthetic restoration after the fracture. To determine the success of treatment Flynn's criterias are applied, which include measurement of bearing angle, flexion and extension (17, 12, 20, 25).

2. GOAL

The goal of this study was to demonstrate the role of radiographic evaluation after measurement of set radiographic parameters in the selection of treatment methods for supracondylar fracture of type I and II by Gartland, to reduce the occurrence of complications and improve treatment outcome.

3. MATERIAL AND METHODS

At the Primary Health Care Center Novi Travnik and Nova Bila Hospital are treated 60 patients 4-14 years of age due to supracondylar fracture of the upper arm of type I and II by Gartland. To collect rele-

vant data on each patient: the method of injury, fracture type, method and course of treatment, and final evaluation (clinical and functional) the questionnaire designed for this study was used. The study included a time period from January 1, 2009 – December 31, 2011. All patients were classified into two groups of 30 patients:

- I group – 30 patients with supracondylar fracture of humerus – type I and II, classified according to Gartland, who had performed radiographic evaluation;
- II group – 30 patients with supracondylar fracture of humerus – type I and II, classified according to Gartland, where radiographic evaluation was not performed.

Uninjured side in both groups was used for the collection of control parameters.

The study is a retrospective-prospective. Data were collected and used from the medical records of patients from surgical protocol of the Primary Health Care Center Novi Travnik and Nova Bila Hospital, from the medical history, surgical protocols and analysis of X-ray images before and after the treatment. Diagnostics (clinical and radiological) for each patient was performed at the Primary Health Care Center Novi Travnik. For each patient med-

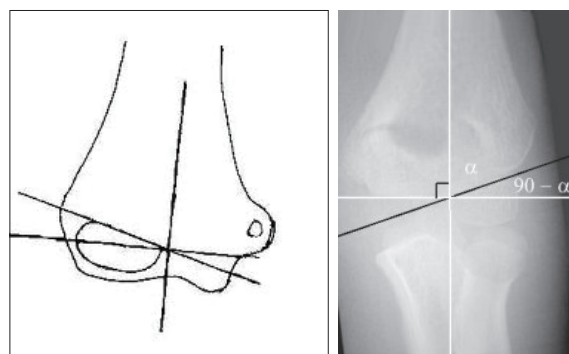


Figure 1. Baumann angle [3]

ical history was taken, examination made, palpation, with examination of the vascular and neurological functions.

Made are X-ray images in standard projections: AP image with the elbow in extension, LL-image with elbow in flexion preferably of 90°.

In patients of group I have done a detailed analysis of X-ray radio-

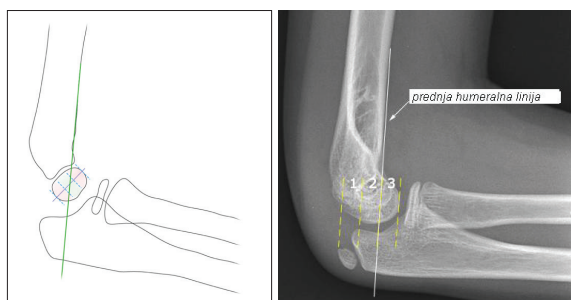


Figure 2. AHL (anterior humeral line) [3]

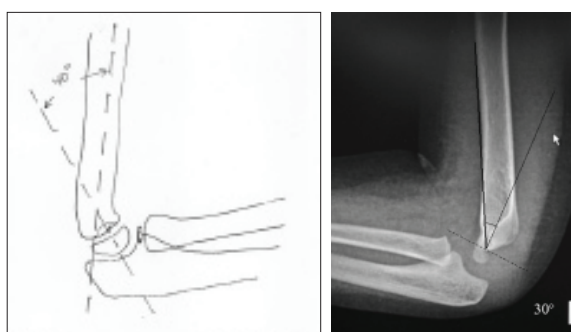


Figure 3. Humerotrochlear angle [3]

graphic images. To estimate the positions of fragments (dislocation, angulation), we used the characteristic angles and perform their measurements:

Baumann's angle is measured on AP image and it represents an angle that makes fisal line of the lateral condyle of the humerus with the longitudinal axis. It should be about 75°. AHL (anterior humeral line)–measured on the lateral image and represents a longitudinal line which runs from the edge of the humeral diaphysis and normally passes through the middle third of the humerus capitulum. Humerotrochlear angle is measured on the lateral image and is consisted of longitudinal lines of diaphysis of the humerus with the axial line of the condyle and is about 40°.

All patients (treated conservatively and surgically) conducted a physical therapy at the Physical Rehabilitation Department at the Nova Bila Hospital. For statistical analysis of data was used statistical software SPSS 12. Analysis is done by using methods of descriptive statistics to calculate the mean and standard deviation, Student's t-test and Chi-square test. Statistical analysis was performed with a confidence interval of 95% and a value of $p < 0.05$ was considered as significant.

4. RESULTS

Of the 60 children with supracondylar humerus fractures of type I and II were classified according to Gartland, 36 boys and 24 girls, with most patients from age group 7-10 years or 13 (43.3%) in group I and 14 (46.7%) in group II. The average age in group I was 8 ± 2.5 years (range 4-13) and 7.5 ± 2.3 (range 4-13) in the group II. Subjects in group I were slightly older than the group II ($t=0.637$, $p=0.428$). In Group I there were 18 fractures of the left arm from which 10 male

(55.6%) and 8 female (44.4%), 12 fractures of the right arm from which 7 (58.3%) male and 5 (41.7%) female. The group II had 16 fractures of the left arm, of which 9 (56.3%) in male and 7 (43.8%) in fe-

males, and 14 fractures on the right side from which 10 (71.4%) in male and 4 (28.6%) in females. More are represented on the left side in both groups. Analyzing the distribution of patients according to Gartland classification 22 (36.7%) patients had G-I and 38 (63.3%) had a G-II observed in both groups. All group II patients had the extensional fracture and in group I 96.7% extensional and 3.3% flexion fracture.

The AP images were measured Baumann's angle. Most of the respondents had a value of 71-75° or 13 (43.3%), and 2 patients (6.7%) had a value less than 65°. The average value was $73.17 \pm 4.49^\circ$ (Table 1). On the lateral image was measured humerotrochlear angle and passing of the anterior humeral line through capitulum. Mean humerotrochlear angle observed in group I was $34.4 \pm 7.04^\circ$. The largest number of respondents 10 (33.3%) had a value in the range of 36-40°, and 4 patients (13.3%) value lower than 25° (Table 2). Anterior humeral line normally passes through the middle third of the capitulum. In our study, in the majority of respondents 14 (46.7%), anterior humeral line passing through the anterior third of capitulum and the least passed through the last third of the capitulum 3 (10%) (Table 3).

In this study for both groups of patients were applied the following treatments: manual reduction and immobilization in 22 patients (51.2%) with I type of the fracture and in 21 patients (48.8%) with type II fractures, manual reduction + fixation with K-wires in 10 patients (100%) who had a Gartland-II fracture, open reduction + fixation with K-wires in 7 patients (100%) who had a Gartland-II fracture (Table 4).

Results indicate that in patients of group I, who underwent radiographic evaluation, is recorded a higher number of surgically treated fractures–12 (40%), while in group II, five patients (16.7%), so there is a statistically significant difference between groups in terms of greater representation surgical treatment in group I and conservative in group II.

According to Flynn's criteria, the total in the two groups of our study, 26 patients (43.3%) had an excel-

Baumann angle (degrees)		
	N	%
<65	2	6.7
65-70	7	23.3
71-75	13	43.3
76-80	5	16.7
>80	3	10.0
Total	30	100.0

Table 1. Distribution of respondents by Baumann angle size

Humerotrochlear angle (degreed)		
	N	%
<25	4	13.3
26-30	6	20.0
31-35	4	13.3
36-40	10	33.3
>40	6	20.0
Total	30	100.0

Table 2. Distribution of respondents by humerotrochlear angle

Frontal humeral line		
	N	%
Passes in front of the anterior third	7	23.3
Passes through anterior third	14	46.7
Passes through middle third	6	20.0
Passes through posterior third	3	10.0
Total	30	100.0

Table 3. Distribution of respondents by passage of the frontal humeral line through capitulum

Fracture type * Grout * Treatment method						
Treatment method			Group			Total
			I group	II group		
Manual Reduction + immobilization	Fracture type	G I	N	8	14	22
			%	44.4	56.0	51,2
		G II	N	10	11	21
			%	55.6	44.0	48,8
	Total	N	18	25	43	
		%	100,0	100.0	100.0	
Manual reduction + fixation with K-wires	Fracture type	G II	N	8	2	10
			%	100.0	100.0	100,0
	Total	N	8	2	10	
		%	100,0	100.0	100.0	
Open reduction + fixation with K-wires	Fracture type	G II	N	4	3	7
			%	100.0	100.0	100,0
	Total	N	4	3	7	
		%	100,0	100.0	100.0	
Total	Fracture type	G I	N	8	14	22
			%	26.7	46.7	36,7
		G II	N	22	16	38
			%	73.3	53.3	63,3
	Total	N	30	30	60	
		%	100.0	100.0	100.0	

Table 4. Method of treatment by fracture type in I and II group, $\chi^2=0.559$, $p=0.331$, $\chi^2=2.584$, $p=0.090$

lent outcome, 25 (41.7%) good, and 9 (15.0%) average. It should be noted that there was no patients with unsatisfactory results (the test group was with I and II type of fractures by Gartland). Although there are no statistically significant differences it can be noted that the patients from group I had an excellent outcome more often compared to group II. After completing physical therapy range of motion was measured by a healthy and injured elbow. There was a statistically significant difference ($p<0.05$) in mean values of flexion and extension between injured and uninjured limb. The difference of flexion and extension according to the type of treatment (surgical or conservative) shows a statistically significant difference in the injured limb, which recorded a higher degree of extension in patients treated surgically compared to patients treated conservatively. By the length of the cast immobilization duration and physical therapy, between the groups observed, indicating that the hospitalization was longer in group II (5 ± 1 days) than in group I (4.33 ± 1.23 days), but without statistically significant differences, as well as duration of cast immobilization, which was shorter in

group I (20.43 ± 1.72 days) compared to group II (21.17 ± 2.58 days), also without statistically significant differences ($p>0.05$). Physical treatment lasted on average shorter in group I (22.67 ± 4.08 days) than in group II (27.9 ± 5.45) without statistically significant difference ($p<0.05$).

In this paper, complications were observed in a small number of patients: contracture (delay in elbow flexion and extension). In the first group the contractures were recorded in 2 patients (6.7%) and in group II in 3 patients (10%) with 1 (3.3%) cubitus varus. Smaller number of complications

was recorded in the first group with initial radiographic analysis. The presence of complications observed between the groups indicates that there is no statistically significant difference ($p>0.05$).

5. DISCUSSION

Supracondylar humerus fractures are the most common elbow fractures in children in the first decade of life. Approximately 60% of fractures among children belong to supracondylar fracture of humerus. The incidence rises between 4-8 years of age, and decreases at the age of about 15 years (3). Analyzing the results we recorded in both groups more boys 60:40%. The average age at the time of injury was 8 years in the I group and 7.5 years in the group II. More fractures were present on the left side in both groups. Extensional type was present in 96.7% and flexion in 3.3% of cases in the group I. In group II, all subjects had extensional type of fractures. Comparing the data obtained in this study with the data found in other studies it can be said that the incidence of supracondylar fractures appear to be related to gender, age, side, and is consistent with the type of fracture (16).

In I group on the AP image, we measured the Baumann's angle (average value was $73.17\pm 4.49^\circ$), and on lateral images humerotrochlear angle ($34.47\pm 7.04^\circ$) and AHL- anterior humeral line, which usually passed through the anterior third of the capitulum.

Lee B, Lee S, Kim S, et al (2011) examined 114 children with supracondylar fractures, and measured the Baumann's and humerotrochlear angle and analyze the effectiveness of treatment which is performed based on the type of fracture. The results showed that radiographic assessment of these angles indicates a good choice of treatment based on the degree of dislocation of the fragments (24). By analyzing this data indicated a stabilization of the fracture mode in group I, while in group II, treatment is indicated only by standard radiographic images without measurement and analysis. In our study in both groups dominated manual reduction with immobilization or 60% of group I and 83.3% of group II. Manual reduction with K-wire fixation was more frequently used in group I (26.7%) than in group II (6.7%) without statistically significant difference ($p=0.042$) in terms of greater representation of surgical treatment. Open reduction and fixation with K-wires was used in 7 patients in both groups.

Tiwari A, Kanojia RK, Kapoor SK (2007) examined the results of surgical treatment of supracondylar fractures of the humerus. According to their results, the method of choice is closed reduction and stabilization by K wires (26).

The average duration of hospitalization was shorter in group I (4.33 ± 1.23 days) as well as length of cast immobilization (20.43 ± 1.72 days) compared to group II, but without statistically significant differences. Physical treatment in patients of group I was shorter, on average 22.67 ± 4.08 days, compared to group II, which lasted 27.9 ± 5.45 days. The analysis indicates that there is a statistically significant difference in the average duration of physical treatment ($p<0.05$). Analysis of average values of flexion and extension between the injured and

uninjured limb and shows that in both cases there is a significant difference $p=0.001$, $p=0.008$ and is considered to be statistically significant ($p<0.05$). Range of motion significantly increased after completion of physical treatment and has impact on the final treatment outcome. For both groups of patients the outcome of treatment was evaluated by Flynn's criteria. From the total number of respondents 43.3% had an excellent result, 41.7% good and 15.0% average. It is important to point out that there was no poor result. In this study, complications were observed in a small number of respondents. In the group I in 2 patients (6.7%) contracture was recorded, in group II in 3 patients (10%) contractures and in 1 patient (3.3%) cubitus varus. It is noticeable that the smaller number of complications was recorded in the group I with initial radiographic analysis in relation to the group II. Neurovascular injuries were not recorded.

Oztürkmen Y, M Karamehmetoglu, Azboy I (2005) in their study on 34 patients with supracondylar fractures treated surgically (manual reduction and fixation with K-wires) had one complication—cubitus varus (27).

The most common dilemma for choice of treatment was observed in type II fractures by Gartland, where there is less movement and preserved posterior cortex. By a precise measurement we determine the shift, if there is rotation and deviations from normal and apply the proper treatment.

Based on the results of our study, we confirmed the importance of radiographic analysis as a method for selecting treatments for supracondylar fracture of type I and II by Gartland, whether the fractures are clearly presented or hidden with a barely noticeable radiological changes.

We proved that the analyzed parameters (length of hospitalization, length of cast immobilization, physical therapy duration, lower frequency of complications and good outcome), are in favor of group I patients with initial radiographic analysis and confirmed the study goal.

Manual reduction and transcuta-

neous Kirschner wire fixation is increasingly considered as the method of choice and is called the "gold standard" for treatment of supracondylar fractures of the humerus (24, 28).

6. CONCLUSION


Detailed radiographic evaluations, after the measurement of radiographic parameters was used in the selection of methods of treatment of humeral supracondylar fractures in children of type I and II according to Gartland. Good choice of treatment (manual reduction and fixation with K-wires) reduces hospitalizations, duration of cast immobilization, physical therapy, with less complications and faster return to daily activities of children.

Conflict of interest: none declared


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