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Diagnostic Tactics for Transcondylar and Supracondylar Fractures of the Humerus in Children

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Abstract

Transcondylar and supracondylar fractures of the humerus in children are one of the most pressing and still not completely solved problems of modern pediatric traumatology. In the problem of condylar and supraorbital fractures of the humerus, the issues of diagnosis, choice of indications for surgical revision of the vascular-nervous bundle of the elbow area in this pathology are insufficiently covered. To solve the problems of the study, we analyzed the treatment of 313 victims with transcondylar and supracondylar fractures of the humerus, which were treated at the City Children's Clinical Hospital in Lviv in the period from 2013 to 2018. The structure of the distribution of arrays on the basis of rotational displacement in condylar fractures of the humerus is dominated by displacement up to 30 °, which in the first group was found in 61.8 % of cases, and in the second group – 69.2 % of cases. The share of severe rotational displacements in the structure of group arrays is almost the same in both observation groups: 29.1 % in the first group and 29.5 % in the second group. Analysis of the proportion of extremely severe rotational displacements up to 90 ° in the structure of group arrays revealed that such victims were 7 times more among the victims of the first group than among the victims of the second group, due to the use of the proposed unified protocol scheme for diagnosis and treatment humeral fractures in pediatric patients, which avoids or reduces the difference in the occurrence of secondary displacements.

Keywords: transcondylar and supracondylar fractures of the humerus in children, diagnosis, rotational displacement of fragments.

1. Introduction

Transcondylar and supracondylar fractures of the humerus in children are one of the most pressing and still not completely solved problems of modern pediatric traumatology (Tan et al., 2018). This is due to the relatively high prevalence of this type of injury to the child (60 % of cases of elbow injuries and up to 50 % of cases of injuries of the upper extremity), and the complex clinical and anatomical situation that occurs in such fractures, which manifests itself primarily , the presence of multiplanar displacements of fragments (Cha et al., 2016) Damage to the bone structures of the elbow joint in children, according to various researchers, is from 16 to 50 % of all bone fractures or 50-80 % of all intra-articular injuries of the upper extremity (Bell et al., 2017; Sahin et al., 2017).

To date, there are quite a number of methods for diagnosing transcondylar and supracondylar fractures of the humerus in children, many author's methods of conservative and surgical treatment, but there is still no consensus among experts on the possible consequences of damage, especially the degree and depth of damage to the vascular bundle joint (Sinikumpu et al.

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2016). In the problem of condylar and supraorbital fractures of the humerus insufficiently covered issues of diagnosis, choice of indications for surgical revision of the vascular-nervous bundle of the elbow area in this pathology (Chen et al., 2015; Claireaux et al., 2019).

Given that the organizational and clinical aspects of emergency care in the prehospital and early hospital stages are widely covered in the literature, we decided to focus on diagnostic and medical-technological aspects of medical care for children with transcondylar and supracondylar fractures of the shoulder and shoulder fractures. The concept of medical care for victims with condylar fractures of the humerus is based on the principles of adequate volume and time of injury diagnosis, formation of an effective unified protocol scheme of medical care and determination of treatment technology taking into account the minimum necessary and adequate medical technology.

2. Materials and methods

To solve the problems of the study, we analyzed the treatment of 313 victims with condylar and supraorbital fractures of the humerus, who were treated at the City Children's Clinical Hospital in Lviv in the period from 2013 to 2018. The age of the victims ranged from 0.5 to 18 years. In order to qualitatively analyze the actual material of the study, we divided the study array into three groups. The first group included 145 pediatric patients who were treated in the orthopedic and traumatology department of the MDCL in Lviv in 2013–2015 before the introduction of the clinical route of a patient with pre-growth and supra-outgrowth fractures at the diagnostic stage. This group accounted for 46.3 % of the total study array. The second group included 168 victims with transcondylar and supracondylar fractures of the humerus, who were treated at the MDCL in Lviv in 2016–2018 after the introduction of the clinical route of a patient with transcondylar and supracondylar fractures at the diagnostic stage. This group accounted for 53.7 % of the total array.

3. Discussion

Upon admission of victims with fractures of the distal metepiphysis of the humerus, we considered it necessary and appropriate to identify the following priorities:

1. Detection of the severity of damage to the humerus;
2. Determining the presence or absence of complications:
3. Choosing the optimal treatment tactics;
4. Prevention of early and late complications.

After the survey, when the anamnesis of the injury was clarified, we analyzed the mechanism of injury, time spent in the prehospital stage, the availability and amount of medical care. An important point in pre-hospital care was considered to be the presence or absence of transport immobilization, as well as the adequacy of such immobilization. Among the victims of our study, transport immobilization was performed in 77.3 % of the victims of the general array, in 73.1 % of cases of the array of the first group and in 80.9 % of the array of the second group.

In the diagnosis of condylar and supraorbital fractures of the humerus, first of all, a clinical method should be used, which allows to determine the previous diagnosis and purposefully appoint further examination. However, it is necessary to take into account the psychophysiological characteristics of pediatric patients, which are characterized by mental liability and fear of pain, which significantly complicate the possibility and effectiveness of a full clinical examination.

The examination of the victims was carried out according to the generally accepted standards of examination of trauma patients. At the beginning, the position of the limb was determined, which was usually forced: the forearm is half-bent, supported by a healthy limb with existing edema and hemarthrosis of the affected elbow joint. During the examination, special attention is paid to the shape of the joint with a dynamic comparison on the contralateral side. On the side of the injury, the clinical signs were classic: the presence of hematoma, crepitation of bone fragments, pathological mobility. The victims complain of pain in the elbow joint, inability to actively move the elbow joint on the affected side.

Of course, the main method for the diagnosis of condylar fractures was radiography. Using this classical technique, we determined the level of fracture of the humerus, the nature and magnitude of the displacement. This method of diagnosis was used in 100.0 % of cases of both observation groups, which indicates that all victims with transcondylar and supracondylar fractures of the humerus were shown to conduct an X-ray examination. Usually X-ray examination was performed in two projections (direct and lateral), in some diagnostically complex cases radiography

of the contralateral joint was performed. According to the location of the fracture line on the radiograph, the condylar fractures were divided into high (proximal), medium and low (distal).

Thus, among patients of the first group, high transcondylar and supracondylar fractures were found in 57 cases, which were 39.3 % of the group array, medium fractures in 72 cases, which accounted for 49.7 % of the group array, and low – in 16 cases, which were 11 0 %. In the second group, high condylar fractures were observed in 65 cases, which were 38.7 %, medium fractures in 81 cases, which were 48.2 %, and low – in 22 cases, which was 13.1 %. It should be noted that among the victims diagnosed with low condylar fractures of the humerus were most common children aged 3-5 years, which was detected in 100.0 % of cases. In our opinion, this type of condylar fractures should be allocated to a special group. This is because the size of the distal fragment is usually very small and therefore causes some difficulties in both diagnosis and treatment.

After performing radiography in direct and lateral projection, we determined the presence or absence of rotational displacement of the fragments. The width of the distal fragment along the fracture line was determined on the radiograph in a direct projection. In the lateral view, the diameter of the humerus at the level of the fracture in the proximal and distal fragments was calculated. After calculating these parameters, to determine the rotational displacement, we used the formula:

(C/B) × 90/ (A/B)

Where:

A – is the diameter of the distal fragment at the level of the fracture on the direct radiograph;

B – is the diameter of the proximal fragment at the level of the fracture on the lateral radiograph;

C – is the diameter of the distal fragment at the level of the fracture on the lateral radiograph;

90 – degree of the greatest rotational shift (Katin et al., 2010)

4. Results

In our study, rotational displacement was detected in 133 patients, accounting for 42.5 % of cases. Among the victims of the first group, a rotational shift was detected in 55 cases, which was 37.9 % of the group. In the second group of patients after the application of a unified protocol scheme for the treatment of transcondylar and supracondylar fractures of the humerus in pediatric patients, rotational displacement was registered in 78 cases, which was 46.4 % of the group.

To determine the structure of rotational displacement among victims with condylar fractures of the humerus, we conducted an analysis, the results of which are shown in Table 1.

Table 1. Structures of rotational displacement among victims with condylar fractures of the humerus in the observation groups

Degree rotational displacement	number of children								
	I group			II group			general array		
	абс.	%	Ri	абс.	%	Ri	абс.	%	Ri
1-10	11	20,0	2	22	28,2	2	33	24,8	2
11-30	23	41,8	1	32	41,0	1	55	41,4	1
31-50	9	16,4	3	15	19,2	3	24	18,0	3
51-70	7	12,7	4	8	10,3	4	15	11,3	4
71-90	5	9,1	5	1	1,3	5	6	4,5	5
In total	55	100,0	-	78	100,0	-	133	100,0	-

As indicated by the analysis of the data in Table 1, there is a difference in the structure of the rotational displacement among the victims in the observation groups. Thus, in the first group, victims with a rotational displacement of 11-30 ° were most often observed, which was detected in 41.8 % of cases. It was these victims who took first place in the first observation group. In the second group of victims with this level of rotational displacement was almost the same, 41.0 % in relative terms of the absolute value, and similarly to the first group in the ranking distribution, they also took first place. In the total array of patients with a rotational displacement of 11-30 ° were 55, which was 41.4 % of cases.

In the second place in the first group suffered with the smallest rotational displacement, equal to 10 °. There were 20.0 % of such victims in the first group. In the second group there were

28.2 % of such victims, which is 1.4 times more than in the first group. The rank distribution determined for them the second rank place among the victims of the second group. In the total array of victims with a rotational displacement of up to 10 ° was 24.8 % and they also ranked second in the distribution. Rotational displacement up to 50 ° was detected in 16.4 % of the victims of the first group. These victims took the third place in the first group. Among the victims of the second group, this rotational shift was detected in 19.2 % of cases. Victims with such a shift as in the first group took third place. The general array confirmed the trend of observation groups.

The fourth place in the first group was occupied by victims with a large rotational displacement up to 70 °. Such a rotational shift was observed in 12.7 % of the victims of the first group. In the second group, victims with a similar rotational displacement were also in the fourth place, but were slightly less common – in 10.3 % of cases. The total array revealed 11.3 % of victims with a rotational displacement of up to 70 ° and they also ranked fourth.

The victims with a critical rotational displacement of 71-90 ° were the least common in the first group. This type of rotational displacement occurred in 9.1 % of the victims of the first group and took the fifth place. There were only 1.3 % of such victims in the second group, but the ranking also placed them in the fifth place. The total number of victims with a critical rotational displacement of 71-90 ° was 4.5 % and they were in the last fifth place.

Polychoric analysis proved that there is a direct positive, moderate strength relationship between these signs, and these provisions are within the probability field (χ^2 10.6 ≥ χ^2st9.5), ($p \leq 0.05$).

Assessment of the color of the hands and fingers, the state of pulsation in the arteries of the forearm and the sensitivity of the skin of the fingers and palms were mandatory. It is important to note that according to our observations, the clarity of clinical manifestations of this injury is adequate and verified only in the early period, and the longer the period from the onset of the injury the more swollen the elbow joint, which makes it difficult to diagnose this type of injury. The presence of such local signs as hematoma, intense edema, lack of pulsation in the arteries of the wrist, capillary reaction on the nail plates of the fingers gave us reason to believe that there are neurovascular complications.

Another symptom that was quite valuable for evaluation was the absence or sharp limitation of sensitivity and motor activity in the affected limb. Victims with vascular disorders usually had a gross deformity, at the base of which was palpated a central fragment under the skin of the elbow fossa with a cyanotic bruise above it. To fully diagnose the presence of vascular complications in all victims with transcondylar and supracondylar fractures of the humerus, the pulsation was determined by palpation on a.radialis with obligatory control on the contralateral limb. At weakening or absence of a pulsation on a. radialis required pulsoximetry on both arms. If SPO2 levels were reduced to 80-95 %, we used color duplex scanning, which allowed us to detect vascular complications at an early stage.

Table 2. Analysis of signs of clinical manifestation according to the criteria of verification and spread of signs of condylar fractures of the humerus in the observation groups

Clinical sign	Verification%	Rank	Occurrence %	Rank
Forced position of the limb	59,3	3	92.9	1
Hematoma in the lower third of the shoulder and elbow joint	42,5	4	50,4	3
Deformation in the lower third of the shoulder and elbow joint	88,5	2	80,5	2
Pathological mobility	100,0	1	43, 5	4

From our point of view, it is expedient and necessary to verify the in formativeness of the clinical manifestation of condylar and supraorbital fractures of the humerus in children affected. This assessment was performed by comparing clinical signs and radiological diagnostic data on the proportion of coincidences. The data obtained are set out below:

1. Forced position of the limb due to the absence or sharp restriction of movements in the elbow joint – 59.3 %;
2. Hematoma in the lower third of the shoulder and elbow joint – 42.5 %;
3. Deformation in the lower third of the shoulder and elbow joint – 88.5 %;
4. Pathological mobility – 100.0 %.

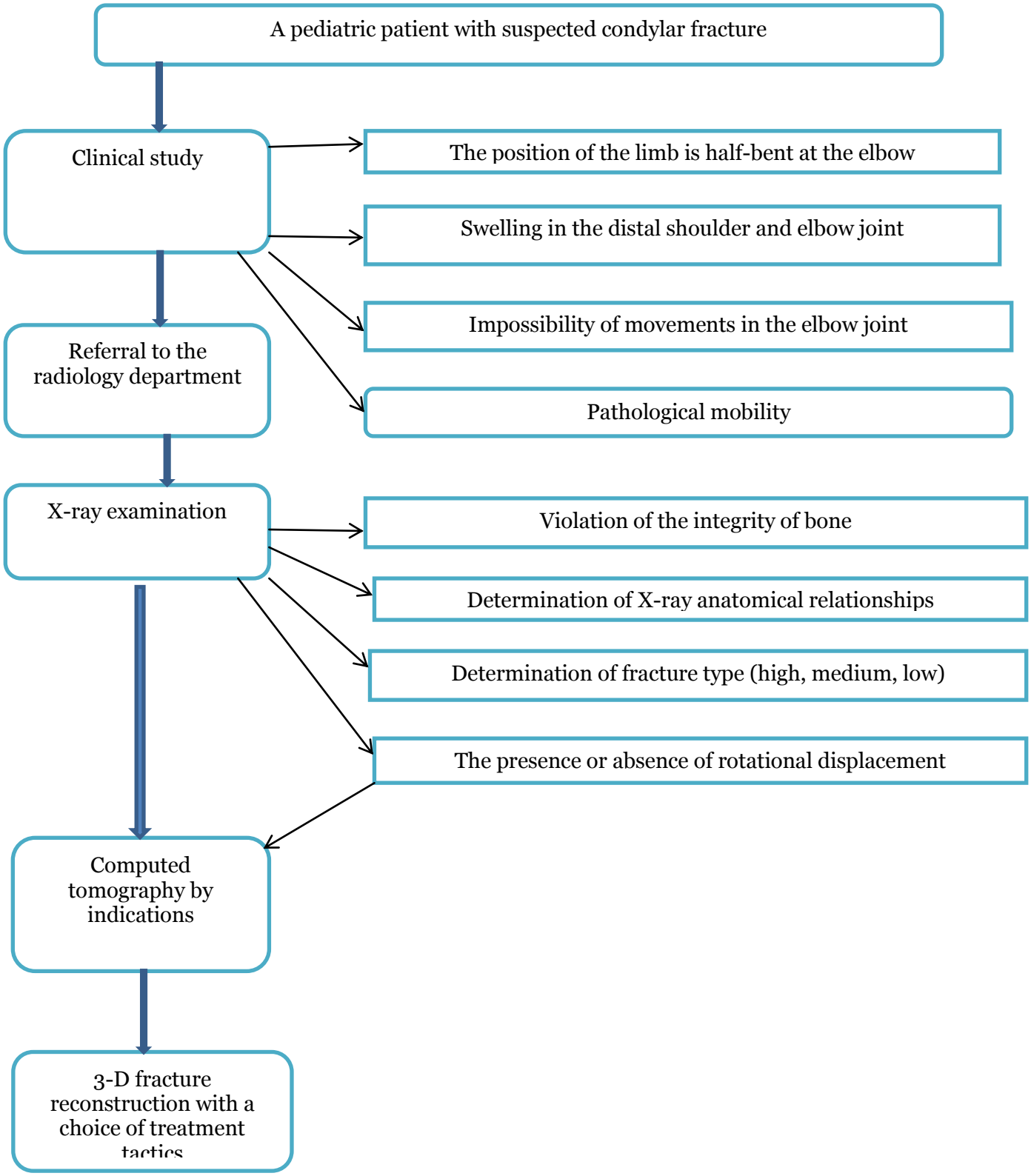

Fig. 1. Clinical route of a patient with transcondylar and supracondylar fractures of the humerus in children at the diagnostic stage

To determine the impact of signs of clinical manifestation on the criteria of verification and prevalence, we conducted an analysis, the results of which are shown in Table 2.

Thus, the most informative clinical sign is pathological mobility, but it actually occurs in only 43.5 % of cases and occupies the last fourth rank. Deformation in the lower third of the shoulder and elbow joint is in the 2nd rank and is verified in 88.5 % of cases, but occurs in 80.50 % of cases, which also brought its occurrence to the second rank. The forced position of the limb due to the absence or sharp restriction of movements in the elbow joint ranks third in the clinical manifestation, which was detected in 59.3 % of cases and occurs in 92.9 % of cases, occupying the first rank. Hematoma in the lower third of the shoulder and elbow joint ranks fourth in the clinical manifestation and was verified in 42.5 % of patients and occurred in 50.4 % of cases, occupying the third rank.

In general, the coefficient of combination of signs of clinical manifestations is 2.9, i.e. on average; each victim has almost three clinical signs of injury.

Based on the results of the rank analysis of the data in Table 3, it should be noted that the most resistant to evaluation is the sign "Deformation in the lower third of the shoulder and elbow joint", its presence most likely indicates the presence of a fracture. In general, a comprehensive assessment of the manifestations of clinical signs is ambiguous. Thus, radiological diagnosis is appropriate and necessary.

To clarify the anatomical and topographic situation regarding the localization of fragments, we performed spiral computed tomography, which made it possible to visualize the ratio of fragments, the structure of bone tissue in the sagittal and frontal planes, performed 3D reconstruction. This method of research is very accurate, allows not only to adequately diagnosing the extent and nature of bone damage, but also, thanks to computer reconstruction to choose the most optimal method of treatment and plan the implementation of treatment measures. Unfortunately, this research method has significant limitations for use in children, primarily due to radiation exposure. Analysis of clinical experience indicates that the relative indications for computed tomography are the need to determine the presence of fractures, the need to clarify the clinical and anatomical characteristics of fractures, especially in rotational displacement of fragments, the need to verify the plan, nature and technology of surgery.

Based on the above, we formed a clinical route of the patient at the diagnostic stage, which is shown in Figure 1.

5. Conclusion

1. The structure of the distribution of arrays on the basis of rotational displacement in condylar fractures of the humerus is dominated by displacement up to 30 °, which in the first group was found in 61.8 % of cases, and in the second group – 69.2 % of cases;

2. The share of heavy rotational displacements in the structure of group arrays is almost the same in both groups of observation: 29.1 % in the first group and 29.5 % in the second group;

3. Analysis of the proportion of extremely severe rotational displacements up to 90 ° in the structure of the groups found that such victims were 7 times more among the victims of the first group than among the victims of the second group, due to the use of the proposed unified protocol scheme for diagnosis and treatment and supracondilar fractures of the humerus in pediatric patients, which avoids or reduces the difference in the occurrence of secondary displacements.

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