POSTOPERATIVE EVALUATION OF CHILDREN AND ADOLESCENTS SUBMITTED TO SURGICAL REDUCTION OF LATERAL HUMERAL CONDILLARY FRACTURE

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ABSTRACT

OBJECTIVES: this article's purpose is to evaluate the post-operatory evolution of patients under 16 years old who have undergone surgical reduction for lateral humerus condylar fracture in a Brazilian hospital between 2015 and the first semester of 2020.

METHODS: this is an observational and description study, with secondary data collected from the hospital's medical records and a quantitative approach.

RESULTS: Males were the most prevalent 65.6%, and the median age was 5 years. The left arm was the most affected 55.2%. 69% (20 cases) were affected by a fall from standing height, and 31% had a fall from other heights. Regarding the synthesis type used in the fractures, 69.0% were fixed with K-wire, 20.7% with a screw + K-wire, and 10.3% with screws. The complications observed were osteophytes, 10.3%; osteonecrosis, 10.3%; pseudarthrosis, 3.4%; fish tail deformity, 3.4%; cubitus varus, 3.4%. 65,5% had a preserved ROM (>90º) after consolidation, and 34.5% had limited ROM (<90º), requiring physiotherapy. The median age of patients who used K-wire was 6 years, the mean age was 6.9 years for screw, or screw + K-wire. 88.9% of patients who had complications had limited ROM (<90°). 89.5% of patients who did not present complications had the ROM preserved (>90º).

CONCLUSIONS: It was possible to associate the existence of complications to the reduction of the range of motion and there was no significant difference in approach related outcomes among the different fracture classifications. A possible inference is that the adequate use of techniques, regardless of the chosen approach, avoids range of motion restrictions and complications.

INTRODUCTION

Lateral humeral condylar fractures are among the most common pediatric fractures, representing about 10-20% of the elbow fractures in children. It is the second most common intra-articular fracture, frequently followed by complications if not treated [1].

These fractures are classified as trasnphyseal and intra-articular to the distal humerus, this fact implicates an incorrect diagnosis, and an unappropriated treatment could potentially lead to a high risk of morbidity [2]. The risk of fracture fragment dislocation, such as primary to the lesion or secondary to the conservative management, is very high due to the action of the extensor muscles inserted in the lateral condyle of the humerus (capitulum) [3].

Diagnosis is based upon radiography findings. Due to the major cartilaginous composition of the capitulum in this age range and, therefore, of the fracture fragment, it may not be seen in traditional incidences of radiography [4]. The review of Stevenson and Perry [5] suggests that, in addition to the traditional anteroposterior and lateral incidences, the internal and external oblique incidences should be used to improve fracture fragment visualization.

The most used systems to diagnose and classify lateral condylar fractures are: Milch classification, based upon radiographic description by fracture line patterns (limitations regarding the prediction of outcomes and choice of treatment should be considered nevertheless) and the Jakob classification, used to categorize the fracture in terms of capsule integrity, joint deviation and determine whether surgical or conservative intervention should apply. There are still doubts regarding the choice of surgical or conservative treatment for stable and minimally displaced fractures (less than or equal to 2 mm), given the potential risk of displacement after immobilization [4,5].

The management of lateral humeral condyle fracture in children include both conservative and surgical approach, in which surgical cases, less invasive techniques can be used without sacrificing the success of the treatment and the prevention of complications [6]. However, the

choice for treatment modality remains a challenge. Studies about this type of fracture are limited, and the recommendations are based on specialist's opinion and small studies [6,7].

Conservative treatment with arm cast is often indicated to incomplete or minimally displaced (less than 2 mm) fractures. The management includes weekly radiography review with anteroposterior, lateral, internal oblique and anteroposterior with 20º of elevation for, at least, four weeks [2,4,5,8].

For surgical fractures, the methods for anatomical reduction include closed approach, either with fracture manipulation or percutaneous pinning with K-wire, or, open approach, with screw or K-wire pinning [1,7,9-12]. Post operatory complications can be associated with a series of factors, including - but not limited to - fracture displacement, chosen surgical approach, and time of immobilization [12]. Those complications include surgical wound infection, limitation of range of motion (ROM), cubitus varus or valgus, delayed consolidation, malunion, avascular necrosis, nerve palsy and early epiphysis closure [2,4,5,7,10-13].

Due to the prevalence of this type of trauma, and the small number of academic studies, the knowledge of the epidemiologic profile and associated trauma mechanisms such as the outcomes are needed. The analysis of those statistics contributes to the criticism and review of employed techniques. It also helps in the development of management guidelines based on the different relations between the variables obtained. This study proposes to evaluate the postoperative evolution of patients under 16 years old who undergone surgical reduction for lateral humerus condylar fracture in a Brazilian hospital between 2015 and the first semester of 2020.

METHODS

This was a single-center observational descriptive study performed retrospectively. All patients with fractures of the lateral condyle of the distal humerus under the age of 16 years, operated

at the institution between 2015 and the first semester of 2020, were retrieved from the hospital's electronic database.

The database was accessed to determine clinical data from the Emergency Department records and consultation sheets. All data were keyed by the researchers using their datasheet comprising epidemiological information and anatomical and functional characteristics of the pathology in question:

- Demographics – age; sex.
- Mode of injury – fall from standing height; fall from other heights.
- Fractured upper limb – left arm; right arm.
- Milch's classification – (Milch I, Milch II).
- Jakob's classification – (Types I, II or III).
- Synthesis material – K-wire; screw; screw + K-wire
- Final Range of Movement (ROM) > 90º – yes or no.
- Postoperative complications – Pseudoarthrosis, Osteophyte, Cubitus Varus, Cubitus Valgus, Fish Tail injury, Osteonecrosis.
- Time elapsed to return to normal activities (weeks).

Statistical analysis was carried out using the SPSS statistical package program (SPSS 26.0 version; SPSS Inc., Chicago, Illinois, USA). Statistical significance was set at an α level of $p = 0.05$ and a CI of 95%. The analysis of quantitative variables' distribution regarding normality were performed using Shapiro-Wilk test. The investigation of the existence of an association between qualitative variables was carried out by applying the Likelihood Ratio and Fisher's Exact tests, followed by residual analysis when statistical significance was observed. The comparison of the medians of quantitative variables was performed using the Mann-Whitney U test.

The data have been made anonymous, with the sole purpose of being used in this research, and the ethics approval for the study was obtained from the hospital's institutional research ethics board and all the research protocols were conducted according to the university's ethical committee guidelines.

RESULTS

A total of 184 medical records were evaluated between 2015 and the first half of 2020, with surgical codes for fractures of the upper limbs and age up to 16 years. Of these, 29 records of lateral humeral condyle fractures were selected, which served as a source for the study.

Males were the most prevalent 65.6% (19 cases), and the median age was 5 years (IQR 4.00-8.00). The left arm was the most affected 55.2% (16 cases). Regarding the mode of injury, 69% (20 cases) were affected by a fall from standing height, and 31% (9 cases) had a fall from other heights (Table 1).

To classify the fractures, Milch's classifications, type I and type II, and Jakob, type I, type II and type III were used. 82,8% (24 cases) were classified as Milch II, and 17.2% (5 cases) as Milch I. In the Jakob classification, 75.9% (22 cases) were classified as Jakob III, and 24 .1% (7 cases) as Jakob II (Table 1).

Regarding the synthesis type used in the fractures, 69.0% (20 cases) were fixed with K-wire, 20.7% (6 cases) with a screw + K-wire, and 10.3% (3 cases) only with screws (Table 1).

In the postoperative evaluations, 65.5% had no complications, 31.0% (9 cases) had complications, and one case had no segment for evaluation (Table 1).

The complications observed were osteophytes, 10.3% (3 cases); osteonecrosis, 10.3% (3 cases); pseudarthrosis, 3.4% (1 case); fish tail deformity, 3.4% (1 case); cubitus varus, 3.4% (1 case) (Table 2).

65,5% (19 cases) had a preserved range of motion (>90º) after consolidation and synthesis material, and 34.5% (10 cases) had limited range of motion (<90º), requiring physiotherapy (Table 2).

Studying the age with the type of synthesis material used, the mean age of patients who used K-wire was 6.0 years (2.0-11.0), while patients who used a screw, or screw associated with K-wire, the mean age was 6.9 years (2.0-16.0) (Table 3).

Comparing the range of motion with the type of synthesis material used, 70.0% (14 cases) of the patients who used a K-wire had a preserved range of motion, and when a screw or screw + K-wire were used, 55 .6% (5 cases) had a preserved range of motion (p = 0.675) (Table 3).

Assessing the presence of postoperative complications with the type of synthesis material used, 65.0% (13 cases) of patients who used K-wires had no complications. When using a screw, or screw + K-wire, 66.7% (6 cases) had no complications (p = 0.651) (Table 3).

Confronting the presence of postoperative complications with the preservation of the range of motion after consolidation and removal of the synthesis material, it was found that, of the patients who had complications, 88.9% (8 cases) had limited range of motion of the elbow (<90°) (Table 4). On the other hand, the patients who did not present complications, 89.5% (17 cases), had the range of motion of the operated elbow preserved (>90º) (p < 0.001) (Table 4).

Comparison of the type of classification with the presence of postoperative complications displays that 77.8% (7 cases) of patients who presented complications were classified as Milch II, but 84.2% (16 cases) of patients who did not presented complications were also classified as Milch II (p = 0.758) (Table 4). When using the Jakob classification, 77.8% (7 cases) of patients who had complications were classified as type III, and 73.7% (14 cases) of patients who had no complications were also type III (p = 0.734) (Table 4).

DISCUSSION

In this study, the prevalence of males was 65.6%, median age of 5 years (IQR 4.00 – 8.00) and greater involvement of the left arm 55.2% (Table 1). The results are similar to the systematic review proposed by Tan et al. regarding the epidemiological characteristics: mean age of 5 years, male sex 67.4% and fracture in the left limb 57.8% [7].

It was observed that most accidents occurred due to falls from standing height, and in 31% of cases due to falls from other heights (Table 1). It was not possible to obtain the specific trauma locations as they were not detailed in the medical record. The study by James et al. details recreational places, playgrounds, and parks as the most frequent, followed by school and home [14].

The most common classifications were Milch type II (82.8%) and Jakob type III (75.9%), following the higher incidence of fractures classified as Milch type II in the literature [15]. One explanation for the higher incidence of severe classifications is the analysis only of cases with surgical indication, since milder fractures are approached conservatively.

The action of the extensor musculature at the injury site is responsible for the high risk of displacement of the fractured fragment [3]. In this study, the fractures with higher levels of displacement, Milch II compared to Milch I (p 0.758) and Jakob III compared to Jakob II (p = 0.734), exhibit higher complication rates.

Relating the range of motion limitation and the type of fixation used, we observed the preservation of the range of movement in 70.0% (14 cases) of patients with K-wire fixation, in contrast to 55.6% (5 cases) of patients who used screw/screw + K-wire (p = 0.675). Although the statistical correlation is of low significance, the results are similar to the retrospective study by Wendling-Keim et al., in which fixation with K-wire presents better indices of preservation of the range of motion [10].

In addition to range of motion limitation, 33.3% of patients operated on with screw/screw + K-wire had complications and 30.0% operated only with K-wire had complications (p = 0.681). Comparing the incidence observed in the study with that described by Tan et al. in a systematic review we found: 10.3% (3 cases) with osteonecrosis formation (1.7% in the literature), 10.3% (3 cases) with osteophytes (27.3% in the literature), 3.4% (1 case) with fishtail deformity (14.3% in the literature), 3.4% (1 case) with varus deformity (7.8% in the literature) and 3.4% (1 case) with pseudarthrosis without similar report [7]. The other complications described in other studies, such as valgus deformity and radiocapitellar osteoarthritis, were not found in the studied sample.

The study demonstrated that the presence of complications is responsible for the decreased range of motion (p <0.001). The results support the implication that poor prognosis is directly linked to an adequate approach, since incorrect diagnoses and inappropriate treatments are often associated with high risk of complications [1].

Although the incidence of complications is small, both in this study and the current literature, the retrospective design of the analysis, difficulty in monitoring outpatients, rapid recovery and bone growth in this population generate limitations inherent to the pediatric study. A long-term follow-up could have a better picture of the postoperative situation, but with the risk of having diminished returns.

The median age for using K-wire was 6 years and for using a Screw/Screw + K-wire was 6.9 years (p = 0.908). The results demonstrate the preference of surgeons in this service to use Screw/Screw + K-wire in older patients, since very young patients, due to the small size and mostly cartilaginous composition of the fragments, may not benefit from fixation and consolidation with screws [15].

Of note, the results demonstrate that patients with lateral condyle fractures often achieve excellent functional results, with satisfactory complication rates, when the measurement of the

radiographic deviation of the fracture is used to determine treatment. In general, outcomes are good if complications such as pseudarthrosis are avoided and range of motion is maintained [8,13].

CONCLUSIONS

It was possible to associate the existence of complications to the reduction of the range of motion and there was no significant difference in approach related outcomes, using K-wire or screw/screw + K-wire, among the different fracture classifications. A possible inference is that the adequate use of techniques, regardless of the chosen approach, avoids range of motion restrictions and complications. Mainly in those commonly linked to iatrogenics, such as fracture reduction failure, osteonecrosis, and inadequate fixation.

Study limitations were evidenced during its development. Our sample, although consistent with pediatric trauma statistics, is small and we do not have access to all patient data, especially preoperative information, given the limited nature of working with secondary data. Despite the heterogeneity of the sample, directly impacting its statistical validity, the observations are similar to those found in the current literature. A significantly larger sample would be essential to normalize the statistical discrepancy and infer more precise analyzes regarding the epidemiology of pediatric trauma.

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Table 1. Demographics

	n (%), Median (IQR), n = 29
Sex	
Male	19 (65,6)
Female	10 (34,5)
Age (years)	5,00 (4,00 – 8,00)
Arm	
Left	16 (55,2)
Right	13 (44,8)
Mode of Injury	
Fall from standing height	20 (69,0)
Fall from Other heights	9 (31,0)
Milch's classification	
Milch I	5 (17,2)
Milch II	24 (82,8)
Jakob's classification	
Jakob II	7 (24,1)
Jakob III	22 (75,9)
Synthesis material for fixation	
K-wire	20 (69,0)
Screw + K-wire	6 (20,7)
Screw	3 (10,3)
Postoperative complications	
No	19 (65,5)
Yes	9 (31,0)
Did not attend follow-up	1 (3,4)

Table 2. Postoperative Complications

	n (%), Média ± DP, n = 29
Type of complication	
Osteophyte	3 (10,3)
Osteonecrosis	3 (10,3)
Pseudoarthrosis	1 (3,4)
Fish Tail deformity	1 (3,4)
Varus deformity	1 (3,4)
Not applicable	19 (65,5)
Range of Motion	
Preserved (>90º)	19 (65,5)
Limited (<90º)	10 (34,5)
Consolidation time (weeks)	4,07 ± 1,00

Table 3. Postoperative outcomes

	Dichotomized Fixation, n (%), Median (Min – Max)		
	K-wire n = 20	Screw or Screw + K-wire n = 9	p Value
Age (years)	6,0 (2,0 – 11,0)	6,9 (2,0 -16,0)	0,908‡
Range of Motion			
Preserved (>90º)	14 (70,0)	5 (55,6)	0,675††
Limited (<90º)	6 (30,0)	4 (44,4)	
Postoperative Complication			
No	13 (65,0)	6 (66,7)	0,681†
Yes	6 (30,0)	3 (33,3)	
Did not attend follow-up	1 (5,0)	0 (0,0)	

‡ Value obtained after applying the Mann-Whitney U test;
†† Value obtained after applying Fisher's exact test;
† Value obtained after application of the Likelihood Ratio test;

Table 4. Correlation of complications and fracture's classification

	Postoperative complications, n (%)			
	No	Yes	Did not attended follow-up	p Value[†]
	n = 19	n = 9	n = 1	
Range of Motion				
Preserved (>90º)	17 (89,5)[b]	1 (11,1)	1 (100,0)	< 0,001
Limited (<90º)	2 (10,5)	8 (88,9)[b]	0 (0,0)	
Milch				
Milch I	3 (15,8)	2 (22,2)	0 (0,0)	0,758
Milch II	16 (84,2)	7 (77,8)	1 (100,0)	
Jakob				
Jakob II	5 (26,3)	2 (22,2)	0 (0,0)	0,734
Jakob III	14 (73,7)	7 (77,8)	1 (100,0)	

[†] Value obtained after application of the Likelihood Ratio test;
[b] Statistically significant value after residual analysis;