Original article

Management of completely displaced extension type supracondylar fractures of humerus in children based on a new classification

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ABSTRACT

Background: Paediatric supracondylar fractures are the most common childhood fractures under 8 years of age. Displaced paediatric supracondylar fractures are mostly classified on the basis of fracture geometry and none of the classification systems takes the clinical condition of the limb into consideration.

Objective: The purpose of this study was to evaluate the functional outcome of displaced extension type supracondylar fractures of humerus in children managed on the basis of our new classification.

Material and methods: A total of 207 children with displaced extension type supracondylar fractures of humerus were classified as per our classification system into simple and complex types. They were managed and followed over a mean period of 24 weeks, and the results were recorded at the final follow-up.

Results: We had 175 simple and 32 complex fractures. There was a significant difference in mean surgical time between simple (19.64 ± 3.52 min) and complex fractures (43.41 ± 27.07 min). Mean duration of hospital stay was significantly lower in simple fractures (1.02 ± 0.31 days) as compared to complex fractures (2.62 ± 1.84 days). Out of 175 patients in simple group 167 (95.4%) had excellent result, 6 (3.4%) had good result, 1 (0.6%) had fair result and 1 (0.6%) had poor result whereas out of 32 patients in complex group 10 (31.3%) had excellent result, 5 (15.6%) had good result, 11 (34.4%) had fair result and 6 (18.8%) had poor result. Overall results were better in simple group as compared to complex group as per Flynn criteria.

Conclusions: Management of patients with displaced supracondylar fractures of humerus using Barza classification in emergency room gives good result and gives an idea about management and prognosis.

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1. Background

Supracondylar fracture of humerus is the most common fracture in children under 8 years of age reported to occur in 55% to 75% of patients with elbow fractures.¹ The aim of treatment of displaced paediatric supracondylar fractures of humerus is to prevent the complications like Volkmann's ischaemic contracture, deformities, and achieve normal function.² Gartland,³ in his seminal article in 1959, noted "the trepidation with which men, otherwise versed in the management of trauma, approach a fresh supracondylar fracture". These fractures have been a topic of great

amount of debate and discussion not just for the treatment modalities involved and potential complications but also on the way these fractures need to be classified.⁴

All the classifications are based on plain anteroposterior and lateral radiographs of the elbow but there are few clinical parameters of importance which need to be considered and timely addressed in the management of supracondylar fractures of humerus in children.

2. Objectives

The purpose of this study was to evaluate the functional outcome of supracondylar fractures of humerus managed on the basis of our new classification called Barza classification which is based on clinico radiological parameters and represents a sub classification of Gartland type 3 extension type of s.c fractures.

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3. Patients and methods

This was a prospective study done from January 2014 to June 2016 in the Bone and Joint hospital Barzalla Govt medical college Srinagar. The patients of 3 years to 11 years with displaced extension type supracondylar fracture were included in the study. A total of 207 patients who were available for follow up were included in the study. Children with polytrauma, bilateral fractures, head injuries and deformed or absent opposite limb were not included in the study. Furthermore fractures more than 1 day (24 h) post trauma at presentation to our hospital were not included in this study. Examination of the involved limb was done before splintage and routine posteroanterior and lateral radiographs of the elbow were taken and patients were divided as per the Barza Classification in the emergency room and were managed as per the standard treatment for that fracture type.

4. Our classification

In this classification completely displaced extension type supracondylar fractures of humerus are further subdivided into simple and complex fractures as shown in Table 1. Clinical and radiological pictures are shown in Plates 1–4.

Simple fractures were managed by closed reduction and k wire fixation. Whereas Complex fractures were managed as per fracture subtype as follows:

Type a fractures were managed with closed reduction and k wire fixation of supracondylar fracture followed by closed reduction with or without k wire fixation of distal fracture depending upon the displacement of forearm fracture.

Type b fractures were managed with debridement of wound, open reduction and internal fixation with k wires.

Type c fractures were managed with open reduction k wire fixation of fracture and fasciotomy.

Type d fractures were managed with closed reduction and k wire fixation of fracture and distal perfusion was checked if there was no sign of perfusion plastic surgeon was called and brachial artery was explored for possible repair. Both type c and type d fractures had impaired distal perfusion clinically and were differentiated on clinical grounds and Doppler study.

We used to apply plaster slab post operatively in 45–60° of flexion in simple fractures and about 30–45° of flexion in complex fractures.

General anaesthesia was used in all the cases. Reduction was done and checked under image intensifier and the fracture was fixed with two or three divergent k wires placed through lateral epicondyle. Follow up was done at 1st, 3rd, 6th, 12th and 24th weeks. During these visits assessment of carrying angle and range of motion were made and recorded. Final assessment was made as per the Flynn's criteria.

Statistical software SPSS (version 20.0) was used to carry out the statistical analysis of data. Descriptive Statistics of data including the mean and standard deviation for quantitative

variables and the percentages of different categories for categorical variables was obtained. Student's independent *t*-test was employed for parametric data. For non-parametric data Chi-square test or Fisher's exact test, whichever appropriate, was applied. A *p*-value of less than 0.05 was considered statistically significant. All *p*-values were two tailed.

5. Results

A total of 207 patients with completely displaced extension type supracondylar fracture who were available for follow up were included in the study (Table 2). Male female ratio in simple group was 2.6:1 and it was 1.7:1 in complex group. The non dominant side was involved in 132 cases (75.4%) in simple group and 20 cases (62.5%) in complex group. Mean age in patients with simple fractures was 6.29 ± 2.27 years and it was 6.59 ± 2.31 years in complex fractures. Regarding fracture displacement in simple fractures 138 cases (78.9%) had posteromedial displacement and 37 cases (21.1%) had posterolateral displacement whereas it was 27 (84.4%) and 5 (15.6%) in complex fractures respectively. In present study three patients had median nerve involvement and two patients had radial nerve involvement at presentation. Full recovery of neurologic deficit occurred in all five patients within three months without intervention. All the Patients were operated between 1 and 24 h since injury with the mean of 6.2 ± 4.24 h in simple fractures and 6.5 ± 3.85 h in complex fractures. There was a significant difference in mean surgical time between simple fractures (19.64 ± 3.52 min) and complex fractures (43.41 ± 27.07 min). Mean duration of hospital stay was significantly lower in simple fractures (1.02 ± 0.31 days) as compared to complex fractures (2.62 ± 1.84 days).

Range of motion in the fractured elbow was compared with the contralateral side (Table 3). All the patients more than 15° restriction of motion had been open reduced. Final assessment was made at 24 weeks as per the Flynn's criteria (Table 4). Children with cubitus varus were considered to have a poor result.

6. Discussion

The first radiological classification of supracondylar fracture of humerus is attributed to Felsenreich in 1931⁵ but the first widely used classification was described by Gartland in 1959.³ The basic classification of supracondylar humerus fracture into extension (commonest- seen in 95–98% of times) and flexion type (seen in 3–5%) is not disputed. It is the internal classification of extension type supracondylar humerus fractures which has been controversial.⁶

Till date various classification systems have been given from time to time besides Gartland classification for extension type of supracondylar fracture. These include Wilkins modified Gartland's classification⁷, Leitch et al. classification.⁸ Lagrange and Rigault classification,⁹ AO classification, Lutz et al.¹⁰ and Bahk et al.¹¹ classifications. All of these classification systems have their positives and negatives. The Gartland classification along with

Table 1
Barza classification for completely displaced extension type of supracondylar fractures in children.

Simple fractures	Complex fractures
These are closed completely displaced supracondylar fractures of humerus without any complication	These include displaced supracondylar fractures associated with complications and are divided into following subtypes; Type 'a' Associated ipsilateral forearm fractures Type 'b' Open fractures Type 'c' Compartment syndrome Type 'd' Absent distal perfusion

Barza Classification for displaced extension type supracondylar fractures of humerus in children.

Plate 1. Simple supracondylar fracture: Clinical picture (a), Radiographs AP and Lateral view (b and c), Post operative Radiograph AP and Lateral view (d and e).

Plate 2. Complex type a supracondylar fracture: Clinical picture (a), Radiographs Antero posterior and Lateral view (b and c), Post operative antero posterior and lateral view (d and e). Distal Physeal injury of radius and ulna was managed by closed reduction and cast application.

its modified version is the main classification used in English speaking countries while the Lagrange and Rigault classification is widely used in France and most French-speaking countries. Almost all of these classifications are based on fracture geometry and none of the classifications takes clinical condition of the limb into consideration. After review of these classifications we were of the opinion that the outcome of all displaced supracondylar fractures should at least be partly determined by clinical factors like whether the fracture is open or close or whether there is any ischaemic insult like compartment syndrome or vascular injury. Being the only tertiary care referral in the region about three to four such fractures present to our emergency daily. We at Bone and Joint Hospital had a consensus that Gartland type 3 extension type supracondylar fractures have a varied clinical presentation and on

these grounds we subclassified these fractures so as to guide management of these fractures and make management protocol simpler and uniform at resident level and reduce the unnecessary need to call consultant in late hours. In this study all the fractures were managed according to guidelines from literature.^{12–23} There was a significant difference in overall results of simple fractures as compared to complex fractures (Tables 3 and 4). Final results were compared with other studies like Flynn et al.²⁴ W.I El-Adl et al.,²⁵ and the results were comparable (Table 5). Although these studies included only those fractures managed with closed reduction and pinning and the sample size was small in these studies. Our classification is simple to remember and reproduce. In addition, our classification guides regarding the management of a particular fracture type, thus reducing the chance of complications. It is a

Plate 3. Complex type c supracondylar fracture. Clinical picture (a) Radiographs, Antero posterior and lateral view (b and c), Post operative antero posterior and lateral view (d and e).

Plate 4. Complex type d supracondylar fracture. Clinical picture (a), Radiograph antero posterior and lateral view (b and c), Post operative radiographs after open reduction and vascular repair.

Table 2

Distribution of patients in each fracture subtype.

	Simple fractures (n = 175)	Complex fractures (n = 32)			
		B/B Forearm fracture	Open Fracture	Compartment syndrome	Brachial Artery injury
Total	175	13	13	5	3

There were a total of 207 patients with 175 simple and 32 complex fractures. Two patients among the B/B (both bone) forearm fracture group had compartment syndrome.

Table 3

Range of movements at final follow up.

	Carrying angle			Flexion loss			Extension loss		
	N.side	P.union	p-value	Flx.norm	Flx.p.u	p-value	Ext.N	Ext.p.u	p-value
Simple	12.13 ± 2.58	11.60 ± 3.04	0.085	141.90 ± 3.29	141.45 ± 3.29	0.236	12.20 ± 2.87	11.71 ± 2.72	01
Complex	13.28 ± 2.79	12.29 ± 2.28	0.121	143.25 ± 2.54	127.56 ± 14.16	<0.001*	12.91 ± 2.82	4.16 ± 4.52	<0.001*

Change in carrying angle and range of motion at final follow up as compared to normal side.

There was a significant loss of flexion and extension in complex group as compared to simple group and insignificant change in carrying angle in both the groups. (N = normal, Flx. = Flexion, p.u = post union, Ext. = Extension).

* Statistically Significant Difference (P-value < 0.05).

Table 4

Results at final follow up.

Result	Rating (loss of motion in degrees)	Simple Fractures [N = 175]	Complex Fractures [N = 32]	Overall Result [N = 207]
Satisfactory	Excellent (0–5)	167 (95.4%)	10 (31.3%)	177 (85.5%)
	Good (6–10)	6 (3.4%)	5 (15.6%)	11 (5.3%)
	Fair (11–15)	1 (0.6%)	11 (34.4%)	12 (5.8%)
Unsatisfactory	Poor (>15)	1 (0.6%)	6 (18.8%)	7 (3.4%)

Final results as per Flynn criteria.

Table 5

Comparison of our study results with other studies.

Study	Flynn et al. ⁴	El-Adl et al. ²⁵	Present study
No. of cases	52	70	207
Excellent	42 (81%)	60 (85.7%)	177 (85.5%)
Good	07 (13%)	08 (11.4%)	11 (5.3%)
Fair	02 (04%)	02 (2.8%)	12 (5.8%)
Poor	01 (02%)	0 (0)	07 (3.4%)

Comparison of our results with other studies.

prognostic classification as well as we can predict the likely outcome of a particular fracture pattern.

In the present study attempt has been made to classify displaced extension type supracondylar fractures in a simple and logical manner and provide the idea of management and prognosis. As we move from simple to complex fractures and further subclasses, the fracture complexity increases with each advancing subclass of fracture. This classification guides the management of a particular fracture type and helps to prioritize one fracture over the other thus reducing the chance of complications. It is a prognostic classification as well, as it can predict the likely outcome of a particular fracture type.

We studied the outcome of 207 supracondylar fractures who were managed based on standard treatment following a new and logical way. Small sample size and short follow-up are the shortcomings of the present study. Further studies are needed to check the usefulness of the new classification in orthopedic practices and draw any conclusion. The standard treatment methods from literature used in different types of supracondylar fractures based on the Barza Classification gives good results.

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Nil.

Conflict of interest

There is no conflict of interest.

Author Contributions

Mehraj D. Tantray: Concepts; Design; Definition of intellectual content; Literature search; Clinical studies; Data acquisition; Data analysis; Statistical analysis; Manuscript preparation; Manuscript editing; Manuscript review; Guarantor.

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