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Outcome of crossed pinning in supracondylar humerus fractures Gartland type III

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Abstract

Background: Displaced supracondylar humerus fracture in children presents a severe degree of injury often associated with potential neurovascular complications. We conducted this study to assess the functional and radiological outcome and complications of supracondylar humerus fractures Gartland type III treated with closed manipulation and crossed pinning.

Methods: We analysed the clinical and radiographic data of 37 children with supracondylar humerus fracture Gartland type III which was collected retrospectively over a 3 year period (January 2013 – January 2016). The average follow-up period in all patients exceeded 1 year. Clinical evaluation included Flynn's criteria, pain, neurovascular examination, and complications (infection or iatrogenic nerve injuries). Humeroulnar angle was measured in the final follow-up radiograph.

Results: The average follow-up period was 22 months. The mean age of the children was 7.4 years. According to Flynn's criteria functional results were satisfactory in 100% and cosmetic results were satisfactory in 89.18% of patients. Outcome was graded as unsatisfactory in 4 (10.8%) patients due to loss of carrying angle. The average carrying angle was 9.4^0 while it was 11.2^0 on the contralateral side. At the final follow-up the average visual analogue scale (VAS) score was 0. Injury related complications included absent pulse in 3 (8.1%) and 1 (2.7%) primary median nerve palsy. Treatment related complications include 3 (8.1%) iatrogenic ulnar nerve palsy.

Conclusion: Closed manipulation and percutaneous crossed pinning of supracondylar humerus fracture Garland type III is an effective and minimally invasive method. Crossed pinning provided biomechanically stable fixation but with an increased risk of ulnar nerve injury.

Keywords: Supracondylar humerus fracture, Closed manipulation, Crossed pinning.

Introduction

Supracondylar humerus fractures in children consists of 50% to 70% of elbow injuries and 7% to 9% of all childhood fractures.[1] Extension injuries account for 95% of supracondylar fractures and remaining is flexion type.[2] Extension type supracondylar fractures were classified by Gartland according to the amount of displacement of the distal fracture fragment.[3] Wilkins in 1984 modified Gartland's classification and type III fracture was subdivided into type III a -posteromedial displacement and III b - posterolateral displacement.[4]

Treating completely displaced supracondylar fractures of humerus Gartland type III is a challenge.[5] The treatment options that have been advocated for supracondylar humerus Gartland type III fracture include closed reduction and immobilization,[3,6] traction[7,8] and closed[9,10] or open reduction[11] stabilized by Kirschner (K) wires. The recent favored treatment for supracondylar fracture Gartland type III consists of closed manipulation and percutaneous pinning.[12,13,14] Two K-wires inserted through medial and lateral cortex provide best stabilization; however the disadvantage is the potential iatrogenic injury to the ulnar nerve with the medially placed pin.[9,15] The fractures with posterolateral displacement and rotational deformity had a higher rate of postoperative complications, residual stiffness and nerve injury.[16]

Aim

The aim of this study is to assess the functional and radiological outcomes and complications of surpacondylar humerus fractures Gartland type III treated with closed reduction and crossed pinning.

Materials and Methods

This retrospective study was conducted between January 2013 to January 2016 at a tertiary care rural center. The approval for the study was given by the institutional ethics committee. The inclusion criteria for the study were

1. Supracondylar humerus fracture Gartland type III.
2. Children below than 12 years.
3. Time at presentation less than 72 hours.
4. A follow-up of at least one year.

The exclusion criteria for the study were

1. Flexion type supracondylar humerus fracture.
2. Previous or associated ipsilateral elbow fractures.
3. Open fractures.

The data concerning the preoperative, operative and post operative details were obtained by reviewing the charts from the medical records department of the institution. The patients were contacted by telephone or letter to arrange for a follow-up visit. All of the patients gave informed consent to participate in the study.

44 patients with supracondylar fracture of humerus Gartland type III were recruited into the study. 7

patients were not available for follow-up. Finally, 37 patients (84.09%) were available for analysis. The modified Gartland's classification was used to classify fractures. We had 22 patients with type III a injury and 15 patients with type III b injury.

Surgical technique: The child was placed in a supine position under general or regional anaesthesia. Closed manipulation was performed correcting the medio-lateral and antero-posterior displacements. Antero-posterior and lateral fluoroscopic views were obtained to confirm reduction without changing the position of the elbow. The first pin was inserted from the lateral side of the elbow across the lateral cortex engaging the medial cortex keeping the elbow flexed. Then the elbow was extended to less than 90^0 to feel for ulnar nerve. The second pin was then inserted from the medial epicondyle to engage the lateral cortex. A third pin was inserted from lateral cortex if there was comminution or if the fixation was less stable. A mini open reduction was done when the closed reduction could not be achieved. Postoperatively, an above elbow cast was given and patients were discharged between one to three days.

Follow up protocol: All patients were seen in the outpatient clinic at 1 week, 3-4 weeks, 6 weeks, 12 weeks and 1 year after injury. The cast and pin was removed at 3 weeks follow-up appointment for children less than 6 years and at 4 weeks follow-up appointment for children more than 6 years. The elbow range of motion was started after pin removal.

Clinical assessment was done by measuring the carrying angle, range of motion (ROM) of the injured elbow, neurovascular examination, pain and looking for complications such as infection, growth disturbances or nerve injuries. The ROM and the carrying angle was measured by manual goniometer and compared with that of the contralateral arm. Flynn's criteria was utilized to grade the clinical outcome. The visual analogue scale (VAS) with a score from 0 (no pain) to 10 (worst pain) was used to assess pain. Radiographic assessment was done with anteroposterior and lateral radiographs of the injured elbow. At the final follow-up examination the humeroulnar angle was calculated on the anteroposterior radiograph with the method of Webb and Sherman.

Statistical analysis: Continuous variables were analysed using means, percentages and standard deviation with ranges.

Results

A total of 37 patients with supracondylar fracture Gartland type III treated with closed manipulation and crossed pinning were available for analysis. The average follow-up period was 22 months (range 13 to 44 months). The mean age was 7.4 years (range 3.6 to 12 years). There were 26 male and 11 female patients. In 16 patients the right elbow was injured and the left in 21 patients. All patients were operated on the same day they reported to the hospital or the next day if they reported late in the night. 34 patients were managed by closed manipulation and percutaneous crossed K-wire fixation, whereas in 3 patients a mini open approach was used to achieve reduction.

Clinical outcome: Based on the Flynn's criteria functional results were satisfactory in 100% of patients and cosmetic results were satisfactory in 89.18% of patients (Table 1). The results were graded as unsatisfactory in 4 patients as there was loss of carrying angle when compared to the uninjured elbow. The mean carrying angle was 9.4^0 (range (4^0-16^0) compared to the 11.2^0 (range 8^0 to 18^0) on the contralateral uninjured side. All patients had regained full elbow function at final followup (Fig. 1). At the final follow-up examination none of the patients complained about any relevant pain symptoms and the average VAS score was 0.

Table 1: Results according to Flynn's criteria

Result	Cosmetic factor			Functional factor		
	Loss of carrying angle	No of patients	Percentage	Loss of motion	No of patients	Percentage
Excellent	$0\text{-}5^0$	33	89.18%	$0\text{-}5^0$	37	100%
Good	$6\text{-}10^0$	4	10.81%	$6\text{-}10^0$	0	0
Fair	$11\text{-}15^0$	0	0	$11\text{-}15^0$	0	0
Poor	$>15^0$	0	0	$>15^0$	0	0

a b c d

e f

Fig. 1: Pre-operative (a) anteroposterior and (b) lateral radiographs of six years old boy with Gartland type III fracture. Immediate postoperative radiographs (c) & (d) showing good reduction and fixation with crossed pinning. 18 months follow-up radiographs (e) & (f) showing healed and remodelled fracture

Radiographic outcome: Fracture union was observed in all of our patients (100%) by 3 months (Fig. 1). There was no secondary displacement noted during the follow-up. The mean humeroulnar angle was 10.2^0 (range 4^0-18^0).

Complications: Trauma related complications were seen in 4 patients (Table 2). Absence of pulse was noted in 3 patients and one patient had primary median nerve injury. The pulse was restored in all patients except one after closed reduction and crossed pinning. No active intervention was done in the child with pulseless hand as the hand was well perfused. The patient with primary median nerve injury recovered spontaneously by 8 weeks. Postoperative ulnar nerve injury was noted in 3 patients. All patients recovered spontaneously after an average 13.3 weeks (10-16 weeks). No cases of iatrogenic median or radial nerve injury was observed in the study. Cubitus varus deformity was seen in 4 patients and none required corrective osteotomy as it was cosmetically acceptable to the parents. In 2 patients superficial pin tract infection was seen.

Table 2: Complications

	Total numbers of patients	Percentage
Injury related complications		
1. Absent radial pulse	3	8.1%
2. Primary median nerve injury	1	2.7%
Treatment related complications		
1. Postoperative ulnar nerve palsy	3	8.1%
2. Cubitus varus deformity	4	10.81%
3. Superficial pin tract infection	2	5.4%

Discussion

The supracondylar fracture of humerus Gartland type III represents a severe variety of injury with significant swelling and increased risk of neurovascular complications.[17] The success in the management of displaced paediatric supracondylar fracture is to safely achieve and maintain an acceptable stable reduction until the fracture is healed.[4] Closed manipulation and percutaneous pinning is the usually suggested treatment for supracondylar fracture Gartland type III.[12,15,16] After pinning the elbow can be splinted in less degree of flexion thus minimizing the risk of limb perfusion. There was no report of physeal injury secondary to insertion of smooth K wire in the study of Flynn et al.[18] A crossed medial and lateral pin design is more stable than lateral pin alone as reported in the biomechanical studies.[19,20]

The most commonly reported complication in the literature is cubitus varus.[18,15,21] A cosmetically unsatisfactory result was reported in 3 of 72 patients (4.2%) due to loss of carrying angle by Flynn et al and none had a considerable loss of elbow motion.[18] Mandl et al reported 2 of 78 patients (2.6%) with cubitus varus deformity and noted that all of these patients had a good elbow motion.[15] In our series 4 of 37 patients (10.8%) had a decrease in the carrying angle at final follow-up. Our results confirms the data described in the literature[18,15,21] that the carrying angle does not affect the functional outcome. According to Flynn's criteria we had satisfactory functional results in 100% of

patients and cosmetic results were satisfactory in 89.18%.

Vascular complication is reported between 2-38% in Gartland type III supracondylar fractures.[22] The fracture should be reduced and stabilized as early as possible with close monitoring of the vascular status of the limb. The management of the viable pulseless hand is divisive with recommendations varying from observation to immediate surgical intervention. Choi et al have published their experience with conservative approach and noted the importance of the hand being perfused rather than having a pulse.[23] Weller et al in their series reported 20 supracondylar fractures Gartland type III with a pulseless hand following reduction.[24] 19 of the 20 patients had a palpable pulse return with no clinical sequelae during the follow-up. In our study we had three cases with absent pulse at presentation. Following closed reduction pulse returned in two cases. Third case had a perfused pulselesss hand and conservative approach was followed. No clinical sequelae were noted at the final follow-up.

Shim et al reported no postoperative ulnar nerve palsy in a series of 63 paediatric supracondylar fracture of humerus treated by cross pinning with 3 K wires.[25] Royce et al in their series had one radial (0.7%) and three ulnar (2.1%) postoperative nerve palsies.[26] In our study we had 3 (8.1%) postoperative ulnar nerve palsy that recovered spontaneously by an average 13.3 weeks. Our results indicate that there is an increased risk of postoperative ulnar nerve injury when cross pinning is performed.

Conclusion

In summary, closed manipulation and crossed pinning of supracondylar humerus fracture Gartland type III results in a functional and cosmetically acceptable extremity with a low rate of complications. It is a consistent and safe method except for an increased incidence of postoperative ulnar nerve injury.

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