Closed Callostasis for Late Presenting Supracondylar Humeral Fractures in Children; Our experience.

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ABSTRACT

Objective: Supracondylar fractures are common in the pediatric age group. Delayed and neglected presentation of supracondylar fractures is frequent especially in third world countries because of various factors. There are no standard guidelines for the management of supracondylar fractures presenting late. Our study aimed at evaluating the clinical and radiological outcomes of delayed supracondylar fractures humerus, who were treated with closed calloclasis, reduction, and percutaneous fixation.

Methods: A prospective cohort study was conducted from 1st July 2019 to 30th June 2020. Inclusion criteria were; Type III Gartland supracondylar fractures, and a delay in fracture presentation of equal to or more than 7 days. Exclusion criteria were; supracondylar fractures associated with neurovascular injuries, and those who required ORIF. Functional and radiological outcomes were measured using Flynn's criteria, Baumann's angle, and humerocaptellar angle respectively.

Results: 46 patients were included in our study. The Mean age was 6.4±2.6 years (2-12 years), average delay in presentation was 12.13±4.4 days, with a mean postoperative follow-up duration of 14±3 months. Based on Flynn's criteria, 71.7% of cases showed excellent grading.

Conclusion: Closed osteoclasis, reduction, and percutaneous pinning and is a feasible option for delayed or neglected displaced supracondylar fractures of humerus.

Keywords: Supracondylar Humerus Fractures, Delayed Treatment, Closed Reduction

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INTRODUCTION

Pediatric Supracondylar fractures of humerus are common, and constitute roughly 55-75% of all elbow injuries in this age group[1]. Conservative treatment is reserved for undisplaced supracondylar fractures (Gartland type I, II), while early reduction and stabilization is advocated for all displaced supracondylar fractures (Gartland type III)[3].

Treatment of choice for early presented displaced supracondylar fractures is accurate closed reduction and K-wire fixation under fluoroscope guidance, to avoid acute complications such as neurovascular injuries, acute or chronic compartment syndrome, and late complications including stiff elbow, heterotrophic ossification, and cubitus Varus.[2] The term "Delay" is defined in western literature as a delay in fracture presentation of 8-12 hours, and most of the authors found no difference in terms of outcome between the early and delayed groups[4].

Late presentation defined in literature for supracondylar fracture humerus is more than 2 days after trauma[5]. About 20% of the supracondylar fractures present late[6]. This percentage is much higher in developing countries where delays may extend over several days or weeks, because of the poor health care system, lack of health education, and long distance referrals[7]. The management guidelines are not specific for patients who present late. Various treatment modalities mentioned in literature for managing such patients include; closed reduction and casting, splint and later corrective osteotomy once fracture heal in malunion[4], traction with or without internal fixation[9], closed reduction and percutaneous pinning, open reduction, and fixation[1,8,9]. Old supracondylar fractures are difficult

to treat because such cases are often complicated by the presence of massive swelling, blisters and poor skin condition, neurovascular compromise, and compartment syndrome[10]. Furthermore, there is a high risk of early and late postoperative complications e.g. nerve injuries, compartment syndrome, elbow stiffness, myositis ossificans, contracture, and malunited fractures[10,11].

There are no specific guidelines in the literature to date for the management of late presented supracondylar fractures[5]. This prospective series aimed at evaluating the functional and radiographic outcome following closed osteoclasis, reduction, and percutaneous pinning of supracondylar fractures humerus presenting 7 days or more after the trauma.

MATERIALS AND METHODS

A prospective, conveniently sampled cohort study was conducted at Pediatric Orthopedic Department from 1st July 2019 to 30th June 2020. Inclusion criteria were Gartland type III fracture, duration of injury equal to or more than 7 days, neglected supracondylar fractures in whom callus formation but fracture line seen on x-rays. Exclusion criteria were; open supracondylar fractures, fractures managed with open reduction, nerve or vascular injuries, ipsilateral associated fractures, previous same elbow fractures, and patients who had lost to follow-up.

All patients were treated with closed reduction and percutaneous cross wire fixation under a fluoroscope. Gentle closed calloclasis was applied and repeated vigorous attempts at reduction were avoided. The procedure was converted to open reduction, when closed reduction was not possible. Lateral pin inserted closely and a medial pin inserted after a small 1 cm incision given on medial side, retracting the ulnar nerve. Optimum fracture reduction, pin placement, and stability were confirmed both in AP and lateral view under C-arm. K-wire ends bent and left outside skin, a long-arm cast or slab applied with the elbow flexed and forearm supinated. The Patient was discharged on 1st postoperative day after the x-rays evaluated by the operative surgeon.

Follow-up was 2 weekly for 6 weeks, 3 weekly for the next 6 weeks, then 6 weekly for another 3 months, and then 3 monthly for one year. Radiographic evaluation through x-ray elbow AP and lateral view performed at each OPD visit. Cast and wire removed at 4-6 weeks' post-operative and physiotherapy for range of motion exercises started. The clinical and radiographic outcomes were reviewed at 6 months and 1 year. Clinical assessment included range of motion, functional assessment, neuro-vascular examination, and carrying angel. Radiographic assessment was done by comparing humerocapitellar, and Baumann's angel in the initial and final visit radiographs. The Outcome was graded according to Flynn's criteria (Table 1).

RESULTS

A total of 46 patients fulfilled the inclusion criteria. All fractures were closed Gartland type III. Mean delay in fracture presentation was 12.13 ± 4.47days (7-24 days). The mean follow-up period was 14 ± 3.6 months (6-22 months). The average hospital stay was 3.6 ± 1.9 days (1-9 days).

Functional and cosmetic factor grading was made based on Patients were graded based on Flynn's criteria. Based on this criteria 33 patients (71.7%) had excellent results, as shown in table[1]. At 1 year follow up, 43 patients had full range of motion (ROM), while 3 patients (6.5%) had deficient ROM both in flexion and extension, the reason being non-compliance to treatment.

Complications occurred in 6 patients. 3 (6.5%) patients had pin tract infections. 1 patient had an olecranon fracture during closed reduction of the fracture, which was fixed simultaneously with two pins. 1 patient developed cubitus varus at final follow-up. Iatrogenic ulnar nerve injury was noted in 1 patient, while 2 patients had preoperative medial nerve injury. All 5 patients had full functional recovery at 3 months postop.

Table 1: Flynn's grading criteria

Outcome	Rating	Cosmetic factor (loss of carrying angel in °)	Functional factor (loss of motion in °)	N= Number of patients
Satisfactory	Excellent	0 – 5	0 -5	33 (71.7%)
	Good	6 – 10	6 – 10	10 (21.7%)
	Fair	11 – 15	11 – 15	2 (4.3%)
Unsatisfactory	Poor	> 15	> 15	1 (2.2%)

Table 2: Baumann's angle of patients

Baumann's angle (°)	Number of patients	Percentage
< 65	0	0
65-70	2	4.3%
70-75	28	60.9%
75-80	9	19.6%
> 80	7	15.2%
Total	46	100%

Table 3: Humerocaptellar angle of patients

Humerocaptellar angle (°)	Number of patients	Percentage
< 25	0	0
25-30	6	13%
30-35	12	26.1%
35-40	26	56.5%
> 40	2	4.3%
Total	46	100%

DISCUSSION

Displaced supracondylar fractures of humerus (Gartland type III) are unstable, preferably treated with closed reduction and percutaneous k-wiring under fluoroscope[6,12,13]. Late presentation is common in developing countries. Neglected supracondylar fractures defined in literature are those presenting 2 weeks after trauma, are challenging to treat[8]. Closed reduction of these fractures is often difficult because of swelling, poor skin condition, contracted soft tissues, and soft tissue callus at the fracture site, posing these fractures to a high risk of perioperative and postoperative complications[14]. Potential complications mentioned in the literature are; loss of elbow motion, myositis ossificans, infections, sub-optimal reduction of fracture, compartment syndrome, and high rate of conversion to open procedures[9-11].

Literature review shows that there is a linear relationship between delay in presentation and the chances of conversion to open reduction[15-17]. The rate of conversion to open reduction for the delay in presentation of a few hours' ranges from 3%-46% in literature[19-21], this figure raises up to 75% in some studies if the delay is in days[18]. In our study 4 cases (8.6%) were converted to open reduction, 3 patients had a delay of more than 3 weeks, and closed calloclasis was not possible because of thick callus at the fracture site, while 1 patient had button holing of the fracture into the brachialis. ORIF of supracondylar fracture is accompanied by an increased incidence of both superficial and deep infections[19,20]. There is also an issue of disfigurement and increased elbow stiffness postoperatively[19,20]. Pin tract infections mentioned in previous studies range from 2-6 %[25], in our series 3 patients (6.5%) had superficial pin tract infections which were treated with pin removal, oral antibiotics, and daily dressing.

There is a continuous debate on the configuration of pin placement and its effect on biomechanical stability at the fracture site. Most studies found no difference[25,26], while some studies show that cross pin fixation is biomechanically superior to lateral pin placement in terms of loss of reduction and rotational stability[13,28]. Kocher et al reported a 2.1% loss of reduction while using lateral pin placement[13]. The major concern with cross pin configuration, is iatrogenic ulnar nerve injury during medial pin placement[1,18]. The rate of ulnar nerve injury ranges from 1.8% to 10.6% in various studies[27,28]. Green DW et al using a modified mini approach for medial pin placement achieved excellent results with no ulnar nerve injury[28]. In our study, using the same modified mini approach for medial pin placement, there was only one case (2.2%) of ulnar nerve injury which resolved at three months postoperatively.

Neglected supracondylar fractures (presenting ≥2 weeks after trauma) are routinely treated with ORIF, but the functional outcomes are variable with an increased rate of complications[29-31]. Ram K Shah et al[33], in their study of 21 patients, who had open reduction for supracondylar fractures with a mean delay of 20.3 days (15-30 days) observed satisfactory results in 14.3% while 87.7% cases had unsatisfactory results based on Flynn's criteria. cubitus varus was noted in 57% of the cases at 1-year postop.

Lal and Bhan[34], in their series of 20 children with a delay in presentation between 11 to 17 days, underwent open reduction. The incidence of cubitus varus was 35%, and a loss of range of motion in 70% of cases. Devnani[5], and Agnus et al[35] evaluated the results of skeletal traction followed by closed pinning. They observed fair functional results but at the expense of prolonged hospital stay, and subsequent corrective osteotomies for cubitus varus deformities. Tiwari et al[8] in their series of 40 patients with a mean delay of 4 days, managed with percutaneous pinning, achieved 88% satisfactory outcome based on Flynn's criteria. He concluded that closed fixation of supracondylar fractures produces superior results with fewer complications compared to continuous traction or corrective osteotomy.

In our study, we were able to achieve 71.7 % (33/46 patients) excellent, while 10 (21.7%) patients had good outcomes based on Flynn's grading criteria as shown in Table (1). 80.5% (37/46) cases had Baumann's angle between 70°-80°, While 81.6%(38/46 patients) had a humerocapitellar angel range between 30°-40°at final follow-up as shown in table 2 and 3. Our results are comparable to Yadav S et al[41], who achieved 95% excellent results according to Flynn's criteria in their series of 36 patients. The average Baumann's angle was 73.4°, they had an average delay in presentation of 7.6 days (5-15 days), and a mean follow-up of 7.4 weeks[5-20].

Limitations of our study are a small sample population, no comparison group, and a short follow-up duration. The strength of this study is its prospective nature. This is probably the only study in our country with a mean delay in presentation of about 12 days that were managed with standard closed osteoclasis, reduction, and percutaneous pinning technique. Our results are encouraging, however more such studies at different centers or even large randomized controlled trials may be required to make treatment guidelines for treating such patients in the best public interest.

CONCLUSION

Closed calloclasis followed by closed reduction and percutaneous k-wiring is a viable option for delayed or neglected Gartland III supracondylar fractures of humerus. The clinical and radiographic outcomes are comparable to open reduction and internal fixation with considerable low complications and high union rates.

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