

Outcomes of Pediatric Supracondylar Fractures of Humerus Treated by Posterior Triceps Splitting Approach

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ABSTRACT:

Introduction: Close reduction and percutaneous pinning is the gold standard treatment for supracondylar fracture of humerus. Open reduction and internal fixation is indicated in patients with unacceptable closed reduction, neurovascular compromise, and open fractures. Open reduction can be performed through various approaches. Every approach has their advantages and limitations. The aim of this study was to assess the functional and cosmetic outcome of pediatric supracondylar fracture of humerus treated by posterior triceps splitting approach. **Methods:** This was a prospective evaluation of 20 consecutive patients with displaced pediatric supracondylar humeral fractures operated by triceps splitting posterior approach in our institution for two years. At initial presentation, 19 cases were Gartland III and one was flexion variant of injury. Complications such as reduction loss, pin migration, infection, osteonecrosis of any part of the elbow, bone healing, and functional results were evaluated. Flynn criteria were used to evaluate the final results. **Results:** Twenty patients underwent open reduction and internal fixation by triceps splitting approach. Thirteen patients were male and seven were female with M:F ratio of 1.86:1. The mean age was 6.8 yr ($SD=2.74$, range 2-14). All the fractures united by six weeks; mean time for union was 4.5 wk ($SD=0.94$). All patients were assessed at six months using Flynn clinical and radiological criteria. Results were satisfactory in all patients. **Conclusion:** Posterior triceps splitting approach is simple, safe and has good functional and radiological outcome. We recommend this approach for open reduction and internal fixation in pediatric supracondylar fracture.

Keywords: humeral fractures • internal fixation • open reduction • pediatric

INTRODUCTION:

In children, supracondylar fractures are the most common elbow fractures that account for about 70% of fractures around the elbow.^{1,2} These fractures are divided into two types; extension (98%) and flexion (2%) type; the extension type is further classified by Gartland into type I (without displacement), type II (with displacement but intact

posterior cortex) and type III (with displacement and disruption of both cortices).^{1,2}

Displaced supracondylar fracture in children is usually treated by closed reduction and percutaneous K-wires fixation (CRIF). There are certain indications for open reduction and internal fixation (ORIF) like unacceptable closed reduction, pucker sign, vascular insufficiency, and compound fractures.^{1,3,4}

Outcome of supracondylar fracture mainly depends upon reduction of fracture fragments and surgical approach used to open the fracture. Open reduction can be performed through a posterior, lateral, medial, or anterior approach or a combination of these approaches. Every approach has their own advantages and limitations. Complications like reduction of range of motion, failure to perfectly reduce the fragments, and nerve injury following open reduction of supracondylar fracture may be

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approach related. The ideal approach should give appropriate exposure of the fracture site, should be safe and quick and be associated with minimal complications.

The aim of this study was to review the advantages and disadvantages of posterior triceps splitting approach and to assess the functional outcome of supracondylar fracture of humerus in children treated by this approach.

METHODS:

This prospective study was conducted from April 2014 to March 2016 in the Department of Orthopedics, Lumbini Medical College Teaching Hospital, Pipla, Nepal. All cases of supracondylar fracture of humerus in children, less than 15 years of age, not able to be reduced by closed method were included. The ethical clearance for this study was taken from the institution review board. Written informed consent was taken from patients' relative. All fractures were classified according to Gartland classification.²

Operative Technique: All surgeries were done under general anesthesia. Patients were placed in lateral position on unaffected side. Tourniquet was used. Midline incision was given on posterior aspect of elbow starting few centimeter above tip of olecranon, curved around it and carried distal to it. Subcutaneous tissue was dissected and ulnar nerve was identified and isolated. Triceps muscle was vertically split to expose fracture site. Hematoma was evacuated and saline wash was done to visualize the fracture site. Fracture was reduced after clearing the interposed soft tissue and hematoma. Reduction was assessed by visualizing the medial and lateral pillar anatomy. After reduction, the fracture was fixed with cross K-wires starting simultaneously from medial and lateral epicondyle area, across the fracture site, to engage the opposite cortex of the proximal fragment. The fractures were secured with 1.5-2.0 mm K-wires depending upon the age of the patient and at least two cross K-wires were used. Number of wires depended on surgeon's preferences, pattern of fracture, and final stability of the fracture. Stability of fracture reduction was checked. The K-wires were bent and cutoff outside the skin to allow removal in the outpatient department without anesthesia. Tourniquet was released. Hemostasis was achieved and wound was closed in layers.

Postoperatively, the extremity was immobilized in posterior splint with elbow flexed

to 90° and patients were transferred to the ward after recovery from anesthesia. Patients were usually discharged from hospital on third day after first wound inspection; called for follow-up after one week, three week, six week, 12 wk and 24 wk. The plaster of Paris (POP) slab and K-wires were removed after fracture union was seen in X-ray. Active range of motion exercises was started after removing the slab and K-wires. The patients were examined clinically and radiologically; range of motion of elbow and carrying angle were noted. The final results obtained were evaluated by Flynn criteria (Table 1).⁵ The results were graded as excellent, good, fair and poor according to loss of range of motion and loss of carrying angle of elbow.

RESULTS:

Ninety children, less than 15 years of age, underwent surgery for supracondylar fracture of humerus during the study period. Seventy nine cases

Table 1: Flynn Criteria

Grading	Loss of carrying angle of elbow	Loss of ROM of elbow
Excellent	0-5°	0-5°
Good	6-9°	6-9°
Fair	10-15°	10-15°
Poor	>15°	>15°

were Gartland type III, ten cases were Gartland type II fractures and one case was flexion type injury. Twenty (22.2%) cases required open reduction and internal fixation. There were 19 Gartland type III injuries and one patient with flexion type injury. All were closed fractures and none of the patients had vascular compromise.

All 20 patients underwent open reduction and internal fixation by triceps splitting approach. Thirteen patients were male and seven were female with M:F ratio of 1.86:1. The mean age was 6.8 yr ($SD=2.74$, range 2-14). The commonest cause of injury was fall while playing in 10 (50%) patients, fall from tree in five (25%), fall from height in three (15%), and fall from bicycle in two (10%) patients. There was a right-sided predominance ($n=14$, 70%) compared to the left side ($n=6$, 30%). However, the difference was not statistically significant ($X^2[N=20, df=1] = 3.2, p=0.07$). There were 12 patients with posteromedial displacement and seven with posterolateral displacements. One

flexion type was medially displaced. Patients underwent surgery between 24 to 72 hr of injury. Postoperative hospital stay averaged 3.75 days ($SD=1.16$, range 3-7). The skin incision healed in all patients without problems by second week and then sutures were removed. Radiographs were performed prior to removal of the K-wires and the plaster slab. All the fractures had united by six week; mean time for union was 4.5 wk ($SD=0.94$).

Among postoperative complications, one patients had pin site infection that improved with wound care and oral antibiotics. There was no complication like permanent nerve palsy, K-wire loosening, and failure of reduction. Radial nerve palsy was seen in two cases and median nerve palsy in other two cases; all recovered without intervention by three months. All patients were assessed at six months using Flynn clinical and radiological criteria.⁵ All 20 cases had satisfactory results (Table 2).

DISCUSSION:

Supracondylar fracture is the most common fracture in children around elbow.^{1,2} Anatomical reduction is the main requirement to prevent malunion. Inadequate reduction can produce

Table 2: Patients grading according to Flynn criteria.

Grading	Loss of carrying angle	Loss of ROM of elbow	n (%)
Excellent	0-5°	0-5°	16 (80%)
Good	6-9°	6-9°	3(15%)
Fair	10-15°	10-15°	1(5%)
Poor	>15°	>15°	0

deformities such as cubitus varus (the most common), cubitus valgus, malrotation, angulation (in sagittal plane), or translation. These deformities can cause functional disability.⁶ Close reductions and percutaneous pinning is the gold standard treatment for supracondylar fracture of humerus in children.³ Open reduction and internal fixation is indicated in patients with unacceptable closed reduction, neurovascular compromise, open fractures, severe displacement, pucker sign, or severe ecchymoses on anterior surface of the elbow.^{1,4,6}

Range of motion (ROM) of elbow is another important factor with respect to outcome. ROM of elbow depends on reduction of the fracture, surgical approach used to open the fracture site, and post

operative complications like myositis ossificans and infections. There are various surgical approaches for ORIF. Each approach has its merit and demerits. Type of approach is also surgeon's choice. Anterior approach gives good exposure to neurovascular bundles but it is a demanding approach and all orthopedic surgeons may not be familiar with this approach.^{7,8} Medial and lateral approaches are limited approach with respect to exposure; visualization of other side of the pillar is not adequate and X-ray is required to see the reduction of fracture fragments and position of K-wires.⁹ There is a chance of ulnar nerve injury in all approaches except posterior approach because in all other approach medial K-wire is inserted blindly.

All orthopedic surgeons are familiar with posterior approach as it is an easy and safe approach. The ulnar nerve is isolated in this approach so that iatrogenic ulnar nerve injury is avoided. Both the pillars are visualized for perfect anatomical reduction. Better manipulation of fracture fragment is possible and no X-rays are required to see the position of wires intraoperatively. Posterior approach is standard approach for treatment in adults. It has been reported to have a high rate of loss of motion and the risk of osteonecrosis secondary to the disruption of the posterior end arterial supply to the trochlea of the humerus but in our study, only one patient had limitation of motion of elbow that is less than 15 degree.^{4,10,11} No complication like osteonecrosis was found.

There are studies where posterior approach was used to operate the supracondylar fracture in children. These studies have similar outcomes as our study. In the study from Iran, Omidi-Kashani et al. reported about thirty six children with displaced Gartland Type III supracondylar fractures who underwent open reduction and internal fixation over six years period.¹² They divided into three groups on the basis of surgical approach; Group A ($n=14$) posterior approach with triceps splitting, Group B ($n=10$) posterior approach with tongue shape flap, and Group C ($n=12$) lateral, anterolateral, or medial approach. Loss of range of motion was not more than 12° in any group. There was no deformity noted in group A triceps splitting approach. They advocated and recommended the posterior approach, particularly posterior triceps splitting approach, in surgical treatment of supracondylar fracture with normal neurovascular state in children, due to its simplicity, greater exposure, lack of interference with vital structures, and better surgical outcome.

Study from India by Gowada et al. reported, among 30 patients who underwent triceps splitting approach, that the functional results based on Flynn grading were satisfactory in 28 patients (excellent in 18 (60%), good in seven (23.3%), and fair in three (10%) patients). They reported loss of carrying angle more than 15° in two patients and loss of ROM more than 15° in one patient.¹³ Karibasappa AG. et al. used posterior approach in 30 patients in their study. Excellent results were obtained in 22 (73.3%), good in six (20%), and fair and poor in one (3.3%) each.¹⁴ In study from Pakistan, Haziqdad Khan et al. used posterior Campbell approach, which is an extensive approach then triceps splitting approach, to treat 30 Gartland type III supracondylar fracture. According to the Flynn criteria, results were excellent in 16 (53.3%), good in six (20%), fair in five (16.7%), and poor in three (10%) patients.¹⁵

In our study, according to Flynn criteria, results were excellent in 16 (80%) patients, good in three (15%), and fair in one case. The later patient had a loss of elbow motion of more than 10°. There

was no poor result.

Shortcomings of this study was small number of cases and short term follow up. We need long term follow up to better understand about osteonecrosis of distal humerus, one of the complication mentioned in literature associated with posterior approach. Another weakness is that we did not perform any measurements on last X-rays. Humeral-ulnar angle, Baumann angle, and lateral humero-capitellar angle are among the measurements that could be used to evaluate accuracy of reduction and alignment of the extremity.

CONCLUSION:

To conclude, posterior triceps splitting approach is simple, exposure is sufficient to visualize both pillars, ulnar nerve is safe because it is isolated, intraoperative X-ray is not needed, there is no interference with anterior neurovascular structure, and functional and radiological outcome is good. So, we recommend this approach for open reduction and internal fixation of pediatric supracondylar fractures.

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