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Original Article

A simple but useful technique using artery forceps for reduction of difficult Type III supracondylar fractures in children: A descriptive study

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ABSTRACT

Introduction: Closed reduction and percutaneous pinning (CRPP) is a gold standard technique for displaced Gartland type III supracondylar fractures of humerus in children. However, it is sometimes very difficult to have satisfactory closed reduction and may require open reduction which is inherently associated with a number of complications. The aim of our study is to introduce the artery forceps technique for reduction of difficult type III pediatric supracondylar fractures and assess the functional outcomes after surgery.

Method: This was the descriptive analytical study conducted from from April 2021 to March 2023. All patients with Type III Gartland supracondylar fractures which were not reduced successfully after three unsuccessful attempts of closed reduction were included in the study. Study variables included age, sex, mechanism of injury, time to complete the surgery, Baumann's angle, flexion and extension deficit of elbow and carrying angle (Flynn's criteria).

Results: Average time to complete the surgical procedure was 20.74±3.78 minutes. Mean Baumann's angle at the time of removal of K wire was 73.09±1.77 degree. Final functional outcomes three months after surgery based on Flynn's criteria showed that 25(80.64%) patients had excellent results, 5 (16.13%) patients had good outcomes while 1 (3.23%) patient had fair result.

Conclusion: Artery forceps inserted into the fracture site through a small nick in skin which facilitates to reduce the distal fragment by levering the artery forceps at proximal fragment, is a simple, reliable and very effective technique for reduction of complicated type III supracondylar fracture of humerus in children which otherwise requires open reduction.

Keywords: Artery Forceps; Children; Closed Reduction; Humerus; Type III Supracondylar fracture

INTRODUCTION

Closed reduction and percutaneous pinning (CRPP) is a gold standard technique for displaced Gartland type III supracondylar fractures of humerus in children and key point is to get the satisfactory reduction for optimal outcomes after surgery[1,2].

However, it is sometimes very difficult to have satisfactory closed reduction and may require open reduction and Kirschner (K wire) fixation which is inherently associated with a number of complications[3,4,5].This technique, where artery forceps is inserted into the fracture site through a small nick in skin which helps to reduce the distal fragment by levering the artery forceps at proximal fragment, is a simple, reliable and very effective technique for reduction of complicated type III supracondylar fracture of humerus in children which otherwise requires open reduction and fixation.

The aim of our study is to introduce the artery forceps technique for reduction of difficult type III pediatric supracondylar fractures and assess the functional outcomes after surgery.

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METHODS

This descriptive analytical study was performed in Devdaha Medical College and Research Institute, Bhaluhi, Rupandehi and Mercy City Hospital, Butwal, Rupandehi from April 2021 to March 2023. Altogether we performed 205 cases of type III supracondylar fractures in both these institutes, out of which 31 patients required reduction of fractures with artery forceps technique. Written consent was taken before enrolling the patients into the study. All patients with Type III Gartland supracondylar fractures (Figure 1A) which were not reduced successfully after three unsuccessful attempts of closed reduction were included in the study. Those patients with less than 2 years and more than 14 years, open fractures, polytrauma fractures, fractures associated with vascular injury were excluded from the study. However supracondylar fractures associated with neurological injury were included in the study. Before decision was made to do surgery, patients were thoroughly evaluated clinically

to assess for compartment syndrome, neurovascular injury and open wound. Parents were properly counselled regarding the nature of surgery, possible complications and overall outcomes. Those patients attended to hospital after 7 pm were posted for surgery next day morning until there was emergency situation to intervene the fracture.

Surgical technique

Patient was positioned supine in Operation Theatre table with Hand Rest on involved side. C arm was placed just opposite to the fracture side to properly see the image without hinderance. However, tourniquet was not applied. Before doing the painting and draping with sterile technique, primary scrubbing with 10 percent Betadine and Savlon was performed. Fracture was tried to reduce by giving continuous traction for 1 to 2 minutes. After the fracture was visualized in C arm to check the alignment in Antero-posterior view, primary surgeon tried to flex the elbow maintaining the continuous traction and constantly pressing the tip of patient's olecranon bone. After flexing the elbow joint as much as possible Fracture was checked in AP and Lateral view to assess the proper reduction. If reduction was not satisfactory, same procedure was repeated carefully for two more times and still satisfactory reduction was not achieved, then our artery forceps technique was introduced. In this technique, small nick was given over the posterior aspect of elbow joint exactly at the level of fracture site (Figure1B). Now a medium size artery forceps was passed through the nick and tried to find the fracture site.Once artery forceps was engaged at fracture site, it was further advanced through the fracture keeping in mind not to penetrate the artery forceps too much anteriorly towards the brachial artery and tried to reduce the distal fragment by levering artery forceps at proximal fragment (Figure 1C and 1D). we were able to reduce the fracture successfully in almost all cases by this technique except in one where we reduced the fracture by open reduction through anterior approach by giving transverse incision at elbow joint. After having the satisfactory reduction, fracture was fixed with 2 lateral K wires (1.8-2 mm size) and one medial K wire (1.8-2mm) in all patients more than 5 years while 3 percutaneous lateral K wires of 1.5 mm diameter were used for the children less than 5 years. After completion of surgery small nick through which the artery was inserted was closed with a stich stapler or one suture bite followed by application of posterior slab.

Post-operative care and follow up

After surgery, limb was elevated in bed with the help of two pillows. Patients were encouraged to mobilize the finger joints as well as shoulder joint.

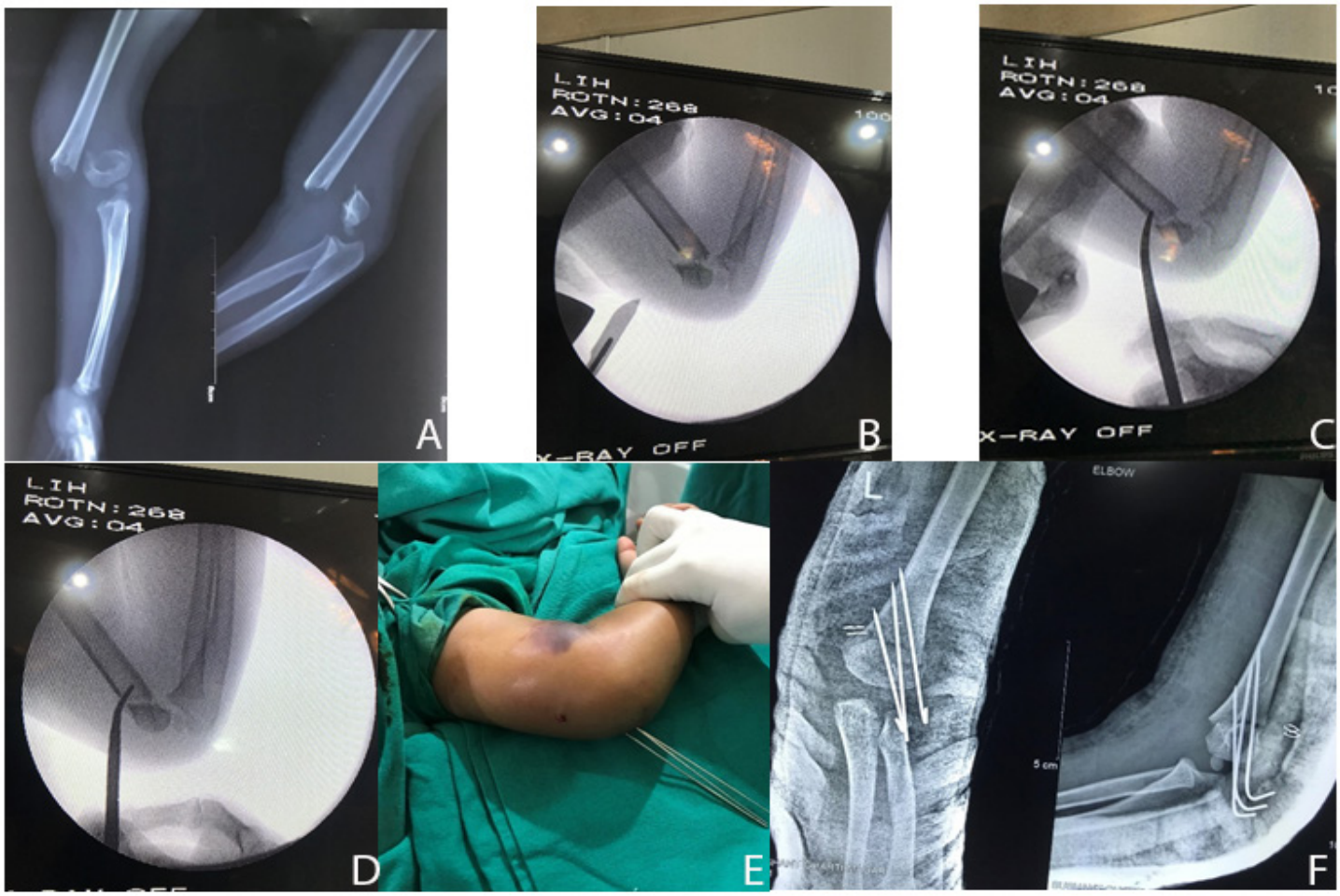

Figure 1. Preoperative Xray of type III supracondylar fracture of humerus in 5 years old child (A); Giving a nick on posterior aspect of elbow with a knife after unsuccessful attempts of reduction of fracture (B); Insertion of artery forceps through the nick and try to reduce the fracture (C); Complete reduction of fracture with artery forceps (D); Small wound on skin after fixation with three K wires (E); Post-operative X-ray AP and Lateral view after fixation with K wires (F)

Next day, fractured limb was assessed for any abnormal swelling, presence or absence of radial pulse, any neurological deficit and features of compartment syndrome. If nothing abnormal was noticed, patients were discharged on that day and advised to follow up in outpatient department in one week, four-week, six week and three months. In case of neurological deficit, patient was followed up in OPD till complete healing of nerve injury. Baumann's angle was measured immediately after surgery and at the time of removal of K wire. Functional outcomes of limb were assessed based on Flynn's criteria at three months after surgery.

Statistical Analysis

All necessary data are first filled in Microsoft excel and then transferred to SPSS (version 20) software. Quantitative data were expressed in mean ± standard deviation while qualitative data were demonstrated in percentage.

RESULTS

A Mean age of the patients in our study was 8.67±2.15 years (range 3 to 12 years). Twenty fractures (64.5%) were in left side while 11 fractures (35.5%) were in right side. There were 19 (61.3%) male and 12 (38.7%) female patients in our study. Regarding mechanism of injury, twelve patients (38.7%) sustained fractures while playing indoor activities, 9 patients (29%) sustained fractures while playing outdoor games, 8 (25.8%) had fractures because of fall from height and 2 (6.5%) patients had injuries due to road traffic accident. Average time to complete the surgical procedure was 20.74±3.78 minutes. Mean Baumann's angle immediately after surgery was 72.83±1.61 degree while Baumann's angle at the time of removal of K wire was 73.09±1.77 degree. Average time of removal of K wire was 31.03±2.55 days after surgery. Functional outcomes of patients based on Flynn's criteria at final follow up were mentioned in Table 1.

Table 1. Functional outcomes of patients based on Flynn's criteria

Results	Rating	Number of patients
Satisfactory	Excellent	25(80.64%)
	Good	5 (16.13%)
	Fair	1 (3.23%)
Unsatisfactory	Poor	0

There were no cases of nonunion, compartment syndrome, Volkmann's ischemic contracture and vascular insult after surgery. However, we had one case of median nerve palsy which was resolved 3 months after surgery, one case of myositis ossificans with range of movement 15 to 120degree, one case with superficial infection of K wire which was resolved after removal of K wire. (Figure 1 A-F).

DISCUSSION

Swenson, who is the first to perform the closed reduction and percutaneous pinning for supracondylar fractures of humerus in 1948, quickly realized that this technique has potential advantages of less surgical trauma to soft tissue, short fixation time, low probability of infection, quick healing time, early recovery rate and satisfactory functional outcomes after surgery[6]. At present context, CRPP is undoubtedly a gold standard technique for displaced supracondylar fractures of humerus because of these potential advantages[7].

More scholars further reinforced that open reduction peels of soft tissue and gets the surgical insult to surrounding soft tissue that further increases the incidence of myositis ossificans, postoperative infection and ultimately affects the functional recovery [8]. Various literatures have mentioned the variable incidence of open reduction for displaced pediatric supracondylar fractures ranging from 3 to 46% [9].

Different techniques have been mentioned in the literatures in order to facilitate the reduction of difficult supracondylar fractures. Novais et al[5] mentioned that Steinmann pin or K wire passed through the distal fragment can be used as a joystick technique for the reduction of fractures, which is effective and safe method for fixation of unstable supracondylar fractures in multiple direction. Similarly, Green et al[10] mentioned that use of temporary trans-olecranon pin to facilitate the reduction of flexion type of supracondylar fractures avoids the need of open reduction of fracture as well as multiple fluoroscopy exposure. Dong et al[7] recommended the auxiliary K wire passed percutaneously through the fracture site for apparent rotational displacement of Gartland type III supracondylar fractures. By levering the K wire at fracture site against the proximal fragment, it helps to reduce the distal fragment and significantly shortens the fluoroscopy exposure as well as operation time.

The principle behind our technique is somehow similar to the technique of Dong et al. However, we used a small sized artery forceps, instead of K wire, passed through a nick in the skin around posterior aspect of elbow and tried to reduce the impacted unreduced distal fragment by levering it against the proximal fragment once the artery forceps had engaged at fracture site. Use of Steinmann pin passed through the distal fragment as a joystick sometimes increases the possibility of distal fragment fracture. Moreover, use of Steinmann pin does not deliver the smooth and efficient force for the reduction of fracture. Similarly use of auxiliary K wire passed through the fracture site does not create sufficient force to reduce the distal fragment because of flexible nature of K wire and meantime it has tendency to injure the vital structures present anterior to fracture. To the best of our knowledge, this artery forceps technique for the reduction of difficult Gartland type III pediatric supracondylar fractures has been mentioned previously for the first time by Shreemal et al[11] from United Mission Hospital, Tansen, Nepal as a Tansen Technique. They demonstrated that it is a simple, cost effective and safe technique with short learning curve for the reduction of difficult fractures.

Average time to complete the surgical procedure was 20.74±3.78 minutes in our study which indicates that this technique significantly helps to shorten the duration of surgical procedure. Mean Baumann's angle immediately after surgery was 72.83±1.61 degree while Baumann's angle at the time of removal of K wire was 73.09±1.77 degree. This observation reinforces that artery forceps technique

helps to reduce the fracture as near as anatomically so that postoperative Baumann's angle is close to normal. Average time of removal of K wire was 31.03±2.55 days after surgery which shows that time to unite the fracture has not been compromised because of preservation of soft tissue around the fracture. Final functional outcomes three months after surgery based on Flynn's criteria showed that 25(80.64%) patients had excellent results, 5 (16.13%) patients had good outcomes while 1 (3.23%) patient had fair result.

Based on the experience of performing the 31 cases of difficult supracondylar fractures by this technique over a period of two years, we can say that artery forceps technique is most appropriate for the type III supracondylar fractures with significant swelling, those presenting late and for the older children where traction and counter traction force is not sufficient to reduce the fracture. However, this technique is not the ideal one for the fractures with rotated distal fragment where we can use other methods.

CONCLUSION

This technique, where artery forceps is inserted into the fracture site through a small nick in skin which facilitates to reduce the distal fragment by levering the artery forceps at proximal fragment, is a simple, reliable and very effective technique for reduction of complicated type III supracondylar fracture of humerus in children which otherwise requires open reduction. Moreover, this technique is most appropriate for the type III supracondylar fractures with significant swelling, those presenting late and for the older children where traction and counter traction force is not effective to reduce the fracture. However, it is not the ideal one for the fractures with rotated distal fragment where other methods have been recommended.

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