International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2018; 4(4): 478-480

www.orthopaper.com
Received: 25-08-2018
Accepted: 26-09-2018

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A clinical study of closed reduction and crossed percutaneous pinning of supracondylar fracture of elbow in children

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DOI: https://doi.org/10.22271/ortho.2018.v4.i4e.49

Abstract
Introduction: Closed reduction and crossed percutaneous pinning under high quality fluoroscopic imaging is a reliable technique for obtaining and maintaining near anatomical reduction of supracondylar fractures of humerus in children, preserving vascular function. There is greater stability or ability to maintain reduction with the crossed pinning technique. The primary risk of injury to ulnar nerve in crossed pinning is minimised by palpating the medial epicondyle and placing the entry point anterior to the ulnar nerve.
Materials and Methods: Twenty Five cases of Gartland Type III supracondylar fractures of humerus in children from December 2016 – May 2018 treated by closed reduction and crossed percutaneous pinning under C-arm was included in the study. Medial and lateral pins are preferable to multiple lateral pins as it provides more stability. The patients were followed up clinically and radiologically in the 3rd, 6th and 12th week postoperatively and their recovery assessed according to Flynn's criteria.
Result: Among the patients in the study, in whom the fracture was treated by closed reduction and crossed k-wire fixation and assessed using Flynn's criteria, 88% of the patients had excellent results, 8% had good results. Altogether 96% of the patients had satisfactory results.
Conclusion: Closed reduction and crossed percutaneous pinning is a safe, stable and effective technique for the treatment of supracondylar fracture in children with a satisfactory outcome.

Keywords: Supracondylar fracture, closed reduction, crossed percutaneous pinning, ulnar nerve injury

1. Introduction
Supracondylar fracture of humerus in children is the commonest paediatric skeletal injury around the elbow [1]. Extreme swelling with blister formation is generally found in patients who are first seen several days after the injury or in whom previous attempts of reduction have been made [2]. The ordinary closed reduction and immobilisation with the elbow in acute flexion may be impossible, because of the danger of Volkman's ischaemia [2]. The most frequent cause of compartment syndrome with subsequent Volkman's contracture of the upper extremity in children is a supracondylar fracture of the humerus [3]. In patients with extensive swelling, elbow flexion much beyond a right angle may obliterate the radial pulse or shut off the venous return, whereas immobilisation in the safer right angle position will frequently allow the fragments to slip [2]. In the past the incidence of cubitus varus deformity after supracondylar fracture ranged from 9% to 58% [4, 5, 6]. No general agreement on the treatment of supracondylar fracture is evident and various forms of conservative treatments are recommended by some authors, while surgical treatment is recommended by others [7]. There are many ways of managing displaced supracondylar fractures of the humerus in children. Closed reduction and plaster cast immobilisation, Dunlop traction, overhead skeletal traction, percutaneous pinning, open reduction and internal fixation are the most commonly reported means of handling these difficult fractures [8]. The difficulty in adequately stabilizing a closed reduction externally without opening the fracture site and without resorting to extremes of positioning has led to the development of internal stabilisation procedures. A significant advancement in the field of paediatric Orthopaedics has been closed reduction and percutaneous pinning of these fractures [9]. This technique using high quality fluoroscopic imaging allows for a near anatomical reduction of these fractures without the need for an open

surgical procedure or prolonged traction [9]. Pin fixation of supracondylar fracture of the humerus has been performed over 50 years [10]. Jones [11] and Swenson [2] were early advocates of this technique. Before the development of the fluoroscopic unit, blind pinning [12] was performed. Flynn [13, 14] and later Wilkins [15, 16] popularised modern pinning techniques and documented their value. The treatment of Type II and Type III supracondylar fractures of the humerus in children with closed reduction and percutaneous pinning has dramatically lowered the rate of complications from this injury [17]. The pins are easily removed after three weeks, function of upper extremity and functional ranges of motion are well preserved. Onwuanyi [18] in a clinical series also concluded that there was greater stability or ability to maintain reduction with the crossed pinning technique.

2. Materials and Methods

A clinical study of 25 cases of Type III supracondylar fracture of humerus in children from December 2016 – May 2018 was undertaken to evaluate the effectiveness of the procedure. Inclusion criteria consisted of fresh cases of supracondylar fractures of humerus belonging to Gartland Type III classification, supracondylar fractures with either vascular or nerve injuries and Gustillo Type I compound fractures. Exclusion criteria consisted of supracondylar fractures more than one week old and Gustillo Type II and III compound fractures. The patients were haemodynamic ally stabilized and a thorough neurovascular examination was done. AP and lateral radiographs of the affected elbow was taken and fractures classified according to Gartland's system. In the absence of peripheral pulsation, a Doppler study of the affected limb was undertaken. Patients were initially treated with an above elbow plaster of Paris posterior slab with the elbow kept in 30 - 40 degrees of flexion. All cases were managed under general anaesthesia and an image intensifier with C-arm was used. Patients were placed in supine position with the affected arm free of the table and placed on an arm trolley or on the image intensifier receiver. The manipulative process first involved longitudinal traction with the elbow in extension and forearm supinated. Counter traction was provided by an assistant. While maintaining traction, the medial or lateral displacement was corrected by applying valgus or varus force at the fracture site. Once the length has been reestablished, the displacement and angulation of the distal fragment is corrected by flexing the elbow. At the same time, a posteriorly directed force is applied to the anterior portion of the arm over the proximal fragment and an anteriorly directed force applied posteriorly over the distal fragment. Adequacy of the reduction was assessed both clinically and radio logically. Radiographically, after manipulative closed reduction with the elbow in hyper flexion, an x-ray (Jone's view) was taken to assess the coronal alignment of the distal fragment. Determination of the presence or absence of an angulation was performed by measuring Baumann's angle. The lateral x-ray was used to assess reestablishment of both the shaft condylar angle and the relation between anterior humeral line and the coronoid line. Stabilisation of fracture was done using 1.8 - 2 mm 'K'-wires. It is easier to rotate the elbow than the image intensifier while placing the pins. Placing the pins in the distal fragment with the elbow lying either internally or externally rotated on the image intensifier surface facilitates correct pin placement in the proper direction. Medial and lateral pins are preferable to multiple lateral pins as this provides more stability. Using two lateral pins prevents the clinical examination of the elbow in extension, which is essential to determine the reestablishment of the carrying angle. Also, two lateral pins do not provide adequate fixation in posterolateral fractures as a medial buttress is needed to prevent their redisplacement in lateral direction. Placement of the first pin is dependent on the displacement of the distal fragment. The more common posteromedial fracture pattern requires that the medial pin be placed first; likewise the lateral pin should be placed first for a posterolateral fracture. The point of entry is critical in pin placement. The pins should enter at the origin of the collateral ligaments on the epicondyles. If they are distal to the point, the collateral ligaments tend to bind with the pins preventing full extension of the elbow. The medial pin is placed directly through the apex of the medial epicondyle. As the medial epicondyle is posterior, the pin should be directed slightly anterior in the shaft. Care was taken to see that the ulnar nerve was posterior to the medial epicondyle while placing the medial pin. The lateral pin was placed at the centre of the lateral condyle and was directed posteriorly in the sagittal plane. In the coronal plane, the pins were placed in the shaft at an angle of 30 degrees with the long axis of humerus, this places the pins in the centre of supracondylar columns and assures wide separation of the pins at the fracture site ensuring stable fixation. Once the pins are in place, the elbow is extended and the carrying angle is assessed clinically. Postoperatively the extremity was placed in a well-padded posterior splint, with the elbow flexed to 90 degrees and the forearm in slight pronation. The external support and pins were removed after 3 to 6 weeks depending on radiological and clinical union of the fracture, to allow initiation of active elbow motion. The patients were followed up clinically and radio logically in the 3rd, 6th and 12th week postoperatively and their recovery was assessed according to Flynn's criteria and the results were rated as excellent, good, fair and poor.

3. Result

The age distribution in the study population ranged from 3 to 13 years with a mean age incidence of 7.5 ± 3.1. There has been a male preponderance with 72% of the affected being males and 28% females. The distribution of the fracture side in the study population was found to be more on the left side, the left side being affected in 64% of the cases and the right side in 36%. All the 25 cases presented to us were of extension type and 72% of these fractures were displaced poster medially and 28% poster laterally. Two out of 25 cases had associated anterior interosseous nerve injury and one had associated brachial artery injury. The longest duration of hospital stay was 13 days for a patient with brachial artery injury and 12 days for a patient with Gustillo Type I compound fracture. The duration of the follow up ranged from 3 to 18 months. Among all the patients presented to us, 88% had less than 5 degrees of loss of flexion, 8% had loss of flexion between 6 to 10 degrees and 4% had more than 15 degrees of loss of motion. The average loss of motion was 4.6 degrees ± 3.5 degrees. Out of 25 patients, the loss of carrying angle in 88% ranged between 0 - 5 degrees and 6 - 10 degrees in 8%. Carrying angle could not be assessed in the patient with Type I compound fracture who developed pin tract infection with subsequent fixed flexion deformity and loss of motion. In the present study in whom the fracture was treated by closed reduction and crossed percutaneous ‘k’ wire fixation and assessed using Flynn’s criteria 88% had excellent results, 8% had good results. Therefore altogether 96% of the patients had satisfactory results.

4. Discussion

Until the advent of percutaneous pinning, it was difficult not only to achieve, but also to maintain closed reduction because of the thinness of bone of the distal humerus between the coronoid and olecranon where most supracondylar fractures occur. Crossed percutaneous pinning using high quality fluoroscopic imaging allows near anatomical reduction of these fractures without the need of an open surgical procedure or prolonged traction [9]. Medial and lateral pins are preferred to multiple lateral pins as this provides more stability. The primary risk of injury to ulnar nerve in crossed pinning is minimised by palpating the medial epicondyle and placing the entry point anterior to the ulnar nerve. None of the cases in our study had postoperative ulnar nerve palsy. In modern series the anterior interrosseus nerve appears to be the most commonly injured [19, 20, 21]. The post traumatic anterior interosseous nerve injury resolved spontaneously within an average time of 10 weeks. The patient with brachial artery injury who presented without radial and ulnar artery pulsation, which did not improve following closed reduction and percutaneous pinning, eventually underwent brachial artery exploration and embolectomy followed by restoration of distal vascularity. The patient with more than 15 degrees loss of motion had Gustillo type I compound fracture at the time of admission. Post operatively patient developed pin tract infection and loosening of pins, hence the pins were removed earlier and the elbow immobilised in a plaster slab for a longer period, the infection resolved completely after removal of pins but patient subsequently developed significant loss of motion.

5. Conclusion

In supracondylar fractures maximum stability was attained by two crossed pins, placed from the medial and lateral condyles. With the fracture being stabilized by crossed pins, an elbow with severe swelling could be extended and the compression of arteries and veins could be avoided. The method was safe, effective and the period of hospitalization was also short. Both functional and cosmetic satisfactory results were obtained consistently. The commonest complication of this fracture, cubitus varus was virtually eliminated.

6. References

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