SUPRACONDYLAR HUMERUS FRACTURE FIXATION IN CHILDREN WITH CROSS K-WIRES VS TWO LATERAL K-WIRES

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ABSTRACT

Objective: To assess and compare outcome of supra-condylar humerus fracture fixation in children with cross k-wires vs. two lateral k-wires

Study design: Prospective quasi-experimental study

Place and duration: Department of Trauma and Orthopedic Khyber Teaching Hospital Peshawar Khyber Pakhtoon Khwa.

Patients and Method: Children with close displaced supra-condylar fracture of humerus. All children with close displaced Supra-condylar fracture humerus (Gartland type II & type III) were treated with closed reduction under fluoroscopic control and stabilized with either two lateral k-wires or two cross k-wires. Post-operative above elbow back slab given for 3-4 weeks. Patients were followed up for clinical and radiological healing of the fracture. After about 4-6 weeks (average 5 weeks) k-wires were removed. At the end of follow-up period Flynn's criteria was used and outcome of both types of K-wire fixation compared.

Inclusion and Exclusion Criteria: Open fracture and poly trauma patients were excluded from the study. All children with closed supra-condylar humerus fracture were included in the study.

Results: A total of 32 patients were enrolled in this study. 14 of them were fixed with two lateral k-wires and 18 with two cross k-wire technique. There were n=24(75%) male while n=8(25%) were female children. Patients were evaluated by recording the outcome measures using Flynn's criteria. There was no significant difference of proportion of excellent, good and fair between patient groups receiving lateral k-wire fixation and crossed k-wire fixation.

Conclusion: There is no significant difference in the outcome of fracture fixation between the two techniques of k-wire fixation. In addition ,in lateral k-wire fixation technique there is no risk of ulnar nerve injury but same outcome as crossed k-wire technique.

Keywords: supra-condyle, K-wire, closed reduction

INTRODUCTION

Supracondylar fracture of the elbow is one of the most common injuries in children. Extension-type (95%) is the most common[1]. Gartland classification[2] is the commonly used classification which is based on degree of fracture displacement i.e. Type I-undisplaced, type II – displaced with intact posterior cortex, and type III – displaced with no cortical contact. There is a high association of this fracture with neurovascular complications and deformity which warrants an aggressive approach for its management.Uncomplicated supra-condylar fracture may even lead to complications like local swelling, deformity and neurovascular complications if not managed properly[3-7].Therefore, these fractures deserve an accurate assessment and precise planning in method of treatment[3].Closed reduction and percutaneous pinning under image intensifier is now the treatment of choice for most of the displaced supracondylar fractures of the humerus in children.[8,9,10] Generally, two pinning techniques have been used i.e. crossed medial and lateral pinning and only lateral pinning techniques .

The purpose of this study was to compare and evaluate the two pinning techniques in terms of functional outcome and complications if any, in children with supracondylar fractures of humerus.

MATERIALS AND METHODS

The study was designed as a prospective clinical trial. 32 patients of age group 3-12 years with displaced extension-type supracondylar fractures of humerus admitted to Khyber Teaching Hospital peshawar from August 2014 to April 2015 were included in the study. Undisplaced fractures, open fractures and supracondylar fracture associated with ipsilateral limb fractures were excluded from the study. Closed reduction and percutaneous pinning was performed under image intensifier control, which was either lateral or crossed

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pinning .There were 24 boys and 8 girls.None of the patients had any neurovascular injury at presentation. All the patients were given an above elbow back slab on admission. The patients were prepared for general anesthesia. The choice of pinning (K-wire) construct lateral or cross pinning was decided after close reduction by the operating surgeon.

All the patients were operated under general anesthesia .According to standard technique described by Rockwood and Wilkins (2006) close reduction was performed[11]. Reduced position was confirmed under the image intensifier in both antero-posterior and lateral planes .Size of the K- wire (pins) used were decided based on fracture configuration and size of the bone. After close reduction evaluation, two pins were inserted from the lateral aspect of the elbow in the lateral pinning technique. The pins were either parallel or divergent engaging the medial cortex. The elbow was kept hyperflexed and in a position of pronation during insertion of the lateral pins. Then the elbow was extended fully and fracture reduction and stability confirmed under image intensifier.

Similarly in the cross pinning technique, after fracture reduction , the lateral pin was inserted first as in the lateral pinning technique above. Then the elbow was extended to less than 90˚ position and a medial pin was inserted. The surgeon palpated ulnar nerve and pushed it posteriorly with the thumb for medial pin insertion. In case of severe swelling and inability to palpate medial epicondyle a small incision was made over the medial epicondyle to explore the ulnar nerve. The fracture reduction and stability was confirmed under image intensifier. Pins were bent and the excess length was cut. Povidone-iodine soaked gauze dressing was applied to avoid pin track infection. An above elbow back slab was applied for two weeks with the elbow in 90˚ flexion and full supination of forearm. Patients were discharged after one to two days based on their comfort. Patients were followed up for clinical evaluation(carrying angle, elbow range of motion, neurovascular complications and pin tract infections)and radiological evaluation (fracture displacement, metaphysio-diaphyseal angle , humero-capitellar angle) at regular intervals till the final follow up.The plaster slab were removed after three to four weeks and pins were removed couple of weeks later. Active elbow 'range of motion' exercises were encouraged. At the end of follow up period, Flynn's criteria[12] were used to grade the result. Results were graded as excellent, good, fair and poor. [Table I]

Table 1: Grading of results according to Flynn's criteria[12]

	Cosmetic factor loss of carrying angle (degrees)	Functional factor loss of movement (degrees)
Excellent	0° - 5°	0° - 5°
Good	5° - 10°	5° - 10°
Fair	10° - 15°	10° - 15°
Poor	> 15°	> 15°

The final outcome was compared between the two pinning techniques based on Flynn's criteria.

RESULTS

A total of 32 patients with supra-condylar humerus fracture were enrolled in this study. 14 of them were treated with lateral pinning and 18 with cross pinning technique. There were n=24(75%) male and n=8(25%) were female children. N=12(37.5%) belonged to age group 6-9 years, n=10(31.25%) 3-6 years, n=6(18.75%), n=6(18.75%) 1-3years while only n=4(12.5%) children were older than 9 years. In n=22(68.75%) left supra-condylar fracture occurred while in n=10(31.25%) right supracondylar humerus fracture happened. There were no significant differences of baseline characteristics such as age, gender and types of fracture between two groups. The mean period of fracture union was about 4 weeks.

Patients were evaluated by recording the outcome measures using Flynn's criteria. Among patients treated with lateral pinning technique, 10 (70.6%) had excellent outcome, 3 (24%) had good outcome while 1 (6%) had fair outcome. No patient had a poor outcome. Similarly, in patients treated with cross pinning technique, 13 (72%), 2 (11%) and 3 (16%) had excellent, good and fair outcomes respectively (Figure 1). Five patients developed superficial pin tract infections which were treated successfully with oral antibiotics and regular dressings. No patient developed any iatrogenic ulnar nerve injury in the cross pinning group. Overall, none of the patient developed any neurovascular complications during the treatment and follow up period.

Figure 1 shows the outcome based on Flynn's grading. There was no significant difference of proportion of excellent, good and fair between patient groups receiving lateral pinning and crossed pinning.

DISCUSSION

In children Supracondylar fracture of the humerus is the most common fracture around the elbow.[13,14] This fracture is notoriously associated with neurovascular complications.[5,15,16]. To avoid serious complications appropriate and aggressive treatment is advised. Child presents with swollen painful elbow with tenderness around bony land marks.In contrast to previous studies, in acute injury of elbow, the extension test alone or in combination with assessment of point tenderness cannot safely rule out clinically significant injury[17].There are frequent neurologic complications, with the anterior interosseous nerve being the most common nerve affected. Although less common but vascular injuries, can result in long-term sequelae, so should be recognized and managed promptly. Similarly, loss of reduction can

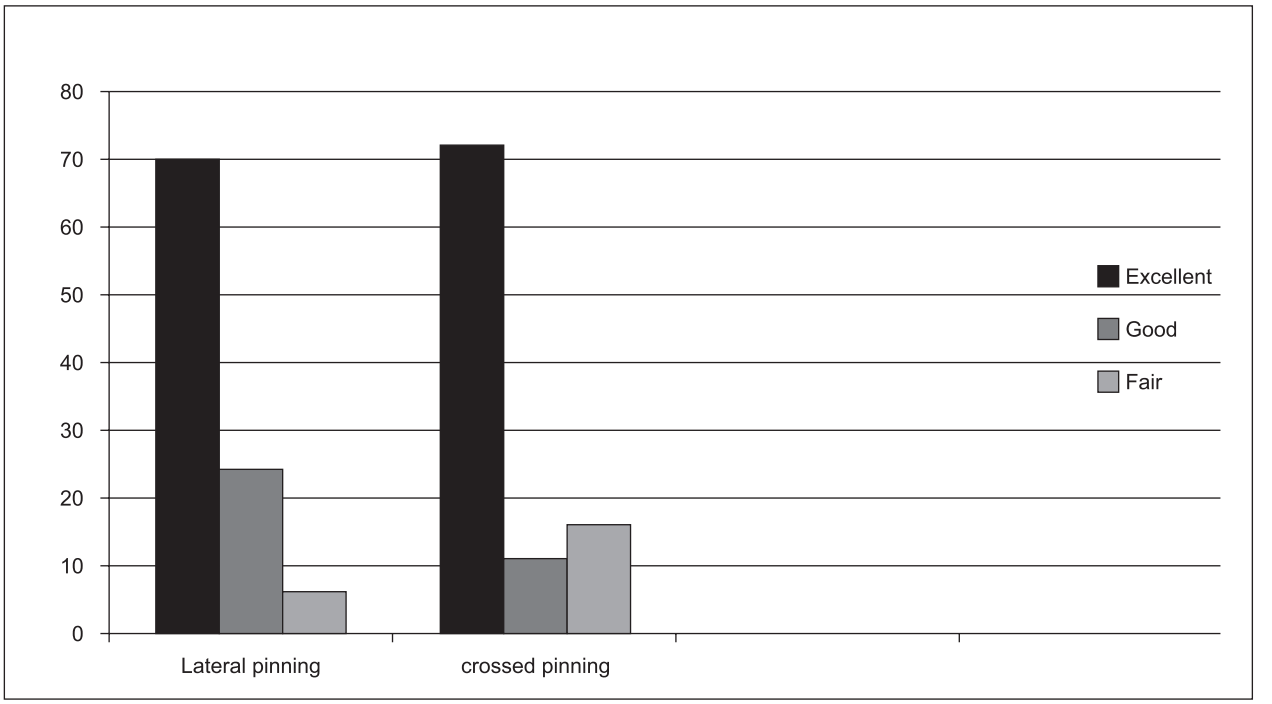

Figure 1: Outcome in patients receiving either crossed pinning or lateral pinning based on Flynn's grading

happen with both surgical and nonsurgical treatment. Infection and compartment syndrome, are rare, but require rapid recognition and solution. Therefore it is very important to be familiar with the potential complications surrounding the treatment of pediatric supracondylar humeral fractures and to know when a referral may be warranted in order to maximize the outcomes [18].Similarly, cubitus varus (30%) and valgus (3-7%) mostly, result from an insufficient initial anatomic reduction of the fracture[19].

Type I(Gartland) fractures can be adequately managed by immobilization in an above elbow cast.[20]. However, controversy exists regards the optimal treatment for displaced supracondylar fracture (Gartland type II & type III).Various treatment options exist for displaced supracondylar fractures of humerus in children i.e. skin traction, closed reduction and plaster casting, closed reduction and percutaneous pinning and open reduction and pinning. Parikh et al. recommends closed reduction and plaster casting for treatment of extension type II supracondylar fractures.[21] To correct the rotational malalignment if exist, Open reduction is often necessary however, a new closed reduction technique for the correction of this deformity using a Kirschner wire as a joystick has been introduced [22]. Lateral cross pinning technique (Dorgan's Technique) is also recommended by some authors.[23,24,25]Multivariate analysis has revealed that a fracture below the level of humeral isthmus was significantly associated with poor prognosis in terms of the range of elbow movement, Flynn grade and angulation. Similarly, age over ten years was also a poor prognostic factor for attainment of the range of elbow movement[26]. Weinberg et al. in a biomechanical model compared four osteosynthesis techniques for management of supracondylar fracture and concluded that external fixators are a good alternative to cross pinning if the fracture reduction is difficult due to swelling[27].In sagittal loading, the external fixators proved to be significantly more stable than crossed pinning[28]. Fahmy et al. proposed a posterior intrafocal pinning technique for extension type supracondylar fractures of humerus.[29] Li et al. described a mini invasive technique using mosquito forceps for reduction of severely displaced supracondylar fractures[30].

Keeping in mind the difficulty and inconvenience of keeping the patients in hospital for long or calling for close follow up, we chose primary fixation with 'k' wires for displaced (Type II & Type III) supracondylar fractures of humerus. This treatment offers adequate stabilization, minimizes soft tissue trauma and rapid recovery. Thus after fracture reduction, fixation with 'k' wires maintains reduction and allows early mobilization. For postoperative immobilization of supracondylar humerus fractures, a new method of placing foam directly on the skin, followed by circumferential fiberglass casting. There is theoretical advantage of the strength of a circumferential cast, along with the benefit of allowing for swelling[31]. A few studies suggest that the treatment of an uncomplicated displaced supracondylar fracture can be delayed up to the next day.[3,32]. In our study none of the patients had any neurovascular complications at presentation as well as during hospital stay.

Regards the choice of pinning technique, for displaced extension type supracondylar fractures

controversy exists. Intact posterior periosteum prevents rotational misalignment in type II fractures. However, type III fractures are inherently unstable and completely displaced. Associated medial cortex comminution adds to this instability further. This is the main reason put forth by the supporters of crossed pinning technique(besides the higher torsional rigidity[26] of the crossed pinning construct).[33,34] However there are studies which document that lateral pin fixation is as strong as crossed pinning [35] while decreasing the risk of iatrogenic ulnar nerve injury also. The risk of iatrogenic ulnar nerve injury varies widely and depends on the pin insertion technique. Iatrogenic nerve injuries after operative treatment of supracondylar fractures occur in as many as 3-4% of cases[36]. Brauer et al. from a systematic review found that the probability of iatrogenic nerve injury is 1.84 times higher with cross pinning technique in comparison to lateral pinning.[37] However in this study, none of the patients in cross pinning group developed any iatrogenic ulnar nerve injury. Moreover, a separate medial incision to explore the ulnar nerve for medial pin insertion is recommended. In our study only very few patients with gross swelling of elbow required an incision on medial side because the swelling precluded the palpation of ulnar nerve. In remaining patients the ulnar nerve was palpable and was pushed backwards with thumb before inserting the medial pin.Based on clinical outcome in our study there is no significant difference between the two pinning techniques . Results of our study support the use of lateral pinning for displaced supracondylar fractures (Gartland type II & type III).

Points which strengthen this study are its prospective design, standardized method of fracture reduction, pin placement, and follow up assessment of the patients. The limitations of this study are the number of patients and relatively short follow up period. However, this study reinforces the recommendations made by other authors[32,37,38] regarding the use of lateral pinning technique in displaced supracondylar fractures of humerus in children.

REFERENCES

1. Rowland D. Common upper limb injuries in childhood. Surgery (Oxford) 2011;29(4):153–61
2. Gartland J. Management of supracondylar fractures of the humerus in children. Surg gynecol obstet 1959;109:145.
3. Sibinski M, Sharma H, Bennet GC. Early versus delayed treatment of extension type-3 supracondylar fractures of the humerus in children. J Bone Joint Surg {Br} 2006;88(3):380–381
4. Ramachandran M, Birch R, Eastwood DM. Clinical outcome of nerve injuries associated with supracondylar fractures of the humerus in children: the experience of a specialist referral centre. J Bone Joint Surg {Br} 2006;88(1):90–94.
5. Blakey CM, Biant LC, Birch R. Ischaemia and the pink, pulseless hand complicating supracondylar fractures of the humerus in childhood: long-term follow-up. J Bone Joint Surg {Br} 2009;91(11):1487–1492.
6. Griffin KJ, Walsh SR, Markar S, Tang TY, Boyle JR, Hayes PD. The pink pulseless hand: a review of the literature regarding management of vascular complications of supracondylar humeral fractures in children. Eur J Vasc Endovasc Surg 2008;36(6):697–702.
7. Robb JE. The pink, pulseless hand after supracondylar fracture of the humerus in children. J Bone Joint Surg {Br} 2009 ;91(11):1410–1412.
8. Zamzam MM, Bakarman KA. Treatment of displaced supracondylar humeral fractures among children: crossed versus lateral pinning. Injury 2009;40(6):625–30.
9. Cekanauskas E, Degli?te R, Kalesinskas RJ. Treatment of supracondylar humerus fractures in children, according to Gartland classification. Medicina (Kaunas, Lithuania) [Internet] 2003 Jan;39(4):379–83.
10. Kocher MS, Kasser JR, Waters PM, Bae D, Snyder BD, Hresko MT, et al. Lateral entry compared with medial and lateral entry pin fixation for completely displaced supracondylar humeral fractures in children. A randomized clinical trial. J Bone Joint Surg {Am} 2007 ;89(4):706–712.
11. Beaty, James H.; Kasser JR. Rockwood & Wilkins' Fractures in Children, 6th ed. Philadelphia:Lippincott Williams & Wilkins, 2006.
12. Flynn C. Blind Pinning of Displaced of the Humerus Supracondylar in Children. J Bone Joint Surg {Am} 1974;56-A(2):263–272.
13. Benjamin HJ, Hang BT. Common Acute Upper Extremity Injuries In Sports. Clin Pediatr Emerg Med 2007;8(1):15–30.
14. Chasm RM, Swencki S a. Pediatric orthopedic emergencies. Emerg Med Clin North Am 2010;28(4):907–926.
15. Laine JC, Kaiser SP, Diab M. High-risk pediatric orthopedic pitfalls. Emerg Med Clin North Am 2010 ;28(1):85–102.
16. Omid R, Choi PD, Skaggs DL. Supracondylar humeral fractures in children. J Bone Joint Surg {Am} 2008;90(5):1121–1132.
17. Jie KE, van Dam LF, Verhagen TF, et al; Extension test and ossal point tenderness cannot accurately exclude significant injury in acute elbow trauma. Ann Emerg Med. 2014 Jul;64(1):74-8. doi: 10.1016/j.annemergmed.2014.01.022. Epub 2014 Feb 13.
18. Meyer CL, Kozin SH, Herman MJ, Safier S, Abzug JM.Complications of pediatric supracondylar humeral fractures. Instr Course Lect. 2015;64:483-91.
19. Lehner M, Schuster B, Dietz HG Strategies in the treatment of supracondylar fractures of the humerus in children - proven and controversial]..Zentralbl Chir.

2014 Dec;139(6):613-20

20. Sherman SC. Pediatric supracondylar fracture. J Emerg Med 2011 Feb;40(2):35–37.

21. Parikh S, Wall E, Foad S. Displaced type II extension supracondylar humerus fractures: do they all need pinning? J Pediatr Orthop 2004;24(4):380–384.

22. Turgut A, Aksakal AM, Öztürk A, Öztaş S.A new method to correct rotational malalignment for closed reduction and percutaneous pinning in pediatric supracondylar humeral fractures. Acta Orthop Traumatol Turc. 2014;48(5):611-4.

23. Queally JM, Paramanathan N, Walsh JC, Moran CJ, Shannon FJ, D'Souza LG. Dorgan's lateral cross-wiring of supracondylar fractures of the humerus in children: A retrospective review. Injury 2010;41(6):568–571.

24. Memisoglu K, Kesemenli CC, Atmaca H. Does the technique of lateral cross-wiring (Dorgan ' s technique) reduce iatrogenic ulnar nerve injury??. International Orthopaedics (SICOT) 2011;35:375–378.

25. El-Adl WA, El-Said MA, Boghdady GW, Al-Sayed MA. Results of treatment of displaced supracondylar humeral fractures in children by percutaneous lateral cross-wiring technique. Strat Traum Limb Recon 3(1):1–7. doi: 10.1007/s11751-008-0030-3

26. Kang S, Kam M, Miraj F, Park SS. The prognostic value of the fracture level in the treatment of Gartland type III supracondylar humeral fracture in children Bone Joint J. 2015 Jan;97-B(1):134-40.

27. Weinberg a M, Castellani C, Arzdorf M, Schneider E, Gasser B, Linke B. Osteosynthesis of supracondylar humerus fractures in children: a biomechanical comparison of four techniques. Clin biomech (Bristol Avon) 2007 Jun;22(5):502–9.

28. Hohloch L, Konstantinidis L, Wagner FC, Strohm PC, S U Dkamp NP, Reising K. Biomechanical evaluation of a new technique for external fixation of unstable supracondylar humerus fractures in children.Technol Health Care. 2015 Mar 3.

29. Fahmy MAL, Hatata MZ, Al-Seesi H. Posterior intrafocal pinning for extension-type supracondylar fractures of the humerus in children. J Bone Joint Surg {Br} 2009;91-B(9):1232–1236.

30. Li Y, Lee P, Chia WT, Lin H, Chiu F, Chen T, et al. Prospective analysis of a new minimally invasive technique for paediatric Gartland type III supracondylar fracture of the humerus. Injury 2009;40(12):1302–1307.

31. Seehausen DA, Kay RM, Ryan DD, Skaggs DL.Foam padding in casts accommodates soft tissue swelling and provides circumferential strength after fixation of supracondylar humerus fractures..J Pediatr Orthop. 2015 Jan;35(1):24-7.

32. Yeoman T, Murphy E, Malhas A, Smith J, Campbell D. Should paediatric supracondylar fractures go to theatre out of hours if there is no neurovascular deficit? International Journal of Surgery 2011 Jan;9(7):547.

33. Sial N, Yasin A, Rashid A. Supracondylar humerus fractures outcome of open reduction and percutaneous crossed pin fixation. Professional Med J 2011;18(1):147–153.

34. Swenson A. The treatment of supracondylar fractures of the humerus by Kirschner-wire transfixion. J Bone Joint Surg {Am}1948;30A(4):993–997.

35. Skaggs D, Hale J, Bassett J, Kaminsky C. Operative Treatment of Supracondylar Fractures of the Humerus in Children The Consequences of Pin Placement. J Bone Joint Surg {Am}2001;83-A(5):735–740.

36. Joiner ER, Skaggs DL, Arkader A, Andras LM, Lightdale-Miric NR, Pace JL, et al. Iatrogenic nerve injuries in the treatment of supracondylar humerus fractures: are we really just missing nerve injuries on preoperative examination?. J Pediatr Orthop. Jun 2014;34(4):388-92.

37. Topping R, Blanco J, Davis T. Clinical evaluation of crossed-pin versus lateral-pin fixation in displaced supracondylar humerus fractures. J Pediatr Orthop 1995;15:435–439.

38. Brauer C, Lee B, Bae D, Waters P, Kocher M. A systematic review of medial and lateral entry pinning versus lateral entry pinning for supracondylar fractures of the humerus. J Pediatr Orthop 2007;27(2):181–186.