Research Article

Comparative study between two patterns of percutaneous K-wire fixation of supracondylar fracture of the humerus in children

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Abstract

Background: Supracondylar fracture of the humerus is the second most common fracture in children. Failure to execute a appropriate treatment plan for these fractures may lead tovarus malunion. For that closed reduction and percutaneous pinning is the treatment of choice. Percutaneous K-wire fixation can be inserted either in a cross medial-lateral pattern or through a lateral entry only with each method having its advantage and disadvantage.

Aim: Is to evaluate the results of two lateral parallel pin fixation versus cross medial lateral pin fixation in displaced supracondylar humerus fracture in children regarding complications (especially iatrogenic nerve injury, cubitus varus deformity), technique and other concepts.

Patients and method: Between March 2010 to May2014, forty _ three (38) patients at Al-Yarmouk Teaching hospital were collected from emergency unite and from orthopedic outpatient to undergo surgery for displaced supracondylar fracture humerus (type B , C) according to gartland classification. it was an urgent operation with less than 24 hours, traumatic posterior supracondylar fracture humerus(type B,C) with no vascular or nerve injury for children aged less than 12 years old. They were divided into two groups [Group I(20 patients) closed reduction and percutaneous two lateral parallel k_wire fixation] and[Group II(18 patients) with two cross medial_ lateral k_wire fixation] and we compare the results between the two groups post operatively.

Results: There were significant differences(P-value=0.0078)regarding complications postoperatively , there were typical cubitus varus deformity 2{10%} in group I while there were no such complication{0%} in group II, while we report one case {5.55%} with ulnar nerve neuropraxia in group II. Regarding functional results; there were significant differences between the two groups, we reported excellent results 11{55%} in group I, while it was 13{72.22%} in group II, good results were about 5{25%} in group I ,while it was 4{27.77%} in group II, fair results 2{10%} in group I, 1{5.55%} in group II. In addition there were significant poor results in group I as we reported 2 cases{10%} in group I, while there were no such results{ 0%} in group II.

Conclusion: Closed reduction and medial-lateral percutaneous K-wire fixation is the treatment of choice for displaced pediatric supracondylar fractures of the humerus with extra precautions during medial wire insertion..

Key words: supracondylar fracture, percutaneous k_wire, ulnar nerve injury.

INTRODUCTION

Supracondylar fracture of the humerus is the second most common fracture in children and the most common fracture in children under 7 years of age[(1)], It accounts for 50–70% of all elbow fractures[(2)] . The typical mechanism is a fall on an outstretched hand that puts a hyperextension load on the arm. The distal fragment displaces posteriorly in over 95% of cases [(3)] As the elbow is forced into hyperextension, the olecranon serves as a fulcrum and focuses the stress on the distal humerus causing fracture. The rare flexion-type supracondylar fracture is often the result of a fall directly onto the flexed elbow.[(4)(5)] Gartland [(22)] classified the pediatric supracondylar fractures of the humerus into three types based on the degree of displacement:

Type-A Non displaced

Type-B Displaced (with intact posterior cortex)

Type-C Displaced (no cortical contact)

a. Posteromedial b. Posterolateral

The available treatment options range from conservative to closed and/ or open reduction and percutaneous Kirchner wire (K-wire fixation) depending upon treatment modalities available to treat such fractures with different outcomes but closed reduction and percutaneous pinning is the treatment of choice [6].

Percutaneous K-wire fixation can be inserted either in a cross medial-lateral pattern or through a lateral entry only with each method having its advantage and disadvantage [7,8].

Failure to execute a timely and appropriate treatment plan for these fractures may lead to various complications including, varus malunion, elbow stiffness, Volkmann ischemic syndrome/contracture, neurovascular injury, myositis ossifi cans, etc.[9]

There had been continuous debate regarding stability of fracture fixation after different configuration of pinning methods. The stability of crossed pinning method is biomechanically more stable but again carries the risk of ulnar nerve injury.[10,11]

Aim of study

The aim of this study is to evaluate the results of two lateral parallel pin fixation versus cross medial-lateral pin fixation in displaced supracondylar humerus fracture in children regarding complications (especially iatrogenic nerve injury, cubitus varus deformity), technique and other concepts.

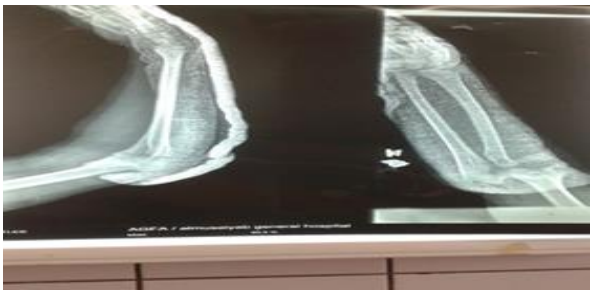

Fig.1 Posterior extension type

Fig. 2 Rare anterior flexion type

PATIENTS AND METHODS

Between March 2010 to May2014, thirty- eight (38) patients at Al-Yarmouk Teaching hospital were collected from emergency unite and from orthopedic outpatient to undergo surgery for displaced supracondylar fracture humerus (type 2 , 3) according to gartland classification.

There were 28 male and 15 female patients. Mean age of the patients was 6.8 years (range 3-12 years), it was an urgent operation, traumatic posterior supracondylar fracture humerus(type B,C) with no vascular or nerve injury for children aged less than 12 years old.

In this study , open fractures, suspicion of compartment syndrome complication, neurovascular injury and children older than 12 years were excluded from our research.

In addition any patient with fracture delayed more than 72 hours was excluded; as there will be huge swelling and this will cause close reduction and percutaneous pinning dangerous and difficult.

After taking detailed history , thorough clinical examination with meticulous concern on neurovascular component was done for all the patients, followed by plain radiological examination of the injured elbow including anteroposterior (AP) and lateral views.

All cases with supracondylar extension type 2, 3 were managed with back slab above elbow at causality and then immediately within hours planning to do surgery (closed reduction and percutaneous pinning by k _ wire) at the surgical orthopedic operative room, they were divided into two groups , group I twenty(20) child (closed reduction and parallel 2 lateral percutaneous k _ wire fixation) and group II eighteen (18) child (closed reduction and cross medial_ lateral k_ wire fixation, written patient's consents are adopted.

Surgical procedure

Either under regional or general anesthesia (depending upon anesthetist's choice and medical fitness of the child), without tourniquet, in lateral position, the surgery was done orthopedic operation table.

By applying the traction on the forearm and counter traction of humerus with elbow being in mild flexion(20 degree), the fracture was reduced under image intensifier (gradual correction of rotation and mediolateral shift and then flexing elbow with pressure on olecranon to correct posterior shift, Pronation of forearm and hyperflexion done). Strapping of forearm with arm done in the same position with cotton bandage.

If reduction is acceptable Two K- wires were then inserted under image intensifier from lateral epicondyle towards medial cortex of the proximal fragment with the attempt to put the pins in maximal separation at fracture site and divergent direction. K-wires were bent outside the skin and cut and above elbow back slab applied.(**this technique for group I**).

For group II, after a satisfactory reduction a1.6-2 mm wire was passed percutaneously through lateral epicondyle across the fracture and taking hold into the opposite cortex of the proximal fragment under image intensifier.

Before inserting the medial wire through medial epicondyle, important precautions should be followed to minimize the risk of iatrogenic ulnar nerve injury as:(Small stab incision was made just behind the medial epicondyle to identify and secure ulnar nerve in few selected cases ,Skin over the medial epicondyle was stretched posteriorly with the help of overlying fingers.

The final position of fracture reduction and K-wires was confirmed by image intensifier.

The extra length of K-wires was cut and tip of the remaining wires was bent outside the skin. a posterior slab above elbow,after a week a plaster of Paris (POP) splint was applied for 3 weeks in all the patients followed by a check X-ray immediately after the surgery.

Post-operatively

Immediately, intravenous antibiotics(second generation cephalosporin),analgesia, with checking of neurovascular bundles especially radial pulse and concentration on ulnar nerve by asking the child to move his or her fingers especially 4th and 5th, fingers and if there is any numbness or parasthesia especially in group II Patients(with cross pinning).

Next day we sent for x_ray (AP and Lat. Views) elbow joint and discharge the patient on oral antibiotics and ask the family to come weekly for follow up and to confirm clinical and radiological union

Clinically, union of the fracture was defined as the absence of tenderness at the fracture site and painless elbow motion while; Radiological union was defined as the presence of bridging callus at the fracture site in both AP and lateral radiographs

After 3 weeks POP splint was removed in all the patients and elbow range motion were started. Removal of K-wires was done after confirmation of clinico-radiological union at the fracture site between 4th and 5th weeks postoperatively.

All patients were followed at the end of 2 months, 4 months,6months & 1 year

Fig.3 percutaneous 2 parallel lateral k- wires

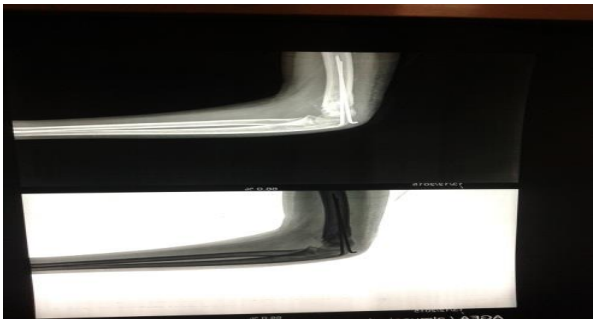

Fig.4 x-ray postoperative

Fig.5 postoperative x-ray cross medial-lateral k-wires

Table 1. Flynn's criteria

result	Rating	Functional outcome Motion loss$^{(0)}$	Cosmetic factor loss of carrying angle$^{(0)}$
Satisfactory	Excellent	0-5	0-5
	Good	5-10	5-10
Unsatisfactory	Fair	10-15	10-15
	Poor	>15	>15

RESULT

According to this table (2) there is common age group(3-7 years) in which is more susceptible to sustained traumatic supracondylar fracture humerus.

According to sex distribution, the boy is more susceptible than girl to be exposed to supracondylar fracture humerus as he is usually more active than the girl. There is iatrogenic nerve injury(ulnar nerve) in group II, and typical cubitus varus deformity in group II. There is excellent results 72.22% in group II, While it is 55% in group I; again poor results 10% in group I while we have not such results in group II. (Table 3,4,5)

Table 2: Age distribution

Age of patients (yrs.)	Group I (No.){%}	Group II (No.){%}
3-7	12{60%}	11{61.11%}
7-10	5{25%}	5{27.77%}
10-12	3{15%}	2{11.11%}

Table 3: sex distribution

Sex	Group I	Group II
Male	14{70%}	15{83.33%}
Female	6{30%}	3{16.66%}

Table 4: Post-operative complications

complication	Group I(No.){%}	Group II(No.){%}
Pin tract infection	2 {10%}	1{5.55%}
Iatrogenic nerve injury	Nil	1{5.55%} ulnar nerve neuropraxia
Vascular injury	Nil	Nil
Compartment syndrome	Nil	Nil
Elbow stiffness	1{5%}	1{5.55%}
Heterotopic ossification	Nil	Nil
Cubitus varus deformity	2{10%}	Nil

Table 5: Functional results according to Flynn's criteria

Criteria	Group I No. {%}	Group II No.{%}
Excellent	11 {55%}	13 {72.22%}
Good	5 {25%}	4 {27.77%}
Fair	2{10%}	1 {5.55%}
Poor	2{10%}	Nil
Total	20	18

DISCUSSION

This is comparative study between two techniques of closed reduction and percutaneous k- wire fixation in displaced supracondylar fracture humerus in children as this fracture is the commonest(second) in the pediatric age group. As study done by M Julfiqar, Ajay Pant. et al[13] .

In our results, most of our patients were under 7 years (3-7), about 23 patients{ 61%} , and this is true to that the peak age group with supracondylar fracture humerus in children is between(3-5). [14]

Again , there was significant male predominance in our study, as there were 29 male patient {76.5%}and this is logic in our population as the male child is more active, bicycle rider and football player as falling on outstretched hand is the commonest mechanism of injury in this fracture, in opposite to female child. This is comparable to study done by Yadagiri, Sureder et al.[15]

Closed reduction and k wire fixation of supra condylar fracture in children is a sound and effective technique especially for type 2 and type 3 fractures, but with sure some complications we encounter in this study.

There were 3 cases of superficial pin tract infection, two {10%} cases in Group I, and one {5.55%} in Group II , and every case treated successfully by daily dressing and sterilization and oral antibiotic for one week without hospital admission or intravenous antibiotics.

This is again good results in comparism to other studies M Julfiqar, Ajay Pant et al[13] (superficial pin tract infection {14.3%}.)

The major complication of cross K-wire configuration(Group II) is the risk of iatrogenic ulnar nerve injury however, it is said to be biomechanically the stronger construct.(LEWIS, Zneist et al)[16]. The major advantage of lateral K-wire placement(Group I) is that it is free from the risk of an iatrogenic ulnar nerve injury[17].

In our study only one (5.55. %) patient had an iatrogenic ulnar nerve injury, fortunately it was neuropraxia and there was just parasthesia and numbness for 3 weeks without clawed hand and immediately cured after we remove the medial k- wire.

The use of ultrasound to minimize the risk of ulnar nerve injury during insertion of medial pin may be helpful however, it is technically demanding, and the expertise may not be available easily[18], so better to follow instructions intra-operative as mentioned above in inserting medial k- wire to minimize ulnar nerve injury.

Although the risk of iatrogenic peripheral nerve injuries following supracondylar fracture of the humerus has been reported ranging from 2% to 6% in various studies[19,20], in our study we observed this complication

in only5.5% patients, and this injury recovered at 3 weeks post-operative.

Fortunately, in this study we did not cause vascular injury , and there was no compartment syndrome post-operative as we exclude cases with impending compartment syndrome, in addition we did our study on patients within 72 hours as it is easy to reduce the fracture under fluoroscopy in one or two trials apposite to cases with delayed treatment as it will be difficult to close reduction and it may need more than one manipulation and many cases need open reduction and internal fixation and this is out of our patients.

In a study by M Julfiqar, Ajay Pant et al[13], only one case sustained compartment syndrome, and another study done by Yadagiri Sureder et al[15], no case of compartment syndrome was reported as post-operative complication.

Another complication we reported which is elbow stiffness , actually there were no difference between the two techniques as we report one case of stiffness in lateral pinning and one case in cross pinning , and both cases there was delay in removal of k- wires and pop because the family delayed to consult outpatient because of national holiday. Within 2 weeks both cases managed successfully with active physiotherapy. In comparism to other studies we report 2 cases 10.55% , while a study by M julficar,Ajay Pant, et al[13] , elbow stiffness was about 11.5%(4 patients), actually closed reduction and percutaneous pinning (lateral pinning or cross pinning) had less incidence to cause stiffness of the elbow joint in comparism to open reduction and internal pinning as there will be soft tissue dissection and damage.

Regarding heterotopic ossification , there were no such complication in our study post-operatively and this is can be explained as we did closed reduction and percutaneous pinning ,in addition we remove k- wires and pop cast in less than 1 month (4weeks) and start early physiotherapy and active exercises., this is again comparable to study done by H.K. Gupta, K.D. Khare, D. Chaurasia, et al[21], in which there were no heterotopic ossification complication reported postoperatively.

To evaluate our results, we chosed Flynn's modified over all rating (Table I). This is the most rigorous classification since any cubitus varus deformity is considered to be a poor result, whatever the function of the elbow.

According to this, we got excellent results 11 {55%} in group I (lateral pinning) while it was 13{72.22%} in group II(cross pinning), good results were 5{25%} in Group I, and 4{27.77%} in Group II, fair results 2{10%}in group I while it was 1{5.55%}in group II.

we got no poor results(no patient) 0% in Group II, while unfortunately we got 2 patients{10%} with poor results (complicated by cubitus varus deformity)in Group I.

The 2 patients with cubitus varus deformity in the Group I, were both type 3 Gartland supracondylar fracture, aged 6 years, 6.5 years , in the x- ray fellow up we see there were displacement of the distal fragment (medial tilt and rotation), and actually both cases the 2 lateral wires were close to each other and no enough space (more than 1 cm) between them.

The K-wires must be strictly parallel and separated by a distance of more than 10 mm. If the wires are positioned too closely, the mechanical construct is equivalent to a single wire construct and allows rotation of the distal fragment around the axes of the wires

In comparism to other study, M julficar,Ajay Pant, et al[13], (cross pinning) excellent results 24 {68.6%}, good 6{17%}, poor2{5.8%}, these results is near similar to our study results.

Other study by H.K. Gupta, et al[21] , (lateral pinning) , excellent results 17 { 68%}, good 8{32%}, Poor 0{0%}, again these results are comparable to our study results.

Conclusion

Closed reduction and medial-lateral percutaneous K-wire fixation is the treatment of choice for displaced pediatric supracondylar fractures of the humerus with extra precautions during medial wire insertion

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