

RESULTS OF INTERNAL FIXATION OF LATELY PRESENTED DISPLACED LATERAL CONDYLE FRACTURES OF THE DISTAL HUMERUS IN CHILDREN. IS THERE A STANDARD MANAGEMENT PROTOCOL?

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ABSTRACT

Background: Late presentation of lateral condyle fractures (LCF) of the distal humerus in children is not uncommon in developing countries due to variable causes. Open reduction and fixation of displaced unstable injuries is difficult due to the need for extensive dissection in the tissues and the newly formed callus putting blood supply of the distal fragment at risk of injury. The aim of this study is to evaluate the effectiveness of open reduction and fixation of lately presented fractures of the lateral condyle of distal humerus in children. **Study design:** a prospective study conducted in Banha university hospital from 2008 till 2014. **Patients and methods:** 21 children with displaced unstable lateral condylar fractures presented more than 3 weeks after injury for medical care. Open reduction - internal fixation was done by Kirschner wires. Patients were followed up for an average period of one year. Results were evaluated at final follow up according to Hardacre criteria. **Conclusion:** Open reduction – internal fixation of lately presented unstable displaced lateral condyle fractures of the distal humerus in children could achieve a high rate of union and a satisfactory clinical outcome upon preservation of the blood supply and anatomical reduction of the distal fragment.

Keywords: delayed presentation, elbow, internal fixation, lateral condyle, paediatric.

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INTRODUCTION

Fractures of the distal humerus lateral condyle in children are not uncommon (about 18% of distal humerus fractures). Improper management will result in multiple complications both early and late after the injury. Cubitus varus or valgus deformities, malunion, non-union, osteonecrosis of lateral condyle, joint stiffness, and tardy ulnar nerve palsy are common complications. Early diagnosis and proper fixation are mandatory to obtain a proper functional outcome. [1-4] Proper radiographic evaluation of suspected cases with three views (anteroposterior, lateral and internal oblique) is essential in all cases to detect posterolateral displacement that may progress to more displacement with underestimation of the injury on the

seemingly non-displaced lateral views. Ultrasonography is also useful in detecting subtle displacement in misdiagnosed cases. [5,7]

Controversy exists in published literature regarding the management of lately presented lateral condyle fractures (LCF) in children. There is no general agreement on a standard protocol for management of these fractures and authors argue about the effectiveness of different treatment modalities including supervised neglect and treatment of the sequela, fixation in situ, closed reduction and pinning, or open reduction and internal fixation. [8-12]

The current prospective study is reporting the results of open reduction and internal fixation of 21 displaced unstable LCF of humerus in children presented more than 3 weeks after trauma.

PATIENTS AND METHODS

Twenty-one child aged five to 11 years old with displaced unstable fractures of the lateral condyle of humerus (14 Milch type 1 and seven Milch type 2) presented more than 3 weeks after initial injury were treated with open reduction and internal fixation through the period from January 2008 till February 2014. There were 14 boys and seven girls.

Surgical technique: all cases were operated through lateral approach between extensor carpi radialis brevis and extensor digitorum communis. Careful anterior dissection was done in the fibrous tissue and callus with no posterior dissection to preserve the posterior soft tissue attachments and blood supply of the distal fragment (Figure 1). Aggressive periosteal stripping on the metaphyseal and condylar fragment sides was avoided to protect against bone overgrowth and prominence of the lateral condyle with union of the fracture. Reduction was done under direct vision and assured by palpation of the articular surface after excision of a small part of the anterior capsule of the joint at the fracture site with aid of manual pressure and a pointed reduction clamp applied on the fracture fragments anteriorly with the elbow extended to

relieve tension on the posterior soft tissues. Fixation was done by three 1.4 mm Kirschner wires. The Kirschner wires that could pass through the ossific nucleus of the capitulum allowed control of rotation and maintaining reduction without tension on the posterior soft tissue hinge. No bone graft was used in all cases. The wounds were thoroughly irrigated to remove any debris of soft tissue or bone callus before the wounds were closed in layers.

Postoperatively, a posterior splint was applied, it was removed for wound care and changed two weeks after surgery. The Kirschner wires were removed in outpatient clinic 6 weeks after surgery with evidence of radiological union, the posterior splint was removed and the child was allowed range of motion exercises.

The duration of follow up ranged from 12 to 18 months. The final outcome was assessed clinically by Hardacre criteria and radiologically by looking for malunion, non-union, prominence of lateral condyle, avascular necrosis of distal fragment or heterotopic ossification. Union of the fracture was defined by the presence of bone trabeculae crossing the fracture site.

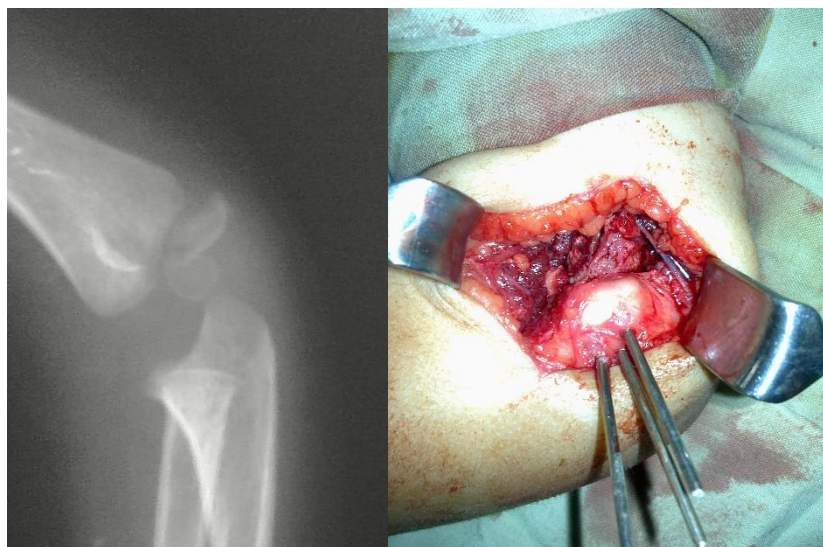


Figure.1: Displaced LCF (Left). Lateral approach with posterior tissues preserved after fixation with 3 Kirschner wires (Right)

RESULTS

The period of delay in presentation was 3-11 weeks after initial injury (average 7 weeks). Twelve cases were managed in another place in a cast after initial X-ray images showed a minimal displacement of the fracture and nine cases did not have a proper medical care due to the critical national situation and the repeated curfew through the period from 2011 till 2013. The mean age of patients at presentation was eight years with 14 males and seven females.

The functional results according to Hardacre criteria (Table 1) were excellent in eight cases (38%), good in 10 (47.6%) and fair in three (14.2%) due to joint stiffness in two cases (9.5%) due to noncompliance with the postoperative protocol and non-union in one case (4.7%) whose reduction necessitated more soft tissue dissection during surgery to mobilize and reduce the distal fragment. Pin-tract infection in one wire with loosening was noticed in 4 cases (19%) and was managed by meticulous pin-tract care and antibiotics after removal of the loose wire.

At the final follow up, the average range of elbow motion was 115 degrees in the excellent cases, 100-110 degrees in the good cases and less than 100 degrees in the three cases with fair outcome. The carrying angle ranged from three to 13 degrees with a mean of 8 degrees on the fractured side and 6 degrees on the non-injured side.

Union was achieved in the 18 cases with good to excellent outcome (85.7%) after 8-12 weeks (average 10 weeks) and in 13-18 weeks in two cases with fair outcome (9.5%). Prominence of the lateral condyle was noted clinically and radiologically in 11 cases with good to excellent outcome (52.3%) mostly due to subperiosteal bone formation during healing.

Due to the relatively small number of treated cases, statistical analysis of the results was constrained to percentages of the collected data.

Table 1. Hardacre criteria for evaluation of results of treatment of LCF.

EXCELLENT	Full range of motion Normal carrying angle Asymptomatic Complete fracture union
GOOD	Efficient range of motion/Extension lag < 15° Mild/Subtle deformity No neurologic/arthritis symptoms Complete fracture union
FAIR	Stiffness to a degree of disability Prominent deformity/alterd carrying angle Neurologic/arthritis symptoms Non-union or avascular necrosis

DISCUSSION

Management of displaced fractures of the lateral condyle of the distal humerus in paediatric patients is challenging because of the possibility of having subsequent complications due to misdiagnosis and delayed management, improper reduction and fixation, and injury of the blood supply of the distal fragment due to aggressive dissection during open reduction. Neglected LCF in children (more than 3 months after injury) remains a concern with misdiagnosed or mistreated cases occur in a relevant number of children, often require delayed management that may increase the complications rate. This complications rate is much lower in appropriately treated fresh fractures. The current study evaluates the outcomes of lately presented LCF (less than 3 months after injury) before the fracture is considered neglected non-united to avoid the possible complications of the technically demanding surgical management of the neglected non-union. [1,2,12]

Milch classified LCF of the distal humerus in children into two types; type 1 exiting into the trochleo-capitellar groove and type 2 exiting the trochlea making the elbow joint unstable. Weiss classified LCF according to the degree of displacement that will be reflected on the treatment

options into; type 1 (less than 2 mm displacement with articular congruity, type 2 more than 2 mm displacement with articular congruity, and type 3 more than 2 mm displacement without articular congruity). Displacement depends on intactness of the articular hinge. If the hinge is intact the condylar fragment is only tilted laterally while if the hinge is torn the fracture may be completely rotated up to 180° making closed anatomical reduction impossible. [2,5,7]

Controversy surrounds definitive management of lately presented LCF due to difficulty in reduction of the obvious displacement caused by the common extensors pull, mal-reduction of the articular surface, injury/early closure of the physis, and damage of the blood supply of the condylar fragment with extensive dissection during open reduction.

Previously several case series studies had reported bad results of surgical treatment of delayed cases more than two weeks after injury with subsequent non-union, malunion, avascular necrosis, and elbow stiffness. Surgical fixation of established non-union was also not recommended because it may not unite and stiffness is inevitable. [13-15] However, other studies had reported better results after proper selection of patient because of the rationale that non-union may cause pain, instability, loss of function and tardy ulnar nerve palsy thus recommended treatment of non-union as soon as possible after injury and before skeletal maturity although these complications may take several years to occur. [16-19]

Several studies recommended open reduction and internal fixation for lately presented LCF with certain precautions to avoid the complications of later interventions. Agarwal et al, reported good to excellent results in most cases treated with open reduction and internal fixation

through lateral approach with bone grafting without stripping of the posterior soft tissues to preserve the blood supply. [16] Shabir et al, recommended limited anterior dissection and cutting of anterior part of the capsule and synovial adhesions in order to achieve near anatomical reduction. [17] Roye recommended assessment of the functional range of motion after fixation of the condylar fragment to avoid subsequent tension on the posterior blood supply. [14] Andrey et al, recommended fixation of the condylar fragment in the best position that allows best range of motion (more than 120 degrees) and a near normal carrying angle. [18] Gaur et al, suggested making multiple pie-crusting incisions in the common extensor origin to better mobilize the displaced-rotated condylar fragment. [15] Launay et al compared immobilization with operative fixation for displaced fractures in 97 patients and reported that non-union was less in the surgically treated group. [19]

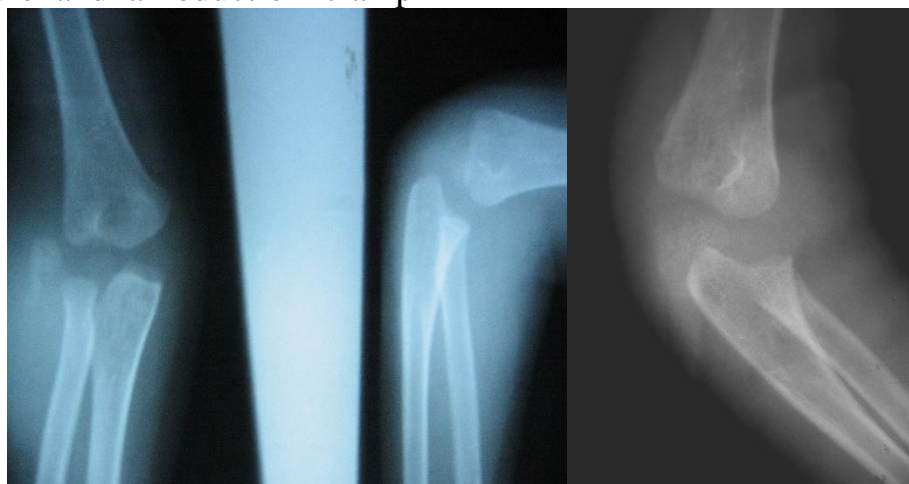
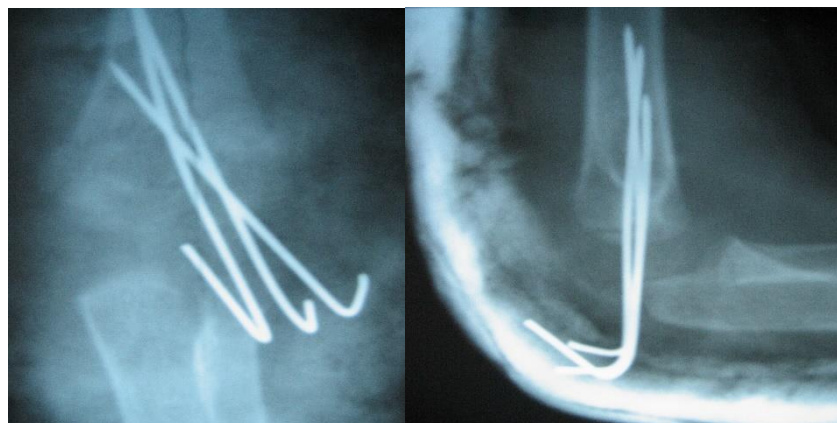
The main cause of avoiding surgery in lately presented LCF or established non-union among older studies was the probability of elbow stiffness, avascular necrosis of the condylar fragment and that established non-union may be asymptomatic. However, recent studies showed successful osteosynthesis or corrective osteotomies. The common symptoms with lately presented LCF are pain, stiffness, cubitus valgus, instability and may be early ulnar nerve symptoms. [5,11,17]

The method of fixation varies according to the size of the condylar fragment. Authors used two or three Kirschner wires with or without screws. Still the issue of rigidity of fixation and the possibility of infection with using the Kirschner wires alone is in concern. [20-24] Kirschner wires and cannulated screws were compared for

fixation of displaced LHF in children and concluded that the wires or the screws should be removed when there is evidence of fracture union in the radiographs, the wires can safely pass the ossific nucleus of the capitulum without damaging it, fixation with wires alone may carry the risk of pin tract infection and subsequent loosening , and the screws reduce the possibility of occurrence of lateral prominence of the lateral condyle and promote healing of the fracture by continuously stabilizing it but may have a negative effect on the ossific nucleus of the capitulum if passed through it. [23-28]

In the current study, the lately presented LCF were managed by careful open reduction through lateral (Kaplan) approach and limited anterior dissection to preserve the posterior soft tissue hinge; that carry the blood supply to the condylar fragment. Gentle reduction was done by manual pressure and a reduction clamp

and articular surface congruity was assessed by palpation and under vision. Three Kirchner wires were used for fixation. Stability of reduction was assessed by mobilizing the elbow in full range of motion. When union is confirmed on the follow up radiographic images, the wires were removed in outpatient setting. The results of the present study showed 38% excellent, 47.6% good, and 14.2% fair clinical outcome according to Hardacre criteria for evaluation of treatment of lateral condyle fractures. (Figure 2). Union was achieved in 20 cases (95.2%); 18 cases with good to excellent outcome at 8-12 weeks (average 10 weeks) and two cases with fair outcome at 13-18 weeks. One case (4.7%) with fair outcome showed non-union of the fracture at its final follow up 18 months after surgery. (Figure.3)

**A****B**

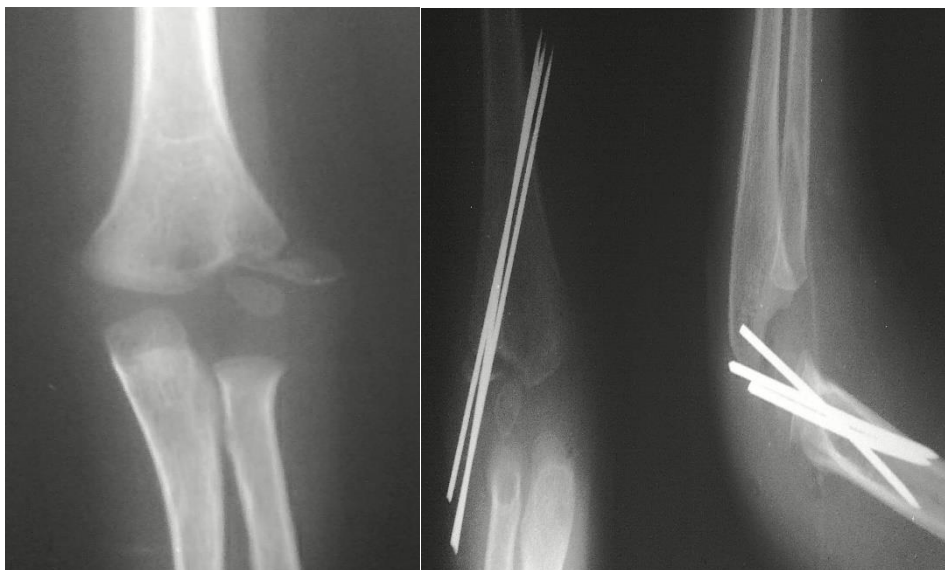


C



D

Figure.2: LCF presented after 29 days (A), Postoperative X-rays (B), X-rays after union with prominence of the lateral condyle (C), Range of motion one year after surgery (D)



A

B

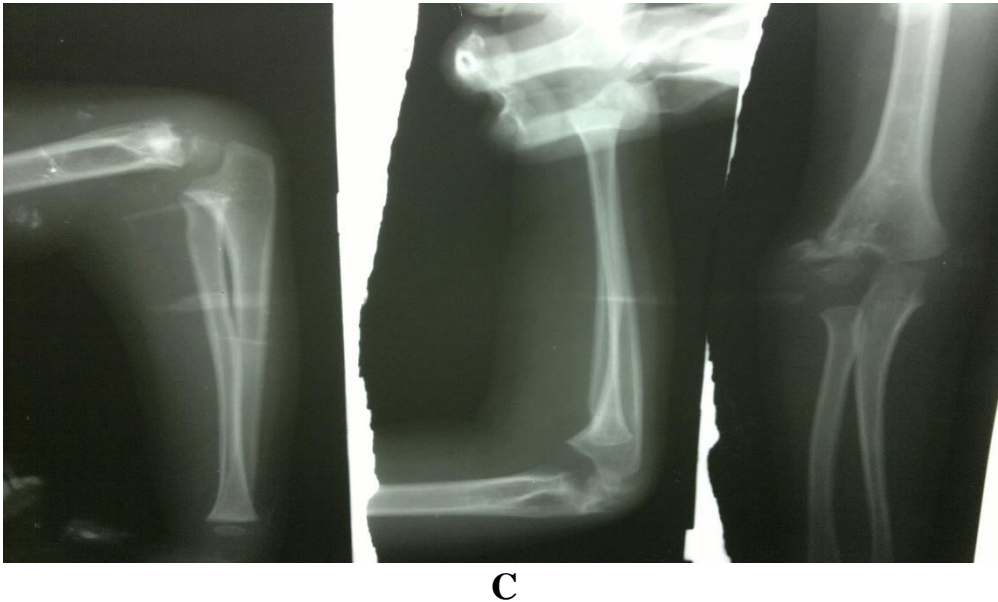


Figure.3: LCF presented after 42 days (A), Postoperative X-rays (B), Final follow up after 18 months show non-union (C).

Prominence of the lateral condyle was noted in 11 cases (52.3%) with good to excellent outcome and it had no implication on the range of motion and was asymptomatic.

The range of motion achieved at the final follow up was 115 degrees in the eight cases with excellent outcome, 100-110 degrees in the 10 cases with good outcome, and less than 100 degrees in the three cases with fair outcome.

The carrying angle in the good to excellent cases ranged 3-13 degrees (mean 8 degrees) in the injured side, compared to an average of 6 degrees on the non-injured side.

Pin-tract infection and loosening of one of the three wires was noted in four cases (19%) with good outcome and necessitated removal of the loose wire and meticulous care of the site of infection under antibiotic treatment keeping the other two wires till evidence of union was radiologically achieved. All sites of infection healed soundly and clean.

Results of Kirchner wires/screws osteosynthesis of displaced LCF were discussed in few studies. Baharuddin et al, reported excellent results in 19 out of 20 cases fixed with a screw. Bielak et al, used

2-3 wires for fixation in 15 cases and reported very good results in all cases. Loke et al, reported secondary displacement of the fracture after removal of the wires, excellent results with screws osteosynthesis in 28 out of 34 cases with lateral condyle overgrowth in 2 cases and cubitus valgus in 2 cases due to avascular necrosis. [26] Wirmer et al, compared fixation with screws and wires versus wires alone among 42 patients and reported excellent results in 35 cases with no non-union or change in the carrying angle, and fair results in 7 cases with 10 degrees flexion deficit and 10 degrees extension deficit; 4 fixed with wires only and 3 fixed with screws and wires. They concluded that the combined fixation with wires and screws is biomechanically more stable and with less complications than fixation with wires alone if the size of the distal fragment permits screw placement. [2] A study by Hasler et al, on 66 patients after an average follow up of 6 years showed that cases fixed with metaphyseal screw had symmetrical elbow carrying angle in comparison with the non-injured side. [3] No metaphyseal screws were used for fixation in the current study because the distal fragment was small in all cases

and would not be amenable for fixation with a screw to avoid any possibility of physeal injury and the need for a second surgery to remove the screw after union of the fracture.

The results of the current study are close to those of Agarwal et al, [16] Loke et al, and Wirmer et al, [2] but less than those of Baharuddin et al, [28] and Bielak et al; [25] this can be attributed to their smaller number of cases.

The present study showed poor correlation between patient's age, duration of late presentation, and limited pin tract infection with the functional outcome. Also, the type of fracture according to Milch classification was not strongly correlated with the final outcome. The case with non-union and fair outcome was a type 1 fracture. The degree of displacement at presentation showed a strong relation with the outcome. The 3 cases with fair outcome had marked displacement of the condylar fragment that necessitated more soft tissue dissection to achieve an anatomical reduction; this predisposed to non-union in one of them and stiffness in the other two.

The weakness points of this study are the relatively small number of patients and the relatively short period of follow up. The points of strength of the study are the early definitive treatment of the lately presented fractures which protects the child from having a more technically demanding surgeries after years for management of the subsequent late complications and that all cases were done by one surgeon through the same technique. More higher evidence studies are required to assess the long-term outcomes of this treatment modality. To the best of our knowledge till now, there is no general agreement on a standard protocol for management of those lately presented fractures and surgeons still argue around the question of fixing

those fractures upon presentation if late or to wait to treat the subsequent late complications, if happened.

CONCLUSION

The presented technique of limited anterior soft tissue dissection and fixation of lateral condyle fractures in children presented more than three weeks after injury may assure a high rate of union of these fractures with minimal complication. This would definitively treat these injures to avoid the surgically demanding techniques for management of late complications even after years. An advantage that will have positive implications on the patient's condition and the overall costs of the care.

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