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ORIGINAL RESEARCH

Functional outcome of open reduction and buried k wire fixation in lateral condyle humerus fracture in pediatric patients-1 year follow up

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ABSTRACT

Introduction: Lateral condyle humerus fractures in children require accurate diagnosis and treatment. Surgical options include K-wire fixation, with buried wires offering better stability and a lower infection risk compared to unburied wires, ensuring proper healing and reducing complications like nonunion or malunion.**Material and Methods:**This study evaluates 28 children (ages 4-12) with lateral humeral condyle fractures treated with open reduction and internal fixation between 2021-2022. Clinical outcomes were assessed after one year using Hardacre's criteria and Milch classification.**Results:** This study included 28 patients (ages 4-12) with lateral humeral condyle fractures who were followed for 1 year. Outcomes showed full range of motion in 25 patients, with minor extension lag in 3. One case had non-union requiring bone grafting and revision, and two cases had pin tract infections. No cases developed avascular necrosis.**Conclusion:** This study highlights buried K-wire fixation as effective for lateral condyle fractures in children, minimizing infection, improving stability, and preserving blood supply with minimal periosteal stripping to reduce avascular necrosis and non-union risks.

Key words: Lateral condyle humerus fractures, pediatric orthopedic surgery, buried k-wire fixation, clinical outcomes, avascular necrosis prevention

INTRODUCTION

Lateral condyle humerus fractures are a significant pediatric orthopedic injury, accounting for 10-20% of elbow fractures in children. These fractures result from indirect trauma, such as a fall onto an outstretched hand or direct force on the elbow[1]. The lateral condyle, located on the distal humerus, plays a vital role in maintaining elbow stability, facilitating joint articulation, and supporting normal upper limb function[2].

Diagnosing lateral condyle fractures can be challenging due to the subtle nature of some injuries on initial imaging and the complex anatomy of the pediatric elbow, with multiple ossification centers that evolve with age[3]. A delay in diagnosis or inadequate treatment can lead to complications, including nonunion, malunion, deformity, and stiffness, potentially causing long-term functional impairment[4].

The blood supply to the lateral condyle of the humerus is a critical factor in understanding the healing potential and risk of complications, such as avascular necrosis (AVN), following fractures. The lateral condyle is primarily supplied by branches of the radial recurrent artery and the posterior branch of the profunda brachii artery and periosteal vessels[5]. It is important to note that too much periosteal stripping per op around the condyle can damage this periosteal vessels leading to increase in changes of delayed or non-union and avascular necrosis[6]. The lateral condyle's blood supply(Figure 1) is relatively tenuous

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compared to other parts of the humerus. Disruption of these vessels during injury or surgical intervention increases the risk of avascular necrosis[7].

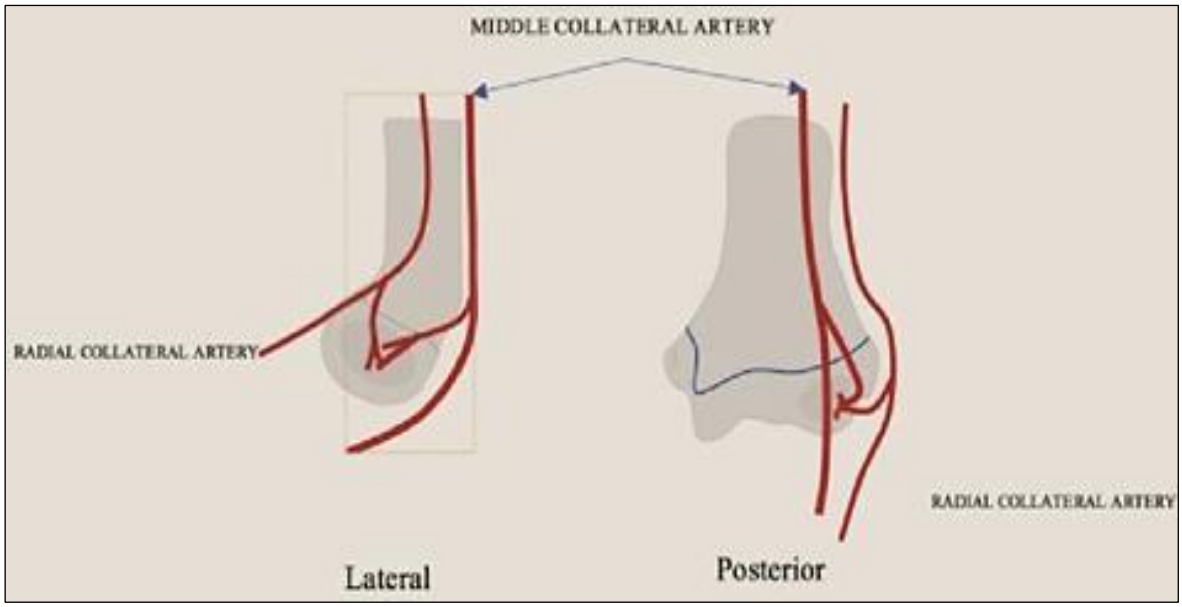

Fig 1:Blood Supply of Lateral Condyle Humerus

The elbow joint is a complex hinge-type synovial joint that connects the upper arm to the forearm, enabling a wide range of motion and essential functions for daily activities.The elbow acts as a hinge joint, primarily between the humerus and ulna, allowing 0-150° of flexion/extension[8].The proximal radioulnar joint allows approximately 85° of supination and 75° of pronation.During lifting or pushing, the joint bears substantial compressive and tensile forces.The trochlea and olecranon process provide a stable articulation, while ligaments counteract varus and valgus stresses[9].The congruency of the bony surfaces and ligamentous support work together to maintain stability throughout the range of motion.

Management strategies range from conservative treatment with immobilization in minimally displaced fractures to surgical intervention for displaced or unstable fractures. However many authors suggest that this is a fracture of necessity as there as chances of non-union and avascular necrosis.Malunion is common in patients who were untreated,mistreated, which may result in deformity in the elbow, loss of motion, degenerative arthrosis, and late ulnar nerve compression[10].Operative management can be done by using K wires or screw fixation. Screw fixation provides strong stability but can damage small blood vessels around the bone (periosteal vessels) and the growth plate in children, which may increase the risk of the bone not healing properly. K-wires, on the other hand, can be used in two ways: buried under the skin or left exposed (unburied). Unburied K-wires are convenient because they can be removed easily in a clinic without the need for a second surgery, saving time and money[11]. However, exposed wires carry a higher risk of infection at the site where the wire enters the skin, which could lead to deeper infections. To reduce this risk, unburied wires are typically removed after about four weeks, but this may not always give the fracture enough time to heal securely[12]. In contrast, buried K-wires are less prone to infection since they are fully under the skin and can stay in place until X-rays confirm that the bone has fully healed. Supracondylar fractures are typically treated with closed reduction and percutaneous pinning because the fracture site is away from the joint surface, and reduction can often be achieved without directly visualizing the fracture[13]. The periosteumis often intact and helps guide realignment. In contrast lateral condyle humerus fracturesare intra articular and need to be treated by open reduction with K wire fixation with K-wire burial preferably as if this fracture is not properly reduced by close reduction and percutaneous pinning there are chances of non-union or malunion. In our study we will give preference to buried K-wires[14].

This article aims to provide a comprehensive overview of lateral condyle humerus fractures in children, focusing on their epidemiology, clinical presentation, diagnostic approaches, management options, and prognosis to guide effective treatment and minimize complications[15].

MATERIALS AND METHODS

28 patients(13 girls and 15 boys)were treated by open reduction and internal fixation in our tertiary care hospital over a time period of 1 years for lateral humeral condyle fractures. Patients included in the study were patient from age group 4 to 12 years. Fracture was close with normal distal neurovasculature. Patients not meeting the above age group criteria and patients having concurrent other

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injuries or fracture were excluded from this study. Out of 28 patients 26 were admitted and operated on the same day. 2 patients had fever and cough on the day of injury and were operated after a couple of days after getting anesthetic fitness. Per op procedure was done in lateral position under brachial block under torniquet control under all aseptic conditions. The K-wire configuration for this surgical procedure involves the placement of two K-wires. The first K-wire, measuring 1.5,1.8 or 2.0 mm depending on the age of patient and bone thickness, is inserted parallel to the joint line, starting from the center of the capitellum and advancing into the medial trochlea. The second K-wire is placed behind the first and advanced along the lateral column of the humerus, providing additional stability to the fracture fragments. This configuration allows for secure fixation and proper alignment of the bone as the K wires go perpendicular to the fracture line giving good fixation, promoting optimal healing and minimizing the risk of complications.Reduction of fracture and especially articular margin was confirmed clinically as well as under fluoroscopy via anteroposterior and lateral views. Then K wires were bent and buried. Burial was not done extensively and bit of impingement was preferred as K wire removal surgery becomes easier and may be performed under local anaesthesia or sedation.Post op care was given in form of above elbow slab for 3 to 4 weeks with oral antibiotics and oral analgesics.After removal of slab active and passive elbow range of motion exercises were started in these patients.K wire removal was done between 3 to 6 months' timepost-surgery.The final clinical examination of cases were performed after one year in average. At the time of follow-up elbow radiographs were taken as Ap and Lateral views and carrying angle was measured. Left elbow was involved in 16 patients and right elbow in 12 patients.For evaluation of fractures, Milch classification(Figure 2) was used.

Stage	Definition	Stability
Stage 1	less than 2 mm of displacement limited fracture line within the metaphysis	stable
Stage 2	less than 2 mm displacement with lateral gap	indefinable stability
Stage 3	less than 2 mm displacement with gapping as wide laterally as medially on any of the 4 views	unstable
Stage 4	greater than 2 mm displacement without rotation of the fragment on any of the 4 views	Unstable
Stage 5	greater than 2 mm displacement with rotation of the fragment on any of the 4 views	unstable

Fig 2:Milch Classification

Patients were evaluated after aoneyear monitoring period. During the final examinations, all patients were interviewed and a thorough examination was performed. Each patient was examined by the same surgeon. Clinical outcomes were evaluated according to the criteria by Hardacre *et al*. (Figure 3) for the lateral humeral condyle fractures.

Score	Range of Motion	Carrying Angle	Symptom
Excellent	Full range of motion	Normal carrying angle	No symptom
			Complete healed fracture
Good	Efficient range of motion	Mild and subtle deformity	No arthritis or neurological symptom
	Loss of extension less than 15 degrees		Completely healed fracture
Poor	Loss of motion to the extent of disability	Alteration of the carrying angle	Arthritis or neurological symptom
		Permanent deformity	Non-union or avascular necrosis

Fig 3:Hardacre Criteria

The results were rated as excellent, good and poor.

PROCEDURE

The procedure begins with preparation under aseptic conditions, utilizing a brachial block for

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anesthesiawithout a tourniquet. The patient is positioned laterally with their arm supported on an arm post. A skin incision is then made on the lateral side of the elbow, and the posterolateral surgical approach (Kocher's or Kaplan's method) is used to access the distal humerus.

Careful tissue handling is crucial, involving incision and retraction of the skin, subcutaneous tissue, and muscle fascia while minimizing periosteal stripping. The fracture site is exposed, and reduction techniques such as direct hand manipulation, temporary K-wire, or small towel clamp/pointed forceps are employed. A blunt Hohmann retractor is used to visualize the medial cartilage fracture line, ensuring precise alignment of the fragments.

Once reduced, the fragment is initially stabilized with pointed forceps. A 1.6 or 2.0 mm K-wire is then inserted parallel to the joint line, starting from the center of the capitellum, using an oscillating drill to prevent heat damage. A second K-wire is placed behind the first, advancing along the lateral column of the humerus.A third K wire may also be used along the lateral column for additional stability.

The K-wires can either be buried under the skin for greater stability, requiring a second surgical procedure for removal, or left exposed for easier removal with a higher infection risk. Finally, the wound is thoroughly irrigated and closed layer by layer to complete the procedure.

RESULTS

28 patients were selected for the study. The ages of the patients ranged between 4 and 12 years with mean age of 7.4 years. There were 15 boys and 13 girls. The right elbow was affected in 12 of the cases whilst the left was involved in 16. None of the cases had bilateral injury.

Most of the patients were followed up for between 8 to 12 months after operation. One patient developed a minor degree of mal-union (cubitus valgus) on account of loose K-wires. One patient developed non-union with cubitus valgus after open reduction and internal fixation for Milch stage 5(figure 2)fracture at the age of six years, using the lateral approach. None of the cases developed avascular necrosis. One patient had ulnar nerve injury which was preop and its full recovery was noted on one year follow up. On follow up, 25 children regained full range of elbow motion. Three children developed about 10° of elbow extension lag but with full flexion and no functional disability. Out of 28 cases, there was only one case with a minor degree of mal-union on account of loose K-wires and one case of non-union following open reduction and internal fixation. In practice the result was unsatisfactory in only one case with non-union.

The child who suffered from non-union of the fracture and needed bone grafting and revision of internal fixation developed persistent elbow stiffness with a range of motion between 45° (extension lag) and 120°.

We had two cases of pin tract infection in these 28 cases, but no deep infection was encountered. The infection in these two cases cleared after removal of the K-wires.

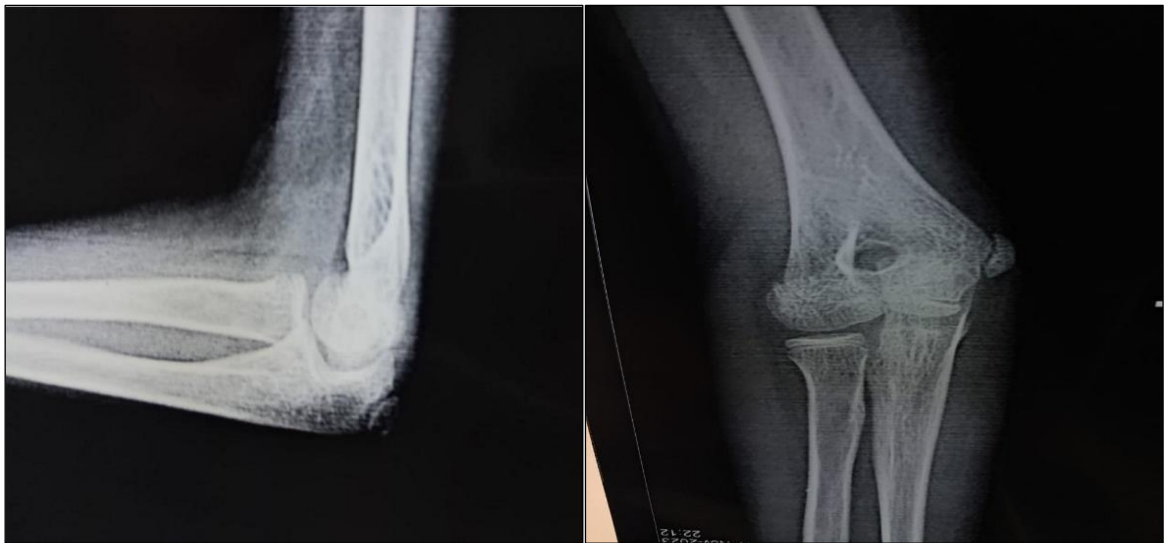

Fig 4: AP and Lateral views of preoperative x-ray of a 8 year old male child with lateralcondyle humerus fracture

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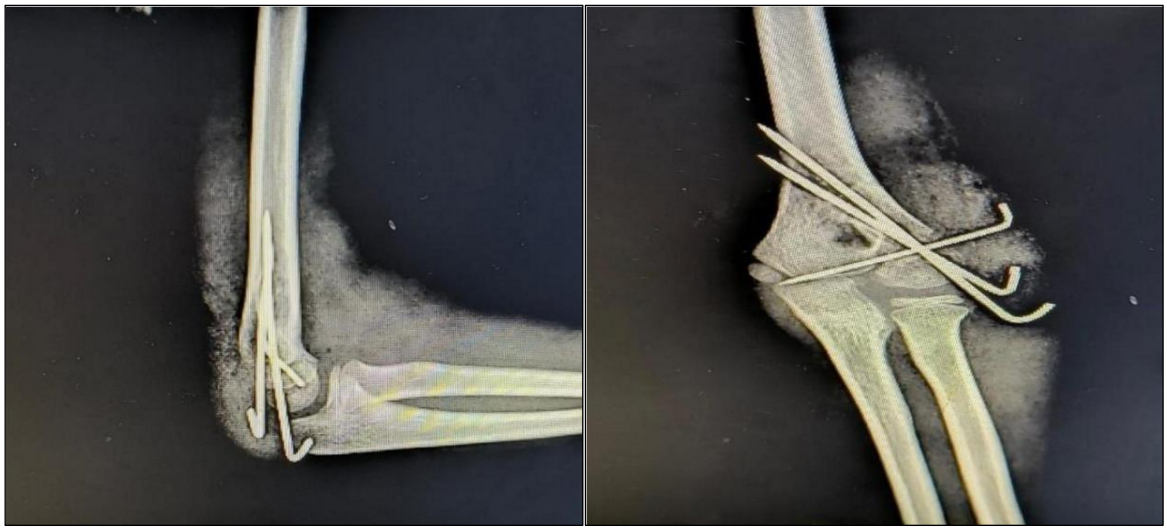

Fig 5: Postoperative AP and lateral views

Fig 6: Healed scar mark at 12 month follow up

Fig 7: Complete elbow range of motion at 12 month follow up

DISCUSSION

Lateral condyle fractures of the humerus in children can be challenging to manage due to the potential complications they pose, such as delayed union, non-union, malunion, or deformities. These fractures often occur near the growth plate (Salter Harris classification type IV), which makes precise treatment crucial to avoid long-term issues[16]. To prevent complications, experts generally recommend surgical intervention, even in cases where the fracture appears minimally displaced or undisplaced.Our study shows that treating displaced lateral humeral condyle fractures with open reduction and K-wire fixation followed by burial produces excellent results with no

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major complications[17]. It is well-established that reducing and stabilizing displaced fractures is important. However, there is some debate on the best surgical approach. One question is whether open reduction internal fixation (ORIF) or closed reduction internal fixation (CRIF) is better for these fractures. Some experts argue that CRIF can often work effectively and avoids the risks of ORIF, such as soft tissue damage[18]. For example, Song *et al*. reported success with CRIF in 73% of cases, but ORIF was still needed in some complex fractures, especially when surgeon experience was limited.

In our study, we treated 28 cases with ORIF and achieved union in all cases with no avascular necrosis and only one case of delayed healing. This supports using ORIF for displaced fractures.

Operative management can be done by using K-wires or screw fixation. Screw fixation provides strong stability but can damage small blood vessels around the bone (periosteal vessels) and the growth plate in children, which may increase the risk of the bone not healing properly. K-wires, on the other hand, can be used in two ways: buried under the skin or left exposed (unburied).Our study was compared with study of Qin *et al*. which suggested that the use of unburied K-wire fixation for treatment of lateral condyle distal humeral fractures in children does not increase the total infection rate, superficial infection rate, reoperation rate, or complications, but use of unburied K-wire fixation has the benefit of early extraction and impartial cost savings[19]. However contrary to that we found that exposed wires carry a higher risk of infection at the site where the wire enters the skin, which could lead to deeper infections. To reduce this risk, unburied wires are typically removed after about four weeks, but this may not always give the fracture enough time to heal securely. In contrast, buried K-wires are less prone to infection since they are fully under the skin and can stay in place until bone has fully healed.Also, burial of K-wiresprovides the surgeon an extra benefit of early mobilisation[20, 21]. There is also delayed removal of K wires (3 to 6 months) contrary to unburied cases hence reducing the chances of delayed union and premature removal.There is also decreased chances of skin erosion. However, there are chances of implant loosening and backout which may lead to increased chances of skin necrosis, erosion, infection and need for early implant removal[22].

The study also reported no infections related to the use of K-wires, a common concern with this method. However, one patient did developcubitus valgus deformity[23]. These deformities are often due to incomplete realignment of the bone fragments during surgery or damage to the growth plate at the time of injury[24].

Surgeons in this study prioritized preserving the surrounding soft tissues during the procedure to protect blood flow to the bone and minimize complications like avascular necrosis (bone tissue death due to poor blood supply)[25] Minimal soft tissue dissection was performed to reduce these risks. The fractures were realigned anatomically, and two K-wires were used for fixation in all cases. This approach allowed for stable fixation and good functional recovery[26].

This study has certain limitations. The sample size is relatively small, as this type of fracture is uncommon, and many patients were lost to follow-up. Additionally, the retrospective nature of the study makes it less reliable compared to a prospective study, which could provide more robust and conclusive results[27].

CONCLUSION

In conclusion, this study shows that using buried K-wire fixation to treat lateral condyle fractures in children leads to excellent results. While buried wires require a second surgery for removal, the benefits outweigh this drawback. Buried K-wires lower the risk of infection, provide better stability, and reduce the chances of the wires becoming loose or loss of reduction compared to unburied wires. Also per op periosteal stripping of lateral condyle should be as minimal as possible as it preserves the periosteal blood supply and reduces chances of avascular necrosis as well as non-union.

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