Original Article

Management of Neglected Lateral Condyle Fracture of Humerus
A Comparison between Two Modalities of Fixation

Rahul Ranjan, Abhinav Sinha, Naiyer Asif[1], Syed Ifthekar[2], Ashish Kumar[1], Suresh Chand

Department of Orthopaedics, Lady Hardinge Medical College, [2]Department of Orthopaedics, Hindu Rao Medical College, New Delhi, [1]Department of Orthopaedics, Jawaharlal Nehru Medical College, AMU, Aligarh, Uttar Pradesh, India

Abstract

Background: Implant for fixation of neglected fracture lateral condyle humerus remains an issue of controversy. This study compares the clinical and radiological outcome of fixation with Kirschner wire (K-wire) and with cancellous screw (CS) in neglected fracture lateral condyle humerus. **Materials and Methods:** 42 patients of neglected lateral condyle humerus fracture, treated either by open reduction and internal fixation (ORIF) with K-wire or ORIF with CS were included in study. The comparisons were made in term of slab immobilization time, union time, improved range of motion (ROM), final achieved carrying angle, and functional outcome measured by Liverpool Elbow Score (LES). **Results:** There were 22 patients in Group I with mean age 7.8 years and 20 patients in Group II with mean age 7.3 years. Mean delay in presentation was 12.9 versus 15.6 weeks ($P > 0.05$). Mean followup was 26.9 versus 26.7 months. Mean duration of immobilization was 11.6 versus 9.4 weeks ($P < 0.001$). Improved carrying angle was 6.8° versus 9.7° ($P < 0.05$). Mean gain in ROM was 17.7° versus 27.5° ($P < 0.05$). Mean LES was 8.15 versus 8.18 ($P > 0.05$). Premature closure of physis was observed in two patients. Pin tract infection was seen in three of Group I ($P > 0.05$). **Conclusion:** There was no difference in LES, irrespective of implant used. Screw was better in terms of duration of slab, improvement in carrying angle and ROM.

Keywords: *Cancellous screw, fracture lateral condyle of humerus, Kirschner wires, Liverpool Elbow Score*

MeSH terms: *Humerus; fracture fixation; osteosynthesis*

Introduction

Fracture of lateral condyle (LCF) of humerus is neglected many a time due to parents/clinician negligence.[1] The diagnosis can be difficult both radiologically and clinically, with the loss of function occurring, due to an intraarticular extension. Incorrectly treated lateral physeal injury may remain unnoticed until months or years after the initial injury.[2] LCF is known for complications such as nonunion, tardy ulnar nerve palsy, hypertrophic scar, avascular necrosis of ossific nucleus, malunion and angular deformity.[3-6]

In late presentation, there is a debate between osteosynthesis of the fracture fragment or correction of deformity with osteotomies and anterior transposition of ulnar nerve or sometimes combination of both procedures.[7-11] The majority are in favor of ostosynthesis early to prevent progressive valgus deformity in a growing child and enable the condyle to take part in the growth of lower humerus.[8,12] The commonly used implants for fixation are Kirschner wire (K-wires) and cannulated screw (CS). However, there has been no reports published, comparing clinical outcome following CS and K-wire in neglected LCF.

This study compares neglected LCF treated with K-wire, or with CS. The fracture was considered 'neglected' in this study if presented after 4 weeks of injury. The comparison was made in term of slab immobilization time, union time, improved range of motion (ROM), final achieved carrying angle and functional outcome measured by Liverpool Elbow Functional Score (LES).

Materials and Methods

42 patients with neglected LCF treated with two modalities of fixation (K-wire or screw) between May 2010 and April 2013 were included in this prospective study. The injured limb was clinically examined for pain, deformity, instability mobility of fragment and neurovascular status.

How to cite this article: Ranjan R, Sinha A, Asif N, Ifthekar S, Kumar A, Chand S. Management of neglected lateral condyle fracture of humerus: A comparison between two modalities of fixation. Indian J Orthop 2018;52:423-9.

Address for correspondence:
Dr. Rahul Ranjan, Department of Orthopaedics, Lady Hardinge Medical College, New Delhi - 110 001, India. E-mail: drrahulranjan2005@gmail.com

Access this article online

Website: www.ijoonline.com

DOI: 10.4103/ortho.IJOrtho_319_16

Quick Response Code:

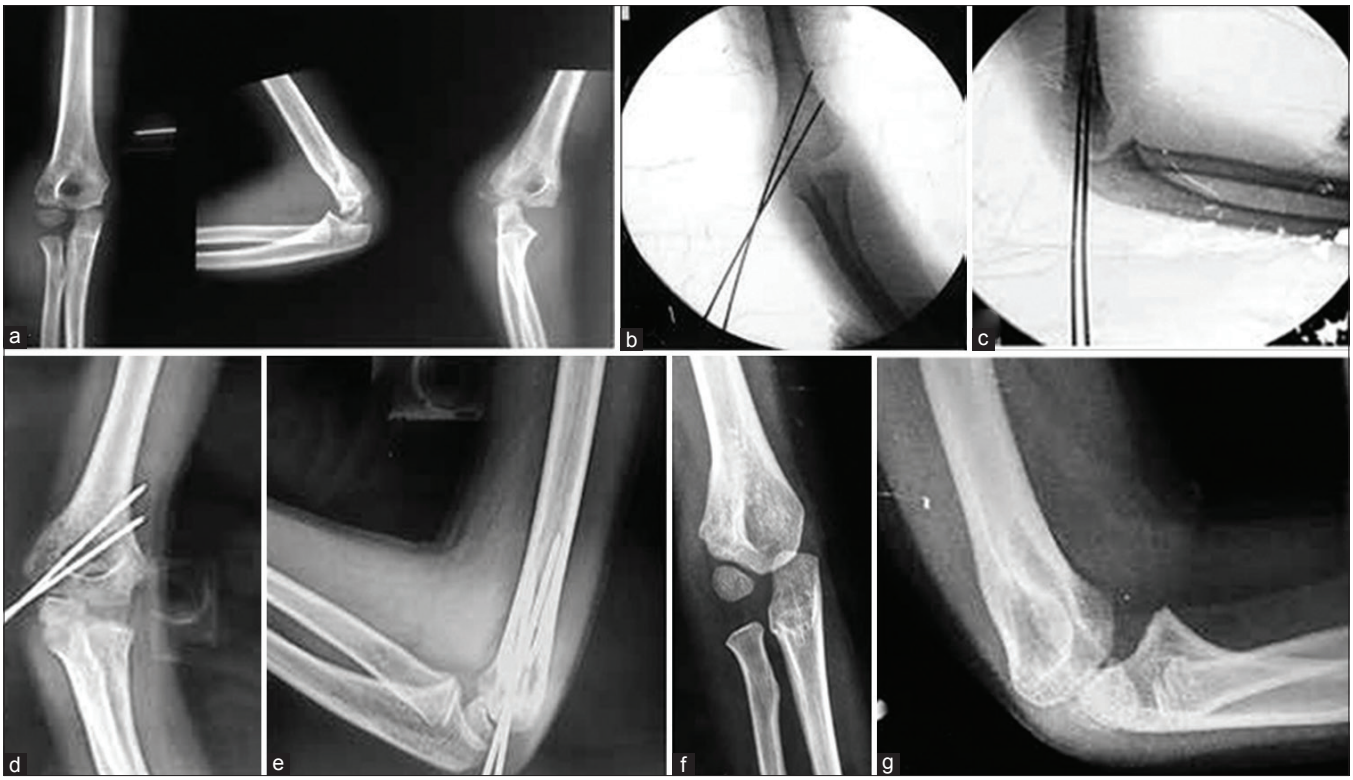

Figure 1: (a) Plain radiograph of a 5-year-old patient with lateral condyle fracture planned for open reduction and internal fixation with Kirschner wire. It is to be noted that fracture is not appreciable in anteroposterior view but well appreciated in internal-oblique view. (b and c) Anteroposterior and lateral postreduction fluoroscopic view showing fixation with 2-K wires (d and e) Anteroposterior and lateral views of the elbow of same patient after 9 weeks, showing union of fracture (f and g) Anteroposterior and lateral view of elbow after 2 months of Kirschner wire removal

Table 1: Difference between the two groups in term of different parameters

Parameter	Group I (fracture fixed with Kirschner wire)	Group II (fracture fixed with CS)	*P*
Number of patients	22	20	
Male	13	12	>0.05 (0.9)
Female	9	8	>0.05 (0.9)
Right	14	7	>0.05 (0.06)
Left	8	13	>0.05 (0.06)
Mean age (years)	7.8	7.3	>0.05 (0.3)
Mean delay in presentation (weeks)	12.9	15.6	>0.05 (0.06)
Lateral condyle prominence	2	3	>0.05 (0.6)
Cartilage damage (seen intra-operatively)	3	2	>0.05 (0.7)
Implant through ossific nucleus of capitulum	8	4	>0.05 (0.2)
Overgrowth of condylar fragment (seen intraopertively)	19	16	>0.05 (0.6)
Mean followup (months)	26.9	26.7	>0.05 (0.8)
Duration of POP in postoperative period (weeks)	11.6	9.4	<0.001
Carrying angle at final followup (°)	6.8 (*n*=14)	9.7 (*n*=15)	<0.05 (0.002)
Gain in ROM at final followup (°)	17.7	27.5	<0.05 (0.02)
LES	8.15	8.18	>0.05 (0.9)
Patients with LES <8	7	6	>0.05 (0.9)
Premature closure of physis	1	1	>0.05 (0.9)
Infection	3	0	>0.05 (0.08)

CS=Cancellous screw, POP=Plaster of paris, ROM=Range of motion, LES=Liverpool Elbow Score

Anteroposterior and lateral view radiographs were taken in all patients. Sometimes, when fracture was not clear then internal oblique view was taken [Figure 1a]. Patients were treated by open reduction and internal fixation (ORIF) with K-wire [Figure 1a-g] or 4-mm CS [Figure 2a-g]. We used ipsilateral ulnar graft [Figure 2d] or iliac crest bone

Figure 2: (a, b) Anteroposterior and lateral views of an elbow of a 7-year-old patient showing lateral condyle fracture (c, d) Anteroposterior and lateral views after procedure (e) Four weeks after surgery, it shows osteopenia at fracture site (f and g) complete union occurred as seen in subsequent followup anteroposterior and lateral x-rays of elbow joint

graft (BG) to promote osteosynthesis in all patients. The patients who were to be treated by ORIF with K-wire were labelled as Group I and those with CS were assigned in the Group II. The group allocation was done using simple random sampling.

The procedure and prognosis were explained to the parents in detail, and then a written consent for surgery was obtained. Following general anesthesia, patient was shifted to the operation table. A single dose of intravenous prophylactic antibiotic was administered half an hour before skin incision. We used Kocher incision to perform surgical procedure under tourniquet control. After proper exposure of the operative site, the humeral metaphyseal area was nibbled to create space for easy realignment/rotation of fragment over the posterior soft tissue stripping. Sometimes, because of overgrowth of condylar fragment, it was difficult to identify the articular area from the metaphyseal region of the fragment [three patients in Group I (delay period was 12, 14, and 10 weeks, respectively) and two patients in Group II (delay period was 11 and 13 weeks, respectively)]. In these cases, search for overhang cartilage was done, and excess overhanging cartilage was then trimmed to get bleeding metaphyseal bone. Ipsilateral ulnar graft or ipsilateral iliac crest BG was retrieved and was kept in between fracture fragments. Finally, an attempt was made to achieve maximum possible reduction and reduction was maintained either using K-wires or CS. POP slab was continued till there was callus formation radiologically. The union was assessed clinicoradiologically initially at 2 months and thereafter every month. Elbow mobilization was started as soon as there was radiological evidence of union. The results were evaluated in the terms of slab immobilization time, union time, improved ROM, final achieved carrying angle and functional outcome measured by LES.The functional score was evaluated using LES which consists of deformity, instability, ROM, strength and ulnar nerve assessment. Statistical analysis was done using applicable standard tests.

Results

There were 22 patients in Group I and 20 patients in Group II. The mean age of the patient at the time of presentation was 7.8 years (range 4.5–11 years) in Group I and 7.3 years (range 5–10.5 years) in Group II ($P = 0.3$). 13 patients in Group I and 12 patients in Group II were male ($P = 0.9$). The right elbow was involved in 14 patients in group I and 7 patients in group II ($P = 0.06$). There were total 12 patients who had been to osteopath

before presentation, out of which 7 were in group I and 5 in group II. The average delay in presentation was 12.9 weeks (range 6–22 weeks) in the patients of group I and 15.6 weeks (range 8–20 weeks) in patients of group II (P = 0.06). According to Jacob's classification, in group I, there were 17 of Type II and 5 of Type III; in group II, 13 of Type II and 7 of Type III. The elbow range of motion was recorded in each group, there were 37 patients with average flexion deformity of 19.5° (range 10–90^0) and hence deformity in the coronal plane was not estimated in those patients. There were 7 patients who had pain at the time of presentation, 5 had swelling of lateral aspect of the elbow. There were 4 patients who had cubitus valgus deformity in Group I but it was not estimated in Group II as all of them had flexion deformity at the time of presentation, prominence of lateral condyle region was seen in 2 patients in the Group I and 3 patients in Group II (P = 0.6). Ulnar nerve dysfunction was not found in any patient preoperatively [Table 1].

The numbers of K-wires were two in 18 patients and more than two in 4 patients. It was preferred to pass wire from metaphyseal fragment, and it was passed in 14 patients. In the rest 8 patients, one or two wire was passed through the ossific nucleus of capitulum. ORIF with 4-mm partially threaded CS was done in 20 patients (Group II). Two screws with or without washer were used in all cases. The screws were passed through metaphyseal fragments in 16 patients and through the ossific nucleus of capitulum in 4 patients (P = 0.2). BG was placed in all patients of either group to enhance osteosynthesis in between the fracture fragments The overgrowth of condylar fragment and lower humeral metaphysis fragment in 19 patients of Group I and 16 patients of Group II was observed (P = 0.6). Intra-operative cartilage damage was seen in 3 patients of Group I and 2 patients of Group II (P = 0.7) [Table 1]. Postoperative above elbow POP slab was applied in all patients of both groups in 90° of flexion or in maximum possible flexion. The average duration of slab in the patients of Group I was 11.6 weeks (n = 22, standard deviation (SD) =1.8; range 9–16 weeks) and in the Group II was 9.4 weeks (n = 20, SD = 1.4; range 9–12 weeks). The duration of POP slab application in K-wire group was significantly more than CS group (P < 0.01). After removal of slab active and passive range of motion was started. The average gain in ROM with respect to preoperative value was 17.7° (n = 22) in Group I and 27.5° (n = 20) in Group II. The difference in ROM was significantly better in the Group II with P = 0.02 (<0.05) [Table 1].

Mean duration of followup was 26.9 months (range 24–32 months) in the Group I and 26.7 months (range 24–30 months) in the Group II (P = 0.8). According to LES, the average score in the Group I was 8.15 (n = 22, SD = 0.8, range 6.6–9) and in the Group II was 8.18 (n = 20, SD = 0.8, range 6.8–9.1). The difference in the score was not statistically significant [P = 0.9 (<0.05)]. There were 7 patients who had LES <8 in the Group I and 6 in the Group II (P = 0.9). Union was achieved in all cases of both groups. There were two cases of premature fusion of physis, one from either group (P = 0.9) [Figure 3]. In spite of the premature closure of physis the LES was more than 8 (8.2, 9). At the end of followup, 8 patients in Group I and 5 patients in Group II had residual flexion deformity, and hence, we were not able to measure the carrying angle. The average carrying angle in rest of the patients was 6.8° (n = 14, SD = 2.8) in Group I and 9.7° (n = 15, SD = 1.3) in Group II. There was a significant difference in mean carrying angle; Group II had better carrying angle with P < 0.05 (0.002) but none of the patients in either group had varus deformity beyond rectus [Table 1].

In all patients K-wire was kept outside the skin, of which 3 had infection (P = 0.08). One of them had severe infection and premature removal of wire was done at 4th postoperative weeks [Figure 4]. Culture from the wire showed *Staphylococcus aureus*. Infection subsided after

Figure 3: Plain radiograph showing premature closure of capitellar physis

Figure 4: Radiograph of the patient whose Kirschner wire was removed due to infection. Fracture united finally

administration of intravenous antibiotics. We did not find the displacement of fracture fragment after removal of wire. In rest of two infected patients, the infection was mild, and it subsided after oral antibiotic, wire in these patients was kept *in situ*.

Discussion

Although LCF in children is very common, there are many reasons of its delayed presentation to orthopedic surgeons like lack of awareness of the parents, financial constraint, health care facilities are not available, fractures are being managed by osteopaths.[13] In our study, there were total 12 patients who had been to osteopath and 4 referred to us from primary health center when they noticed cubitus valgus deformity after initial treatment.

The well-accepted treatment modality of this fracture in acute cases is ORIF.[7,10,14] When these fractures present 12 weeks postinjury, the majority are in favor of conservative management to avoid the stiffness of the elbow, avascular necrosis of the fragment, and difficulty in reduction.[7,9,15] Achieving anatomical reduction is often not possible because of remodeling of the fracture fragment, sclerosis and smoothening of the fracture line and new bone formation. For these various reasons, in long standing untreated nonunion, difficulty occur in the reduction of the fracture fragment. In case of highly displaced fracture, it sometimes becomes very difficult rather impossible to bring the fragment into normal position without violating the soft tissue attachments on the displaced fragment. As extensive soft tissue stripping may later result in avascular necrosis of the fracture fragment, and hence many recommend that these fractures should be left alone.[7,16] It is in between 3 and 12 weeks of presentation that falls under gray zone of the treatment modality. If these fractures are treated nonoperatively, the possible complications are malunion, nonunion, instability of the elbow joint, stiffness, cubitus valgus/varus, and tardy ulnar nerve palsy. Whereas, if these fractures are treated operatively, precarious blood supply to the fractured fragment due to excessive stripping of the soft tissues, may later results in avascular necrosis of the fracture fragment.[7,15] Despite the inherent risk associated with the surgery, there are reports in the literature of successful outcomes of ORIF of these established nonunion cases.[8,12,17]

Regarding implants for fixation of fracture fragment, K-wires and screws are the most commonly used implant. Although comparison between these two implant in acute cases have been done in literature by Li and Xu in 2012, we have not found any literature regarding the comparison in neglected cases. Li and Xu found no significant difference in functional outcome after reduction and fixation with K-wires or CS in acute cases of lateral condyle fracture. In their study, they passed screw through the ossific nucleus of the capitulum if there were no enough metaphyseal bone for screw purchase.[18] In our cases, the screw was passed through physis in 6 cases and their clinical outcome LES was more than 8, without having significant deformity.

Although, K-wire is more common implant than screw for internal fixation, a plaster cast is required for longer duration,[19-21] whereas the screws provide more continuous and secure stabilization for fracture than K-wires[13,22] and patient can initiate elbow physiotherapy early and have better functional outcome. In our study, the average duration of immobilization in K-wire fixation was significantly longer than its comparative screw fixation group. Saraf and Khare used K-wires in majority of the neglected cases but they were of the opinion that fixation by screw is more secure; however, it was not possible to use screw fixation in the majority of their cases due to the disposition of the fracture line and due to apprehensions regarding damage to the physis. In fracture of more than 3 weeks, retaining the implants for at least 6 weeks is recommended since premature removal of the wire can lead to displacement of the reduction.[13] In this study, premature removal of K-wire was done in one case due deep infection but fortunately fracture fragment was not displaced probably because the fracture was mildly displaced preoperatively.

Growth disturbances after LCF of the distal humerus in children present mostly because of the lateral physis stimulation transiently. Clinically, lateral condylar overgrowth leads to a radial bony prominence and varisation of the elbow.[8] Hasler and von Laer reviewed with an average length of followup of 10 years to assess all sequels of growth disturbances. Screw osteosynthesis results in anatomical union, symmetric carrying angles and full range of motion in all operated cases, and proved to prevent stimulating growth disturbances contrary to the common but relatively unstable fixation with K-wires.[5] In our comparative study, carrying angle in screw fixation group was significantly better than K-wire group. None of the patients in either group had varus deformity beyond rectus. Agarwal *et al*. observed overgrowth of condylar physis and lower humeral lateral metaphysis in all patients and articular cartilage damage in 18.2% of the patients.[23] We also observed overgrowth of condylar fragments and distal lateral metaphysis in the majority of the patients and articular damage in total 5 (11.9%) patients.

Premature closure of the physis and fishtail deformity is a known complication of LCF nonunion after operative treatment. Agarwal *et al*. in their case study of 22 patients treated with open reduction, 4 had premature closure of phyis and 7 with fishtail deformity, but it hardly affects the functional outcome. It is interesting to note that none of the patients in their study was treated with screws.[23] In this study, premature closure of physis was seen in two patients one from each group, but both had reasonably good range of motion and functional score. Hence, it can be inferred from this observation that premature closure of physis and

fishtail deformity can be seen as complication irrespective of implant being used.

Being, outside the skin, pin-tract infection occurred in three cases. One had a deep infection, for which premature removal of wire was done, and two had mild infection which was given oral antibiotic and it subsided. Similarly, Agarwal *et al*. noticed deep infection in one case and premature wire was removed that leads to loss of reduction.[23] This could be a limitation for the use of K-wire as an implant for fixation of lateral condyle or this could be avoided if wire is buried.

Different functional score has been used for the assessment of elbow function. Dhillon *et al*. reported on 16 pediatric patients that elbow function was good in 5, fair in 7, and poor in 4 patients based on clinical score devised by them. They recommended a conservative management in patients presenting more than 6 weeks after injury but also observed that untreated cases always resulted in subsequent valgus deformity.[24] Toh *et al*. used Broberg and Morrey score to grade their results in series of 20 patients presenting more than 6 months after initial injury. Outcome was rated as excellent in 7 and good in 13 patients.[4] Saraf and Khare analyzed results in 16 patients with LCF humerus of 5–12-weeks old using criteria defined by Aggarwal *et al*.[13,25] They observed excellent to good results in 6, fair in 6, and poor results in 4 patients. In 2012, Agarwal *et al*. used LES for the assessment of elbow function in 22 neglected case of LCF.[23] We have also used LES as it consists of ROM of elbow, forearm rotation, ulnar nerve function, pain and use of affected limb in all necessary daily activities which are very essential in circumstances of developing countries.[23] In our study, there was no significant difference between the both the group in respect of LES. The average gain of ROM in the group of patients treated with screws was better than the group of patients treated with K-wire.

Conclusion

ORIF of neglected LCF of humerus gives excellent result irrespective of implant used for fixation and augmented with BG. Postoperative immobilization is recommended till radiological sign of callus formation is seen. CS is better than K-wires in term of duration of POP immobilization, final carrying angle and gain in final ROM. Use of both implants is comparable in term of complications such as premature closure of physis and infection. Both implants can be passed through ossific nucleus of capitulum without significant risk of damage to it.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Landin LA, Danielsson LG. Elbow fractures in children. An epidemiological analysis of 589 cases. Acta Orthop Scand 1986;57:309-12.
2. Beaty JH, Kasser JR. Rockwood and Wilkins' Fractures in Children. Philadelphia: Lippincott Williams and Wilkins; 2006.
3. Skak SV, Olsen SD, Smaabrekke A. Deformity after fracture of the lateral humeral condyle in children. J Pediatr Orthop B 2001;10:142-52.
4. Toh S, Tsubo K, Nishikawa S, Inoue S, Nakamura R, Harata S. Long standing nonunion of fractures of the lateral humeral condyle. J Bone Joint Surg Am 2002;84-A: 593-8.
5. Hasler CC, von Laer L. Prevention of growth disturbances after fractures of the lateral humeral condyle in children. J Pediatr Orthop B 2001;10:123-30.
6. Marcheix PS, Vacquerie V, Longis B, Peyrou P, Fourcade L, Moulies D. Distal humerus lateral condyle fracture in children: When is the conservative treatment a valid option? Orthop Traumatol Surg Res 2011;97:304-7.
7. Jakob R, Fowles JV, Rang M, Kassab MT. Observations concerning fractures of the lateral humeral condyle in children. J Bone Joint Surg Br 1975;57:430-6.
8. Shimada K, Masada K, Tada K, Yamamoto T. Osteosynthesis for the treatment of nonunion of the lateral humeral condyle in children. J Bone Joint Surg Am 1997;79:234-40.
9. Masada K, Kawai H, Kawabata H, Masatomi T, Tsuyuguchi Y, Yamamoto K. Osteosynthesis for old, established nonunion of the lateral condyle of the humerus. J Bone Joint Surg Am 1990;72:32-40.
10. Hardacre JA, Nahigian SH, Froimson AI, Brown JE. Fractures of the lateral condyle of the humerus in children. J Bone Joint Surg Am 1971;53:1083-95.
11. Tien YC, Chen JC, Fu YC, Chih TT, Hunag PJ, Wang GJ. Supracondylar dome osteotomy for cubitus valgus deformity associated with a lateral condylar nonunion in children. J Bone Joint Surg Am 2005;87:1456-63.
12. Roye DP Jr., Bini SA, Infosino A. Late surgical treatment of lateral condylar fractures in children. J Pediatr Orthop 1991;11:195-9.
13. Saraf SK, Khare GN. Late presentation of fractures of the lateral condyle of the humerus in children. Indian J Orthop 2011;45:39-44.
14. Conner AN, Smith MG. Displaced fractures of the lateral humeral condyle in children. J Bone Joint Surg Br 1970;52:460-4.
15. Fontanetta P, Mackenzie DA, Rosman M. Missed, maluniting, and malunited fractures of the lateral humeral condyle in children. J Trauma 1978;18:329-35.
16. Rohl L. On fractures through the radial condyle of the humerus in children. Acta Chir Scand 1952;104:74-80.
17. Mazurek T, Skorupski M. Nonunion of the lateral humeral condyle – Operative treatment, case report. Chir Narzadow Ruchu Ortop Pol 2006;71:227-9.

18. Li WC, Xu RJ. Comparison of Kirschner wires and AO cannulated screw internal fixation for displaced lateral humeral condyle fracture in children. Int Orthop 2012;36:1261-6.
19. Foster DE, Sullivan JA, Gross RH. Lateral humeral condylar fractures in children. J Pediatr Orthop 1985;5:16-22.
20. Launay F, Leet AI, Jacopin S, Jouve JL, Bollini G, Sponseller PD. Lateral humeral condyle fractures in children: A comparison of two approaches to treatment. J Pediatr Orthop 2004;24:385-91.
21. Ayubi N, Mayr JM, Sesia S, Kubiak R. Treatment of lateral humeral condyle fractures in children. Oper Orthop Traumatol 2010;22:81-91.
22. Sharma JC, Arora A, Mathur NC, Gupta SP, Biyani A, Mathur R. Lateral condylar fractures of the humerus in children: Fixation with partially threaded 4.0-mm AO cancellous screws. J Trauma 1995;39:1129-33.
23. Agarwal A, Qureshi NA, Gupta N, Verma I, Pandey DK. Management of neglected lateral condyle fractures of humerus in children: A retrospective study. Indian J Orthop 2012;46:698-704.
24. Dhillon KS, Sengupta S, Singh BJ. Delayed management of fracture of the lateral humeral condyle in children. Acta Orthop Scand 1988;59:419-24.
25. Aggarwal ND, Dhaliwal RS, Aggarwal R. Management of fractures of the lateral humeral condyle with special emphasis on neglected cases. Indian J Orthop 1985;19:26.