ORIGINAL RESEARCH

Comparative Study on the Management of Neglected Lateral Condyle Humerus Fracture in Children: A Retrospective Cohort Study

[1]Dr.Varun Garg, [2]Dr. Surinder kumar, [3]Dr.Aditya K.S. Gowda, [4]Dr. Anil Regmi, [5]Dr.Vivek Singh

[1]Assistant Professor, Department of Orthopedics, Chacha Nehru Bal Chikitsalya, New Delhi, India
[2]Assistant Professor, Department of Orthopedics, Acharya Shri Chander College of Medical Sciences and Hospital, Jammu, India
[3,4]Junior Resident, [5]Additional Professor, Department of Orthopaedics, All India Institute of Medical Sciences, Rishikesh, India

Corresponding author
Dr. Vivek Singh
Additional Professor, Department of Orthopaedics, All India Institute of Medical Sciences, Rishikesh, India
Email: singhvr27@gmail.com

Received: 23 February, 2023 Accepted: 28 March, 2023

ABSTRACT

Introduction: Multiple treatment options have been recommended for management of neglected lateral condyle humerus fracture. A controversial topic is whether these injuries requires bone graft for osteosynthesis or not. This study compares the clinico-radiological outcomes and complications of neglected lateral condyle humerus fracture treated by open reduction with or without bone grafting after a minimum of twelve months follow-up.

Material and Methods: A retrospective review of children aged less than or equal to 16 years with neglected lateral condyle humerus fracture presented after 4 weeks of initial trauma was done from January 2017 to December 2020. Patients were divided into two groups. Group A included children who underwent bone grafting, in addition to open functional reduction or open in-situ fixation, while Group B included patients who were managed without bone grafting. **Result:** Eighteen children were included (11 male, 7 female) in this review. Eleven patients were included in group A, while seven patients were included in group B. The mean age of patients in group A was 10.2 ± 3.9 years (range 5-16y) which was comparable with patients in group B (7 ± 3.5 years) . According to Hardacre criteria in both the groups at the last follow-up, in group A, 7 patients (63.63%) had excellent results, 2 (18.18%) had good, and 2 (18.18%) had a bad outcome. In group B, 4 patients (57.14%) had excellent results, 2 (28.57%) had good, and 1 (14.28%) had a bad outcome. **Conclusion:** Both in-situ fixation and open functional reduction are acceptable, but ORIF yields excellent results. Bone grafting after osteosynthesis is not essential. Osteosynthesis in situ could provide a solid bony union and improve elbow function without bone grafts. **Level of Evidence:** Level IV

Keywords: lateral condyle fracture; bone grafting; osteotomy; osteosynthesis; Hardacre criteria; bony union; pediatric distal humerus; milch classification

INTRODUCTION

Lateral condyle humerus fractures are the second most common elbow fractures in children after supracondylar fractures. They account for 12-20% of all pediatric distal humerus fractures.[14,21] These fractures are often missed due to the presence of radiolucent epiphysis, parental ignorance, improper radiographic views, or treatment by an osteopath.[12] Neglected fractures often go into non-union because the synovial fluid that bathes this intra-articular fracture compromises fracture healing by limiting fibrin formation, strong extensor muscle distraction forces over the fracture site, and precarious blood supply of the lateral condyle fragment.[20] Children often present with pain, instability, stiffness, tardy ulnar nerve palsy, lateral prominence, and angular deformity of the elbow.[29]

Management of acute fractures presenting within two weeks of injury is relatively standard. If the fracture shows more than 2 mm displacement, then it needs to be internally fixed. Otherwise, it can be treated conservatively with close attention to fracture

displacement at regular follow-up.[20] Late presentation poses difficulty in management due to the fragment displacement because of the common extensors pull, incongruous reduction of articular surfaces, and injury to the growth plate.[20] Although multiple treatment protocols such as conservative management, osteosynthesis, corrective osteotomy, or anterior transposition of ulnar nerve have been recommended, treatment of established non-union remains controversial.[5,20,24,26] Conservative management is fraught with the risk of further progression of the symptoms.[3] As a result, several authors suggest that surgical treatment must be undertaken to achieve better functional results.[24] However, surgical procedures carry the risk of extensive soft tissue stripping leading to osteonecrosis of the fragment and stiffness at the elbow.[20,22] Some authors recommend functional reduction of the fracture fragment. The fracture fragment is not reduced anatomically but in a position that provides the maximum range of motion at the elbow.[2,4,17] Others have recommended in-situ fixation without extensive soft tissue dissection with acceptable long-term functional results. Some have recommended a proper anatomical reduction to achieve long-term results.[18,28] Many times patients present with valgus deformity at the elbow with or without ulnar nerve symptoms. Corrective osteotomy with or without ulnar nerve transposition can be combined while addressing non-union in the same setting.[6] Another controversial topic is whether established non-union requires bone graft for osteosynthesis or not. Most of the authors recommend that a bone graft must be used while doing osteosynthesis to increase the chances of the sound bony union.[1,2,23] In contrast, others believe that bone grafting is not required to achieve union, and the more critical issue may be solid fixation and curettage of fibrous tissue.[17] Although there are multiple reports in the literature describing osteosynthesis with or without bone grafting, there is no evidence in the published literature to our knowledge comparing these two modalities in the pediatric neglected lateral condyle fracture.

This study aims to compare the clinico-radiological outcomes and complications of neglected lateral condyle humerus fracture treated by open reduction with or without bone grafting after a minimum of twelve months follow-up.

MATERIAL AND METHODS

After taking consent from the institutional review, a retrospective chart review of all the children aged less than or equal to 16 years, with neglected lateral condyle humerus fracture (presentation after four weeks from initial trauma) from January 2017 to December 2020, were included in the study. Medical records were analyzed for demographic characteristics, presenting complaints, mechanism of injury, fracture type, and injury to treatment duration. Important examination findings like lateral condyle prominence, deformity, and ulnar nerve signs were recorded. Fracture type was classified according to Milch classification.[15] Definitive management in all the patients was done by open reduction and internal fixation with a screw or Kirshner wire. We followed an algorithm for the treatment of such fractures, as shown in figure 1.

In this study, the patients were divided into two groups; Group A included children who underwent bone grafting, in addition to open functional reduction or open in-situ fixation, while Group B included patients who were managed without bone grafting.

The standard surgical technique of open in-situ fixation or open functional articular reduction was carried out.[8,9] In the latter technique, important points to consider are the minimal posterior dissection of the distal fragment, removal of interposed fibrous tissue, maximal possible apposition of bony fragments in a position where elbow range of motion (ROM) is found to be maximum after provisional fixation as shown in figure 2 and figure 3.

FOLLOW-UP

Patients were assessed at two weeks following surgery for suture removal and to note any early complications like infection and wound dehiscence. At six weeks, active range of motion excercises of the elbow were started. Children were followed four weekly till the radiological union was attained. The children were further followed every three months till a minimum of one year. Patients were clinically assessed to check for elbow range of motion, pain, and any deformity at every follow-up. The functional outcome was assessed at the final follow-up using Hardacre criteria in both groups.[7] At the final follow-up, radiographs were evaluated for fracture union, premature physeal closure, fishtail deformity, and avascular necrosis.

STATISTICAL ANALYSIS

Categorical variables were presented in number and percentage (%), and continuous variables were presented as mean ± SD and median. Quantitative variables were compared using the Student t-test and ANOVA test. A p-value of <0.05 was considered statistically significant. The data was entered in MS EXCEL spreadsheet, and analysis was done using Statistical Package for Social Sciences (SPSS) version 23.0.

RESULT

Eighteen children were included (11 male, 7 female) in this review. Eleven patients were included in group A (bone grafting), while seven patients were included in group B (without bone grafting). The demographic characteristics of patients are compared in table 1. The mean age of patients in group A was 10.2 ± 3.9 years (range 5-16y) which was comparable with patients in group B (7 ± 3.5 years) (range 2-12y). The average delay in the presentation was higher in group A (19.8

± 5.17 weeks; range-15 to 31weeks) as compared to group B (16.9 ± 1.46 weeks; range-15 to 19weeks) (p-value: 0.81) (table 2). The most common complaints were elbow stiffness (8 group A, 5 group B) followed by pain and swelling (7 group A, 3 group B), and one patient presented with deformity in group A. None of the patients had symptoms of elbow instability or late ulnar nerve palsy (Table 1). Fracture fragment was fixed with k- wire in 6 patients, while cannulated screw/s were used for fixation in 12 patients.

Table 1: Demographics and fracture characteristics

Cases operated with Bone Graft (Group A)						
Age (years)	**Sex**	**Side**	**Mechanism of injury**	**Presenting complaint**	**Delay in presentation (weeks)**	**Milch type**
12	M	R	RTA	Decreased elbow motion	8	II
5	M	R	Fall on ground	Pain and swelling, Decreased elbow motion	7	II
8	M	L	Fall on ground	Pain and swelling	6	I
15	F	R	Sports activity	Decreased elbow motion	8	II
11	M	L	RTA	Decreased elbow motion	9	II
9	M	L	RTA	Pain and swelling, Decreased elbow motion	16	II
8	M	R	RTA	Valgus deformity	24	I
8	M	R	RTA	Pain and swelling, Decreased elbow motion	14	II
5	M	R	RTA	Pain and swelling, Decreased elbow motion	15	II
16	M	R	Sports activity	Pain and swelling	6	I
15	M	R	Sports activity	Pain and swelling ,Decreased elbow motion	8	I
Cases operated without bone graft (Group B)						
Age (years)	**Sex**	**Side**	**Mechanism of injury**	**Presenting complaint**	**Delay in presentation(weeks)**	**Milch type**
2	M	R	Fall on ground	Decreased elbow motion	9	I
9	M	R	RTA	Decreased elbow motion	8	II
4	M	R	Fall on ground	Pain and swelling, Decreased elbow motion	8	I
10	M	R	Fall on ground	Decreased elbow motion	10	II
12	M	R	Sports activity	Pain and swelling	6	I
6	M	L	RTA	Pain and swelling	6	I
6	M	L	Sports activity	Decreased elbow motion	8	II

Abbreviations: M: Male; F: Female; R: Right; L: Left; RTA: Road Traffic Accident

On clinical assessment, the mean preoperative flexion-extension arc was 82.5º ± 5.2 in group A while it was 81.71º ± 7.520 in group B (p-value=0.33 (> 0.05)). The average follow-up time was comparable in both the groups: Group A (16.2 ± 2.08 months) and Group B (16 ± 2.64 months) (p-value: 0.43). The mean flexion-extension arc improved significantly in both groups at the final follow-up. In group B the gain in the flexion-extension arc was significantly more compared to group A (p-value: 0.17) (table 2).

Table 2: Summary of Study

	Group A	**Goup B**	**p-value**
Number of patients	11	7	

Male	7	4	0.78
Female	4	3	0.78
Right	8	5	0.95
Left	3	2	0.95
Mean age (years)	10.18	7	>0.05 (0.051)
Milch 1	4	4	0.38
Milch 2	7	3	0.7
Mean delay in presentation (weeks)	19.818	16.85	0.81
Mean followup (months)	16.18	16	0.43
Preop flexion-extension arc (°)	82.45	81.71	0.33
Postop flexion -extension arc (°)	106.45	107.85	0.17
Gain in ROM at final follow-up (°)	24	26.14	<0.00001
Infection	3	1	0.08
Hardacre;			
Excellent	63.63%	57.14%	
Good	18.18%	28.57%	
Bad	18.18%	14.28%	0.000142
Meantime to union (weeks)	11.40	13.10	<0.00001

Functional assessment was done using Hardacre criteria in both the groups at the last follow-up.[7] In group A, 7 patients (63.63%) had excellent results, 2 (18.18%) had good, and 2 (18.18%) had a bad outcome. In group B, 4 patients (57.14%) had excellent results, 2 (28.57%) had good, and 1 (14.28%) had a bad outcome. On applying the ANOVA test, the functional outcome was significantly better in group B (p-value = 0.000142) (table 2).

In group A, 3 patients had a superficial infection, while this complication was seen in 1 patient in group B (p-value>0.05). In all these cases, k-wire was used for the fixation of the fracture fragment. Superficial infection at the surgical site was treated with oral antibiotics and local care. There were no other serious complications such as nerve palsy, premature physeal closure, fishtail deformity, and AVN. Union was achieved in all the cases in both the group. The mean union time in group A was 11.4 ± 3.2 weeks as compared to group B which was 13.1 ± 3.8weeks (p-value <0.00001) (table 2).

Figure legends:

Figure 1: Algorithm for the treatment of Non-united lateral condyle fracture in children

figure 1

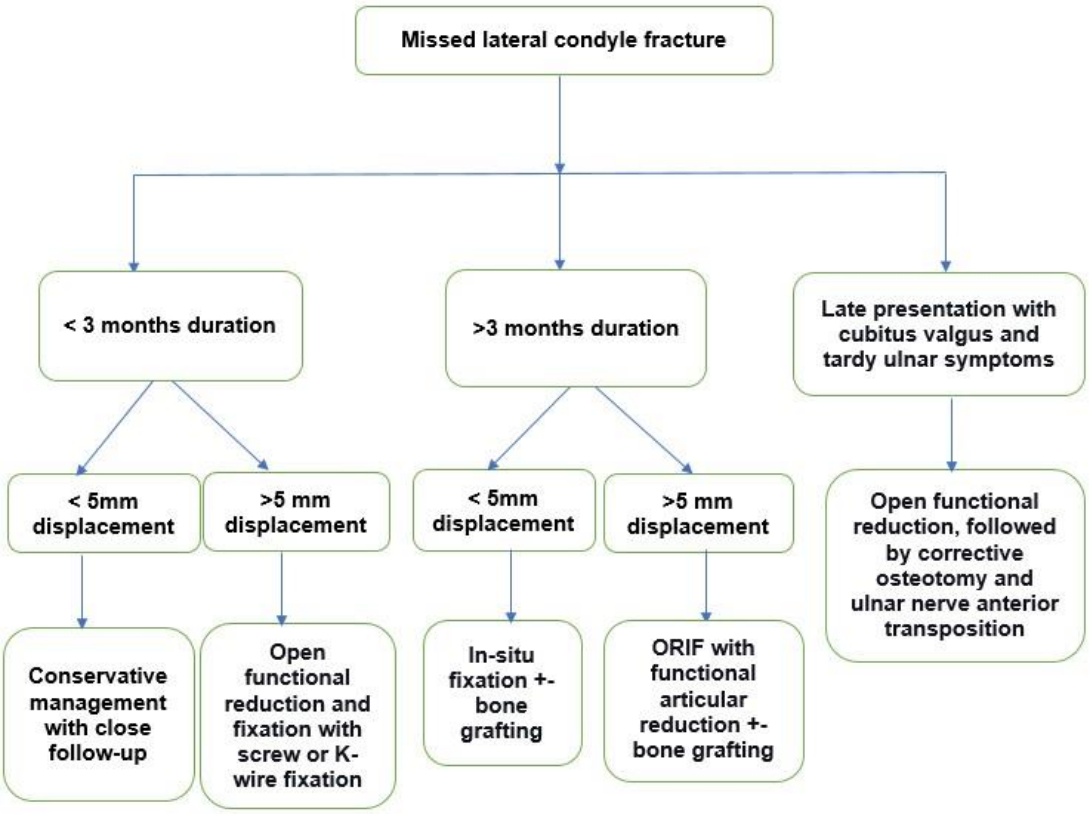
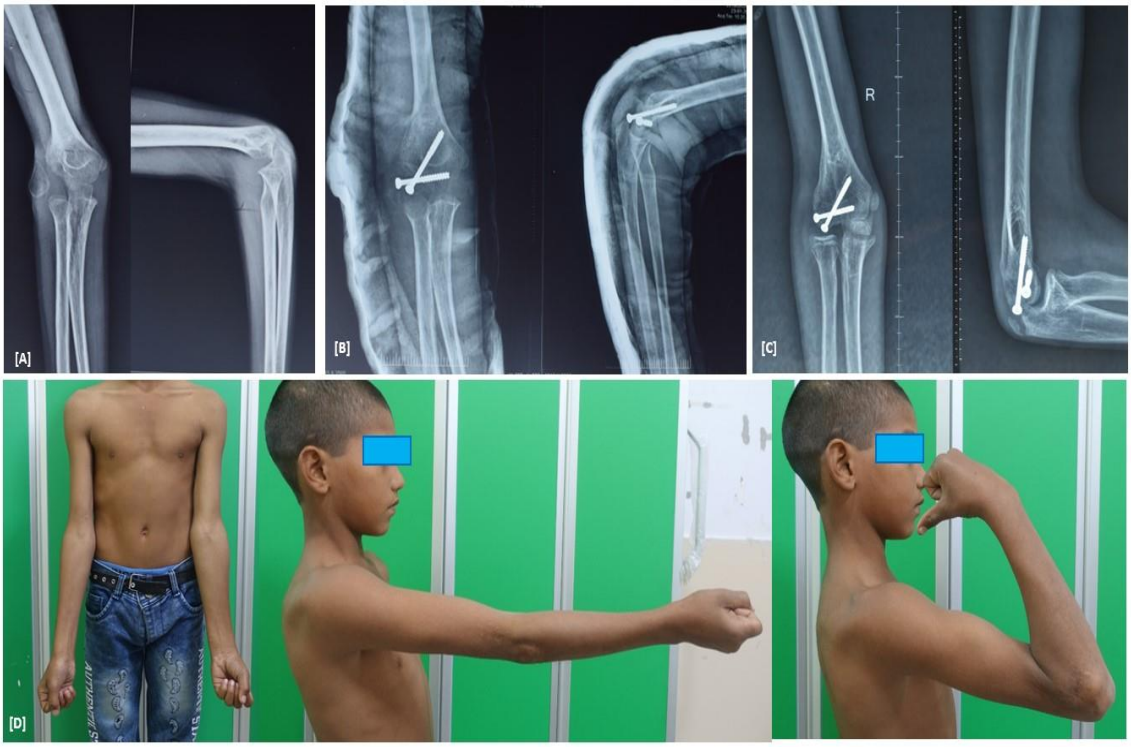


Figure 2. 11 years male presented at 8 weeks presented with complaints of decreased elbow motion, managed with in-situ fixation and bone grafting. A: Initial radiograph at presentation showing AP view of X-ray, B: immediate post-op X-ray; C: X-ray at two months follow up; D: X-ray at one year of follow up, E: Clinical image at one year of follow up.

Figure 2

Figure 3: 9 years male presented at 8 weeks with the complaint of decreased elbow motion and managed with ORIF. A: Initial radiograph at presentation showing AP view of X-ray, B: immediate post-op X-ray; C: X-ray at two months follow up; D: Clinical image at one year of follow up.

Figure 3



DISCUSSION

The operative management of non-union lateral condyle humerus fracture remains controversial, which is illustrated by the fact that no single technique has been universally accepted. The literature has described multiple procedures: osteosynthesis (in-situ Vs. articular reductions), corrective osteotomy, or anterior transposition of the ulnar nerve.[10,17,25,26] Many authors in the past have suggested against surgical intervention in these cases. Their observation was that open articular reduction causes AVN of the fragment and worsens pain and stiffness.[9,10,23,25] Another reason for the nonsurgical approach was that most of the time, children usually presented with minimal or no complaints. Jakob et al. reported AVN and stiffness in 66.67.% and 100 % of their patients, respectively, who were treated between 3 weeks to 3 months after injury.[11] This is the reason why few authors recommend treatment for symptomatic children only. But later studies showed that many of the complications inherent to the surgical procedure could be avoided either by in-situ fixation without disturbing vascularity of the fragment or by anatomical articular reduction (if possible) provided that posterior dissection was kept minimal. In situ fixation has been a favored technique because the risk for AVN is minimal, the articular surface is not recognizable many a time, and just providing union provides relief from pain and instability. Other authors have favoured more anatomical type of articular reduction with the hope that oy will provide immunity from gradual development of valgus deformity. There is almost universal agreement in the recent literature that to achieve union is warranted in these cases. A child who might be asymptomatic or have minimum symptoms at presentation to the surgeon may detioriate few years down the line. There is no fixed management protocol for the management of these problem. Recently Trisolino et al. has given an algorithm for management of these injuries.[27] Another controversy on which much focus has not been given is use of bone grafting during osteosynthesis for non-union.

In this study, in group A the average delay in the presentation was 19.8± 5.17 weeks in group B was 16.9 ± 1.46 weeks. However, the difference was found to be statistically insignificant (p-value >0.05). No patient in both groups showed any AVN changes at the final follow-up. These results might be explained by the fact that minimal soft tissue dissection was carried out posteriorly, preserving the blood supply and gentle handling of the fracture fragment. Park et al. theorized that the improvement in range of motion after surgery is due to improved radio-capitellar congruence due to the children's higher remodeling potential. All of their patients who were treated with open reduction and fixation without bone grafting demonstrated improvement in range of motion.[17] According to Inoue et al., bone grafts may restrict elbow range of motion due to accidental placement in the olecranon fossa or distal migration of the graft in the radio-capitellar joint.[10] While comparing groups A and B, the gain in the range of motion was found to be significantly greater in group B (p-value <0.00001) in accordance with Park et al.[17] However, we were unable to determine the reason for the statistically significant improvement in range of motion in group B over group A.

Prakash et al. reported union in 39 out of 45 non-union lateral humeral condyle fracture patients who were treated with open reduction and internal fixation with bone grafting.[19] The average union time in their study was less than six months. Similarly, Trisolino et al. reported union in 17 out of 18 patients within six months who were treated with open reduction and bone grafting.[27] Many surgeons believe that bone grafting is necessary for the union of the fracture fragment. Tan et al. reported good results in their systematic review of 2018, with 98.4 percent of patients achieving union with the use of bone graft.[24] But Morris et al. described successful management with percutaneous fixation in a four-year-old child.[16] The child progressed to the union within 6 months after the surgery. A study by Knight et al. showed union in 75 % of their patient treated with percutaneous in situ fixation.[13] Park et al. believed that removal of fibrous tissue along with firm fixation of fracture fragments was necessary for the union.[17] In our study, the union was achieved in all the patients. This could be explained by the fact that children usually have higher healing potential, and fracture involves the metaphyseal part of the bone. Thus, only removal of fibrous tissue and firm fixation is required for the union. However, the union time in group A was significantly lower than group B (p-value <0.00001). We believe that cancellous bone graft promoted bone healing by its osteogenic and osteoinductive potential.

The findings of this study suggest that bone grafting is not essential to achieve union in these cases. It seems that removing all the interposing fibrous tissue and apposition of the fragments is required to achieve union. The addition of bone graft might accelerate union, but findings of our study suggest that this comes at the cost of less gain in postoperative elbow range of motion. The findings of this study do not refute the benefit of bone grafting. Still, it can be safely assumed that even if the surgeon does not add bone grafting after the osteosynthesis, then also union should not be a problem.

This research has a few limitations, including its retrospective nature. The sample size is insufficient to draw any firm conclusions. The duration of the follow-up is short. Because all patients could not be followed up until they reached adulthood, the long-term consequences of osteosynthesis remain to be seen.

CONCLUSION

Regardless of the technique used, ORIF of the neglected lateral condyle fracture of the humerus yields excellent results. Both in-situ fixation and open functional reduction are acceptable. Bone grafting after osteosynthesis is not essential, but further prospective studies will be needed comparing osteosynthesis with or without grafting need to be carried out to substantiate this observation further. Osteosynthesis in situ could provide a solid bony union and improve elbow function without bone grafts. This treatment is safe and successful for children neglected lateral condyle fracture non-union and offers a suitable alternative for management.

BIBLIOGRAPHY

1. Abzug JM, Dua K, Kozin SH, Herman MJ. Current Concepts in the Treatment of Lateral Condyle Fractures in Children. JAAOS - J. Am. Acad. Orthop. Surg. 2020 Jan 1;28(1):e9. doi:10.5435/JAAOS-D-17-00815
2. 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(6):698–704. doi:10.4103/0019-5413.104221
3. Bartlett CSI. Elbow fractures. Curr. Opin. Orthop. 2000 Aug;11(4):290–304.
4. Eamsobhana P, Kaewpornsawan K. Should we repair nonunion of the lateral humeral condyle in children? Int. Orthop. 2015 Aug 1;39(8):1579–1585. doi:10.1007/s00264-015-2805-8
5. Gallay SH, McKee MD. Operative Treatment of Nonunions About the Elbow. Clin. Orthop. Relat. Res. 1976-2007. 2000 Jan;370:87–101.
6. Gong MQ, Huang XW, Wang C, Zha YJ, Li Y, Zhang LD, et al. Management of chronic neglected lateral condyle elbow non-union in adults: functional results of a cohort study and a proposed treatment algorithm. Int. Orthop. 2017 Jan 1;41(1):157–164. doi:10.1007/s00264-016-3276-2
7. Hardacre JA, Nahigian SH, Froimson AI, Brown JE. Fractures of the Lateral Condyle of the Humerus in Children. JBJS. 1971 Sep;53(6):1083–1095.
8. Hung NN. Kirschner Wire Fixation of Neglected Lateral Condylar Fracture of the Humerus in Children. Open Access Libr. J. 2017 Jan 4;4(1):1–19. doi:10.4236/oalib.1103330
9. brahim MA, Ismail MSAM. Corrective osteotomy and in situ fusion for late-presenting nonunion of lateral condyle fractures of the humerus in adults. J. Shoulder Elbow Surg. 2019 Mar 1;28(3):520–524. doi:10.1016/j.jse.2018.08.005
10. Inoue G, Tamura Y. Osteosynthesis for longstanding nonunion of the lateral humeral condyle. Arch. Orthop. Trauma Surg. 1993 Sep 1;112(5):236–238. doi:10.1007/BF00451882
11. Jakob R, Fowles JV, Rang M, Kassab MT. Observations concerning fractures of the lateral humeral condyle in children. J. Bone Joint Surg. Br. 1975 Nov 1;57-B(4):430–436. doi:10.1302/0301-620X.57B4.430
12. Jeon TY, Yoo S-Y. Pediatric Skeletal Trauma [Internet]. In: Kim I-O, editor. Radiology Illustrated: Pediatric Radiology. Berlin, Heidelberg: Springer; 2014 [cited 2022 Feb 3]. p. 951–968.Available from: https://doi.org/10.1007/978-3-642-35573-8_30doi:10.1007/978-3-642-35573-8_30
13. Knight DM, Alves C, Alman B, Howard A. Percutaneous Screw Fixation Promotes Healing of Lateral Condyle Nonunion in Children. J. Pediatr. Orthop. 2014 Mar;34(2):155–160. doi:10.1097/BPO.0000000000000077
14. Kropelnicki A, Ali AM, Popat R, Sarraf KM. Paediatric supracondylar humerus fractures. Br. J. Hosp. Med. 2019 Jun 2;80(6):312–316. doi:10.12968/hmed.2019.80.6.312
15. Milch H. FRACTURES AND FRACTURE DISLOCATIONS OF THE HUMERAL CONDYLES. J. Trauma Acute Care Surg. 1964 Sep;4(5):592–607.
16. Morris S, McKenna J, Cassidy N, Stephens M. A new technique for treatment of a non-union of a lateral humeral condyle. Injury. 2000 Sep 1;31(7):557–559. doi:10.1016/S0020-1383(00)00033-4
17. Park H, Hwang JH, Kwon YU, Kim HW. Osteosynthesis In Situ for Lateral Condyle Nonunion in Children. J. Pediatr. Orthop. 2015 Jun;35(4):334–340. doi:10.1097/BPO.0000000000000353
18. Pennock AT, Salgueiro L, Upasani VV, Bastrom TP, Newton PO, Yaszay B. Closed Reduction and Percutaneous Pinning Versus Open Reduction and Internal Fixation for Type II Lateral Condyle Humerus Fractures in Children Displaced >2 mm. J. Pediatr. Orthop. 2016 Dec 1;36(8):780–786. doi:10.1097/BPO.0000000000000570
19. Prakash J, Mehtani A. Open reduction versus in-situ fixation of neglected lateral condyle fractures: a comparative study. J. Pediatr. Orthop. B. 2018 Mar 1;27(2):134–141. doi:10.1097/BPB.0000000000000443
20. Saraf SK, Khare GN. Late presentation of fractures of the lateral condyle of the humerus in children. Indian J. Orthop. 2011 Feb 1;45(1):39–44. doi:10.4103/0019-5413.67119
21. Shrader MW. Pediatric Supracondylar Fractures and Pediatric Physeal Elbow Fractures. Orthop. Clin. North Am. 2008 Apr 1;39(2):163–171. doi:10.1016/j.ocl.2007.12.005
22. Shrestha S, Hutchison RL. Outcomes for late presenting lateral condyle fractures of the humerus in children: A case series. J. Clin. Orthop. Trauma. 2020 Mar 1;11(2):251–258. doi:10.1016/j.jcot.2019.09.012
23. Sullivan AJ. Fractures of the Lateral Condyle of the Humerus. JAAOS - J. Am. Acad. Orthop. Surg. 2006 Jan;14(1):58–62.
24. Tan SHS, Dartnell J, Lim AKS, Hui JH. Paediatric lateral condyle fractures: a systematic review. Arch. Orthop. Trauma Surg. 2018 Jun 1;138(6):809–817. doi:10.1007/s00402-018-2920-2
25. Tien Y-C, Chen J-C, Fu Y-C, Chih T-T, Hunag P-J, Wang G-J. Supracondylar dome osteotomy for cubitus valgus deformity associated with a lateral condylar nonunion in children. J. Bone Joint Surg. Am. 2005 Jul;87(7):1456–1463. doi:10.2106/JBJS.C.01545
26. Toh S, Tsubo K, Nishikawa S, Inoue S, Nakamura R, Narita S. Osteosynthesis for Nonunion of the Lateral Humeral Condyle. Clin. Orthop. Relat. Res. 1976-2007. 2002 Dec;405:230–241.
27. Trisolino G, Antonioli D, Gallone G, Stallone S, Zarantonello P, Tanzi P, et al. Neglected Fractures of the Lateral Humeral Condyle in Children; Which

Treatment for Which Condition? Children. 2021 Jan;8(1):56. doi:10.3390/children8010056
28. Wattenbarger JM, Gerardi J, Johnston CE. Late Open Reduction Internal Fixation of Lateral Condyle Fractures. J. Pediatr. Orthop. 2002 Jun;22(3):394–398.
29. Wilkins KE. Residuals of Elbow Trauma in Children. Orthop. Clin. North Am. 1990 Apr 1;21(2):291–314. doi:10.1016/S0030-5898(20)31546-7