

Risk factors of loss reduction after percutaneous fixation in supracondylar humerus in pediatric: a descriptive-analytical study

Hassan Taleb¹⁾, Ali Tabrizi²⁾, Aida Nouri³⁾

Received 15 June 2020, Accepted for publication 16 September 2020

Abstract

Background & Aims: supracondylar humerus fracture is one of the most common pediatric elbow fractures accounting for about 16% of the pediatric fractures. Loss of reduction is one of the complications after closed and percutaneous fixation. This research is aimed to investigate the factors involved in the loss of reduction.

Method: In this descriptive study, the children with supracondylar humerus fractures were examined. 175 children under the age of 10 with type 3 and 4 supracondylar humerus fracture fractures who underwent closed fixation and pinning were entered into the study. The studied factors were analyzed by a logistic regression method.

Results: in this study 175 children under the age of 10 including 71 girls and 104 boys (59.4%) with the average age of 5.4 ± 2.4 were investigated. In 153 cases, (87.4%) the fixation was anatomical and stable during the follow-up; while 22 cases (12.6%) had the loss of fixation. The most important anatomical disorder was internal rotation displacement in the medial distal part of fracture in these 22 cases. Pinning technique and obesity were among the effective factors in the failure of the anatomical reduction. In a way that obese children (above 85th percentile or $IBM > 25$) and the lateral pinning location were divergent but they crossed in the fracture site and were effective with odd ratios of 1.3 (CI 95% 0.8-2.3) and 1.8 (CI 95% 0.9-2.3), respectively. In 14 cases (63.6%) the failure was due to the place of fracture cross and in 8 cases (36.6%) the complication occurred in the obese children. The fracture type had no effect on the loss of reduction as no difference was observed.

Conclusions: Obesity and fixation technique are among the effective factors in the loss of reduction in pediatric supracondylar humerus fractures. In obese children, cross-suitable fixation should be considered to prevent complications.

Keywords: Children, Supracondylar humerus fracture, Closed reduction, Risk factors

Address: Department of Orthopedics, Imam Khomeini Hospital, Urmia University of Medical Sciences, Urmia, Iran

Tel: +989144124481

Email: hassantaleb_dr@yahoo.com

Introduction

Supracondylar humerus fracture is one of the most common pediatric elbow fractures accounting for about 16% of the pediatric fractures. This fracture may result in hospitalization in two-third of the cases. These

fractures are also one of the most common causes of morbidity among children which can result in non-union, neurovascular injuries, and even compartment syndrome. (1-3) One of the best therapeutic methods in the case of displacement is the closed percutaneous

¹ Department of Orthopedics, Imam Khomeini Hospital, Urmia University of Medical Sciences, Urmia, Iran (Corresponding Author)

² Department of Orthopedics, Imam Khomeini Hospital, Urmia University of Medical Sciences, Urmia, Iran

³ School of medicine, Urmia University of Medical Sciences, Urmia, Iran

fixation with several pins to maintain the anatomical stability of the reduction. (2) In 1960, Casiano described this therapeutic method for the first time. Since, then, this method has attracted the attention of orthopedic surgeons and has become a standard method for pediatric supracondylar humerus fractures. (1) In a study by Pennock et al. in 2014, the loss of reduction after percutaneous fixation with pinning was 4.2%. This study suggested that spread pins are the most important factor in preventing the loss of reduction; the distance between the pins should be 13 mm or of 3/1 of the humerus diameter in the fracture site. The risk factors involved in the loss of reduction in this study included obesity, pinning, and closed/open fixation. The effective risk factors are not, however, clear and further studies are required in this field. (4) In this study, the risk factors involved in the loss of anatomical reduction during the follow-up of the patients after closed reduction and percutaneous pinning are investigated.

Method

In this descriptive-analytical study, all the children (under the age of 10) with supracondylar humerus fracture who were admitted in the trauma center of Urmia University of Medical Sciences were entered the study. The inclusion criteria were: type 3 and 4 supracondylar humerus fracture treated with closed reduction and pinning. Lack of previous deformity or fracture in the elbow, no open fractures and ulcers, and no vascular circulation disorder in the involved organ.

The cases undergone open surgery were excluded. All the children were treated with general anesthesia using traction maneuver, full pronation, and flexion under the fluoroscopic guide and closed fixation. For percutaneous fixation, two or three pins (1.5 mm) were used from the lateral direction. The anatomical criteria were evaluated from two lateral and anteroposterior views.

Second week post surgery, the children experienced full and profile radiography of elbow which were compared with the radiographs obtained immediately after the surgery. The anterior humeral lines, Baumann's angle, rotation in the distal section relative to the proximal direction, and flexion or extension were investigated after reduction; then the cases with anatomic reduction and the other children with anatomical defects were classified into two groups. The two groups of anatomical reduction and those with lost reduction were compared in terms of the studied variables. The demographic data were extracted from the patients' files and their body mass index was determined according to the formula dividing the weight by the square height. The body masses above the 85th percentile and BMI>25 were considered obese. The fracture type was also determined according to the Gartland standard classification. (4) this study was performed under the supervision of the ethics committee (with the code 98-06-63-1956) at Urmia University of Medical Sciences.

In this study, the obtained data were statistically analyzed by SPSS/21/win software. The data were first presented descriptively in the form of frequency, percentage, and mean values, then the qualitative variables were compared between the two groups through the chi square test. For the quantitative variables, an independent t-test was employed; while the probable risk factors involved in the loss of reduction were evaluated by the logistic regression model. The p-values below 0.05 were considered significant.

Results

In this study, 175 children (under the age of 10) including 81 (40.6%) girls and 104 (59.4%) boys with the mean age of 5.4 ± 2.4 were entered the research. In 153 cases (87.4%), the stable anatomical reduction was observed in the follow-up period. But 22 cases (12.6%) had loss of reduction. The major anatomical disorder

was internal rotation displacement in the medial distal part of fracture in these 22 cases. According to Ttable 1, the pinning technique and children obesity were the most prominent causes of the failure of anatomical reduction (Fig. 1 and 2). The obese children (above 85th percentile or BMI>25) and divergent lateral pinning caused the incidence of cross at the site of the fracture

and affected the outcomes with odd ratios of 1.3 (CI 95% 0.8-2.3) and 1.8 (CI 95% 0.9-2.3), respectively. In 14 (63.6%) and 8 (36.6%) cases failure occurred in the cases with crossed pins at the site of the fracture and obese children, respectively. The fracture type also showed no impact on the outcomes.

Table 1. Comparison of findings between two groups of children with loss of reduction and anatomical alignment

| Variable | Loss of reduction N=22 | Anatomical alignment N=153 | P value |
|-------------------------|---------------------------|-------------------------------|---------|
| Type III Gartland | 10(8.8%) | 103(91.2%) | 0.06 |
| Type IV Gartland | 12(19.4%) | 50(80.6%) | |
| Divergent pin insertion | 17(10.2%) | 150(89.8%) | 0.03 |
| Parallel pin insertion | 5(62.5%) | 3(37.5%) | |
| Obesity>85th | 10(71.4%) | 4(28.6%) | <0.001 |

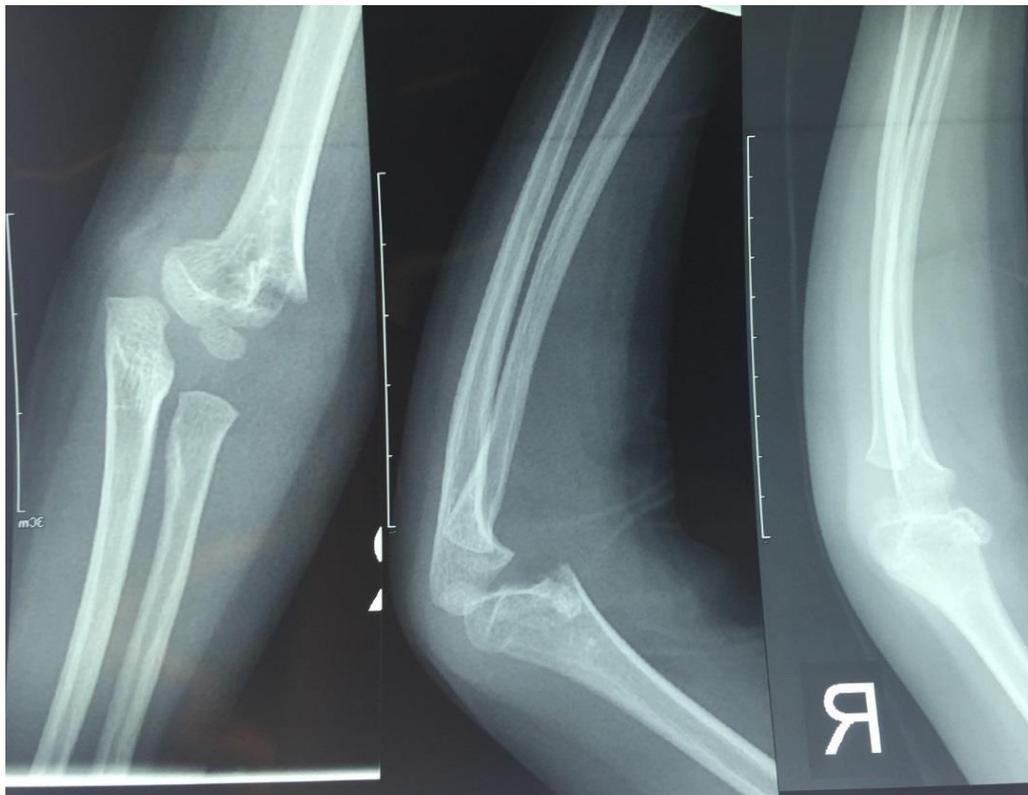


Fig 1. Fracture of suprachondylar(type 3 Gartlend)

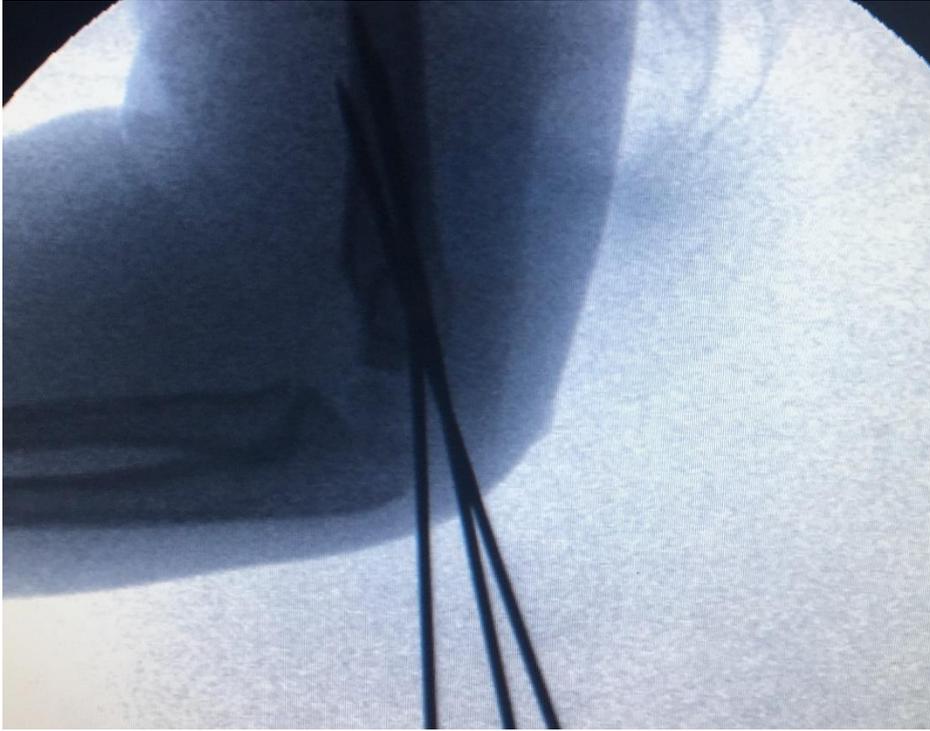


Fig 2. Fluoroscopy of operation time with anatomical reduction after pin percutaneous fixation

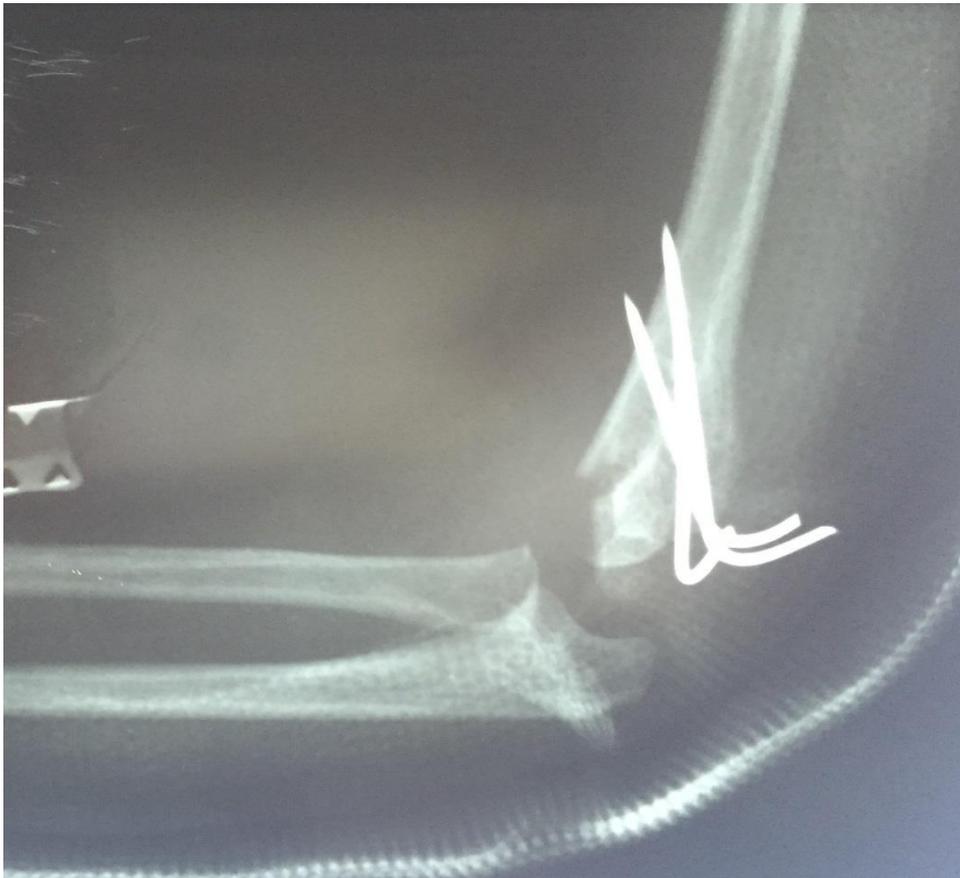


Fig 3. Radiography of post operation in follow up period after a week with loss of reduction due to internal rotation of medial

Discussions

The most important goal in the treatment of pediatric supracondylar humerus fracture is the proper anatomical reduction and maintaining the stability of the fracture by pin fixation. The most loss of reduction was occurred due to distal part displacement and internal rotation of distal and medial columnen.. Based on the literature, the post-reduction displacement rate is above 17%. (5-7) In some studies, loss of reduction is reported after k wire fixation in the supracondylar humerus fracture with a rate of 1.6 to 33.2%. In a study by Balakumar et al., about 18.2% of the treated children had a loss of reduction during the follow-up period. In our study, 12.6% of the cases had a loss of reduction and residual internal rotation was the most important complication after the anatomical reduction. Internal rotation of the distal residuals is the major factor in the deformity of varus. Thus proper measures have to be considered to prevent varus tilt in the coronal residuals. Cubitus varus is the main complication upon improper treatment of the supracondylar humerus fracture. (7-9) Various factors are involved in the failure of the reduction which is one of the major challenges in pediatric trauma treatment. Studies have mentioned factors such as the timing of the surgery, quality of reduction, pin configuration, the pinning technique. (9) Today anthropometric and obesity have gained considerable attention. In a study by Seeley et al. on the pediatric supracondylar humerus fracture, type II and III (based on the Gartland classification) had no impact on loss of reduction. (10) Similarly, our study also showed no impact of the type of fracture on the loss of reduction. The time of surgery, however, affected the outcomes; in a way that the children receiving treatment in less than 8 h showed lower rates of loss reduction as compared with those treated in more than 8 h. (11, 12) In a study by Seeley et al., the obesity of the children with supracondylar humerus fracture had a significant

influence on post-treatment complications. In the children with BMI>25, the risk of complications and nerve palsy was higher with an odds ratio of 4.-3 [95% CI, 2.66-22.3]. In our study obesity was associated with a high risk of loss of reduction with an odds ratio of 1.8. (10) In a study by Bloom et al. pin construct was effective on the residual internal rotation in the children with supracondylar humerus fracture. In the cases in which lateral pinning was only applied, a high risk of loss of reduction was observed. (13) Green et al. studied 65 cases with medial and lateral cross pinning and observed no malunion. (14) Lee and Shim reported one case (1.6%) of cubitus varus after treatment of supracondylar humerus fracture in 63 children treated with medial and lateral cross pinning. (12) Similar findings were observed in the research by Flynn et al on 72 patients which resulted in 4.2% undesirable outcomes with declined the carrying angle; no functional disorder was, however, reported. (15) Krusche et al. studied 78 treated patients who had finished their follow up period. Varus deformity was observed in 2.6% of the cases but the carrying angle of all the patients was normal. (16) The important point is the superiority of cross pinning over the lateral pinning. Medial fixation, although may cause ulnar nerve injury, can stabilize the medial residuals and prevent the internal rotation of the distal residuals. This can provide proper stability for the reduction which is highly valuable. In obese children, proper stabilization is of crucial importance due to the high risk of loss of reduction.

Limitation of study:

In this study, we tried to investigate involved the possible risk factors. But many factors can be influential. The number of surgeons, their skills and different methods of fixation can play a role that in our study could not be investigated.

Conclusion

Obesity and fixation techniques are among the effective factors on the loss of reduction in the pediatric supracondylar humerus fractures. In obese children, proper cross fixation should be considered to prevent complications.

Acknowledgments

This study was financially supported by Urmia University of Medical sciences.

Conflict of Interest

There is no conflict of interest to be reported.

Ethical Issues

The study was confirmed by Ethics Committee of Urmia University of Medical Sciences.

References

- Otsuka NY, Kasser JR. Supracondylar Fractures of the Humerus in Children. *J Am Acad Orthop Surg* 1997; 5(1):19-26.
- Cheng JC, Shen WY. Limb fracture pattern in different pediatric age groups: a study of 3,350 children. *J Orthop Trauma* 1993;7(1):15-22.
- Skaggs D, Pershad J. Pediatric elbow trauma. *Pediatr Emerg Care* 1997;13(6):425-34.
- Pennock AT, Charles M, Moor M, Bastrom TP, Newton PO. Potential causes of loss of reduction in supracondylar humerus fractures. *Journal of Pediatric Orthopaedics* 2014;34(7):691-7.
- Skaggs DL, Kay RM, Tolo VT. Fracture stability after pinning of displaced supracondylar distal humerus fractures in children. *J Pediatr Orthop* 2002;22:697; author reply 697-8.
- Slobogean BL, Jackman H, Tennant S, Slobogean GP, Mulpuri K. Iatrogenic ulnar nerve injury after the surgical treatment of displaced supracondylar fractures of the humerus: number needed to harm, a systematic review. *J Pediatr Orthop* 2010;30:430-6.
- Walmsley PJ, Kelly MB, Robb JE et al. Delay increases the need for open reduction of type-III supracondylar fractures of the humerus. *J Bone Joint Surg Br* 2006; 88:528-30.
- Tripuraneni KR, Bosch PP, Schwend RM, Yaste JJ. Prospective, surgeon-randomized evaluation of crossed pins versus lateral pins for unstable supracondylar humerus fractures in children. *J Pediatr Orthop B* 2009;18:93-8.
- Balakumar B, Madhuri V. A retrospective analysis of loss of reduction in operated supracondylar humerus fractures. *Indian J Orthop* 2012;46(6):690-7.
- Seeley MA, Gagnier JJ, Srinivasan RC, et al. Obesity and its effects on pediatric supracondylar humeral fractures. *J Bone Joint Surg Am* 2014;96(3):e18.
- Mehlman CT, Strub WM, Roy DR, Wall EJ, Crawford AH. The effect of surgical timing on the perioperative complications of treatment of supracondylar humeral fractures in children. *J Bone Joint Surg Am* 2001;83:323-7.
- Gupta N, Kay RM, Leitch K, Femino JD, Tolo VT, Skaggs DL. Effect of surgical delay on perioperative complications and need for open reduction in supracondylar humerus fractures in children. *J Pediatr Orthop* 2004;24:245-8.
- Bloom T, Robertson C, Mahar AT, Newton P. Biomechanical analysis of supracondylar humerus fracture pinning for slightly malreduced fractures. *J Pediatr Orthop* 2008;28:766-72.
- Green DW, Widmann RF, Frank JS, Gardner MJ. Low incidence of ulnar nerve injury with crossed pin placement for pediatric supracondylar humerus fractures using a mini-open technique. *J Orthop Trauma* 2005;19:158-63.
- Shim JS, Lee YS. Treatment of completely displaced supracondylar fracture of the humerus in children by cross-fixation with three Kirschner wires. *J Pediatr Orthop* 2002;22:12-6.
- Krusche-Mandl I, Aldrian S, Köttstorfer J, Seis A, Thalhammer G, Egkher A. Crossed pinning in paediatric supracondylar humerus fractures: a retrospective cohort analysis. *Int Orthop* 2012;36(9):1893-8.