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Outcome of Closed Reduction and Percutaneous Fixation of Humeral Supracondylar Fracture in Children

Dr. Ali Tariq Jassim[1], Dr.Hussein Ali Hakeem AlKhazraji[2], Dr. Buriar Mohammed Ali Alasadi[3*]

1. *Specialist Orthopedic Surgeon Imam Alhussain Teaching Hospital, Kerbala-Iraq*
2. *M.B.Ch.B, CABS (Ortho). Imam Alhasan Almujtaba Teaching Hospital, Kerbala-Iraq*
3. *M.B.Ch.B, , FIBMS (Ortho), Consultant orthopedic surgeon, Imam Alhussain Teaching Hospital, Kerbala-Iraq*

* *Corresponding Author*

Original Article

Abstract

Background*: Supracondylar fractures of humerus are the commonest injuries in this population, the extension supracondylar fractures are the vast common. Different treatment interventions are currently available; percutaneous pinning has been suggested as the standard operative method for displaced supracondylar humeral fractures in children.*

Objective*: To study the outcomes of closed reduction and percutaneous fixation of humeral supracondylar fracture in children.*

Methods*: A prospective study was carried out during a period of 12 months in Al-Imam Al-Hussain medical city/Karbala, middle of Iraq. Included a total of 20 child patients with type 3 displaced supracondylar fracture of humerus. They were 14 males and 6 females. A standard protocol for this procedure was followed. Fluoroscopy –controlled reduction followed by fixation of the fracture were performed in all cases. Patients were followed up postoperatively and their short and long term outcomes were reported in a follow up period of at least 6 months.*

Results*: Majority (95%) of our cases had extension type of fractures. There was predominance of male gender and left side fractures. Regarding the outcomes, 13 patients (65%) showed excellent outcome (according to Flynn criteria), 4 patients (20%) showed good outcome and 3 patients (15%) had a poor outcome who were later developed stiffness of the elbow. Surgical complications included pin tract infection which was treated and resolved after removal of the K-wire after 3 weeks. One patient complained of transient Ulnar nerve palsy but did improve and resolve after 6 postoperative weeks.*

Conclusion *:Closed reduction and percutaneous pinning for displaced supracondylar humerus fractures in children is effective and safe procedure and it was cost effective and time preserving method that provide a stable fixation with good-excellent outcome*

Keywords: *Supracondylar Fracture, Humerus, Treatment, Closed Reduction, Percutaneous Fixation, Outcomes*

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1. INTRODUCTION

Supracondylar humeral fractures are recognized to be the most common fractures around the elbow in children. Because children being an active age group, these fractures are often caused by the injuries sustained during sporting activities. Supracondylar humeral fractures are common in children under the age of seven; hence, osteosynthesis is the most common upper limb operation in this age group. They make about 3-15% of the total number of fractures in children. Most of the injuries are mechanism extensive and result from a pivot fall onto the hyperextended elbow. The tension created as the olecranon sheath forced itself forward may also strip off the anterior cuff. Due to the contractions of the triceps, the distal fragment is often displaced posteriorly and proximal. The proximity of the brachial artery or an anterior interosseous nerve explains the seriousness of the curse due to vascular or neurological injury reported in twenty five percent of displaced fractures (1) . Most simply dendrites lesions follow nerve injuries due to the fact that most nerves recover in a matter of time without treatment (2). These fractures affect the distal humerus of children at a rate of 308 per 100,000, and 56% of these elbow fractures are supracondylar. Mean age of patients at time of injury is almost 8 years (range: 2- 12 years). This fracture is rare in adults, with rates of distal humerus fractures at 5.7 cases per 100,000.

Regarding the mechanism of injury, posterior angulation or displacement contributted for 95% suggests a hyperextension injury, usually due to a fall on the outstretched hand. Anterior displacement is rare; it is thought to be due to direct violence (e.g. a fall on the point of the elbow) with the joint in flexion.

Humeral Supracondylar Fracture can be calssified according to the mechanism of injury as

• Hyperextension type contributted for almost 95% of fractures

• Flexion type

However, the Gartland classification system (3) is the most commonly used which is consist of three types:

• Type I: Nondisplaced (Figure 1)

• Type II: Displaced, but with an intact cortex; hinge or greenstick (Figure 2)

• Type III: Completely displaced, with no continuity between fragments (Figure 3), this type associated with the highest risk of complications

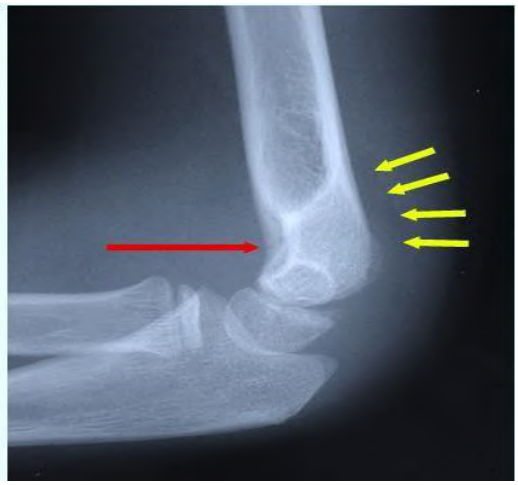

Figure 1. Type 1fracture, non-displaced

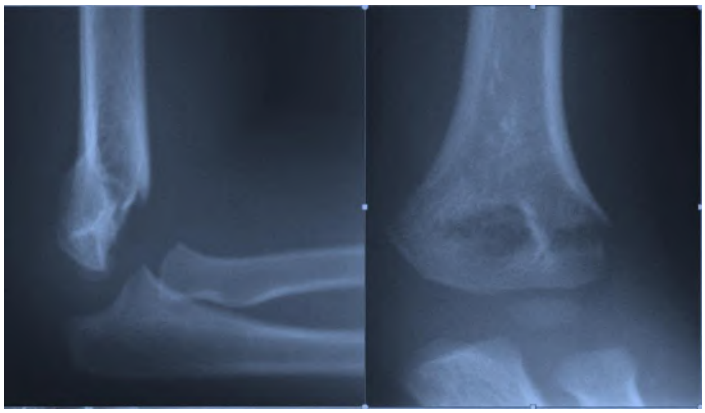

Figure 2. Type II, angulated/displaced fracture with intact posterior cortex

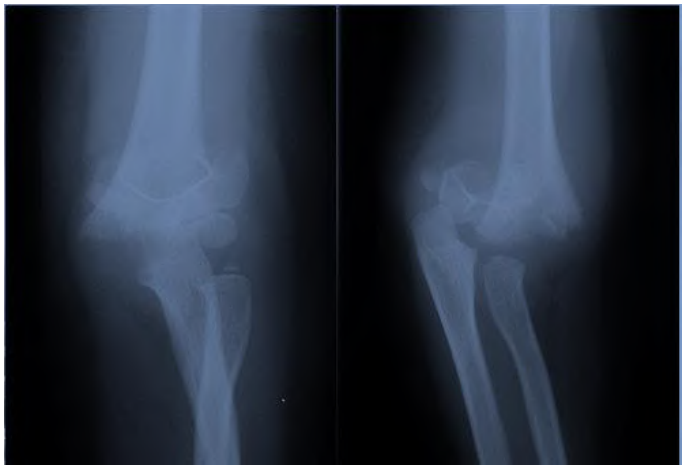

Figure 3. Type III, complete displacement, with no contact between fragments

Humeral supracondylar fracture may be accopmpanied by some complications such as nerve injury which occur in high incidence rate up to 16%; radial, median, and ulnar nerve can injured.

The anterior interosseous branch of the median nerve is commonly injured. In most if not all of these cases there is a limitation in the evaluation of nerve integrity because of the fact that the under-aged patients sometimes are incapable of cooperation with the examiner. A good and detailed pre-manipulation evaluation is important because the presence of any post-manipulation neurological deficits could affect the outcome of the current decision.

Despite the fact that vascular injury is rare complication, the pulses must be always checked before and also after the reduction. Although the radial and/or ulnar pulses may be absent, perfusion of the digits continues, due to excellent collateral circulation at the elbow. In addition, 5 percent of patients with distal radial deformity may be associated with the fracture of distal radius.

Clinically, the child after injury experienced pain. Post trauma swelling of the elbow region when and when the fracture is posteriorly displaced, S-deformity of the elbow is often present obviously with abnormal landmarks. Hence, it is crucial to assess the pukse and capillary return. Additionally, the passive extension of the flexor muscles should be performed with no pain. The proximal segment should also be examined for nerve root injury at the wrist and hand.

The first examination includes the X-ray imaging in the AP and lateral view. Sometimes in these views can be less than ideal especially because of the enforced movements of the injured limb. Furthermore in primary care or in the emergency room, physicians often make comparison views. Radiographic Anatomy/Landmarks – Bauman’s angle basically describes an angle between vertical line passing through humeral axis and resterting the physis of capitellum. This particular angle has a widely regarded normal reference value, however, it may change when the x-ray is altered in some other way. The correction of angular deformity was evaluated in views taken with the arm as a 60° angle notch. Evaluation of the reduction was more precisely achieved by using the KY angle rather than Bauman’s angle. Another landmark that should be assessed is the anterior humeral line which serves as a 'bread line region' outline to the anterior humeral cortex.

Management of humeral supracondylar fractures in children is based on the mechanism of injury, in type I injuries, immobilization is most efficacious. In Type II injuries, progression involved closed reduction and immobilization or operative intervention. Type III injuries however are accompanied by considerable amount of swelling and present high probability of neurological injuries or vascular compromise. Percutaneous pin fixation is currently the treatment option for almost all cases of type III fractures. However, open reduction may be utilized and required in cases that associated with vascular damage, open injuries with bone exposure or other complex fractures which cannot be closed.

2. PATIENTS and METHODS

A prospective study was carried out during a period of 12 months in Al-Imam Al-Hussain medical city/Karbala, middle of Iraq

A total of twenty cases of displaced supracondylar fracture (type 3) collected and treated with closed reduction and percutaneous pinning.

Usually, patients are admitted through emergency room or orthopedics outpatient clinic . Patients included were those who were aged 2-12 years with closed displaced fractures less than or equal to 72 hours post injury (we reported two cases attended at 5 days post injury).

Patient was excluded from the study if he/she had vascular injuries, hematological disorders, mental disorder, the parents did not consenting the participation or the management plan and those who were missed to follow up.

The excluded patients were managed separately and properly regardless their participation in the study.

Management protocol

A standard management protocol was followed; where, the patient was turned supine on the operating table and intubated as part of the routine procedure for percutaneous K wires insertion. Intravenous cefotaxime 500mg was given preoperatively.

Fluoroscopy –controlled reduction followed by fixation of the fracture was performed in all cases. The injured site (elbow) of the patient was cleaned, dressed and draped. The close reduction was manipulated under an image intensifier with maximum flexion of the elbow . Two cross or 2 lateral K-wires of 1.6 mm thickness were used. K-wires were held protruded in

their places with for easier extraction subsequently. A plaster splint was done on the for support.

Assessment of outcomes:

The duration of postoperative hospitalization was between 12 to 24 hours. K-wires and the back slabs were taken out after 3 weeks. Cases were assessed as per Flynn criteria (Table 1), which included functional and aesthetic aspects, and follow up was conducted for a period of up to six months.

Table 1. Criteria for fracture assessment

Results	Cosmetic factor loss of carrying angle (degree)	Functional factor loss of motion (degree)
Excellent	0 – 5	0 – 5
Good	6 – 10	6 – 10
Fair	11 – 15	11 – 15
Poor	> 15	> 15

3. RESULTS

Our study included a total of 20 patients, they were 14 males (70%) and 6 females (30%). Flexion type supracondylar fracture was observed in only 1 (5%) patient whilst the majority, 19/20 (95%) manifest with an extension type. Left elbow was more frequently affected, it was reported in 15 patients (75%), while right side elbow involved in the remaining 5 (25%) patients. Out of these patients, 13 patients (65%) showed excellent outcome (according to Flynn criteria) after management by closed reduction and percutaneous pinning with elbow motion loss and carrying angle loss of 0-5 degrees. In four patients (20%), good outcome was achieved i.e. 6-10 motion loss and carrying angle loss, three patients (15%) had a poor outcome with elbow motion loss of ≥ 15 degrees. None of the 20 studied patients achieved fair outcome (loss of motion and carrying angle loss of 11-15 degree). Unfortunately, 3 patients (15%) with poor outcome developed stiffness of the elbow

Surgical complications included pin tract infection which was treated and resolved after removal of the K-wire after 3 week. One patient complained of transient Ulnar nerve palsy but did improve and resolve after 6 postoperative weeks .

Table 2. Baseline characteristics of the studied group

Variable		No.	%
Gender	Male	14	70.0
	Female	6	30.0
Total		20	100.0
Affected elbow	Left	15	75.0
	Right	5	25.0
Total		20	100.0

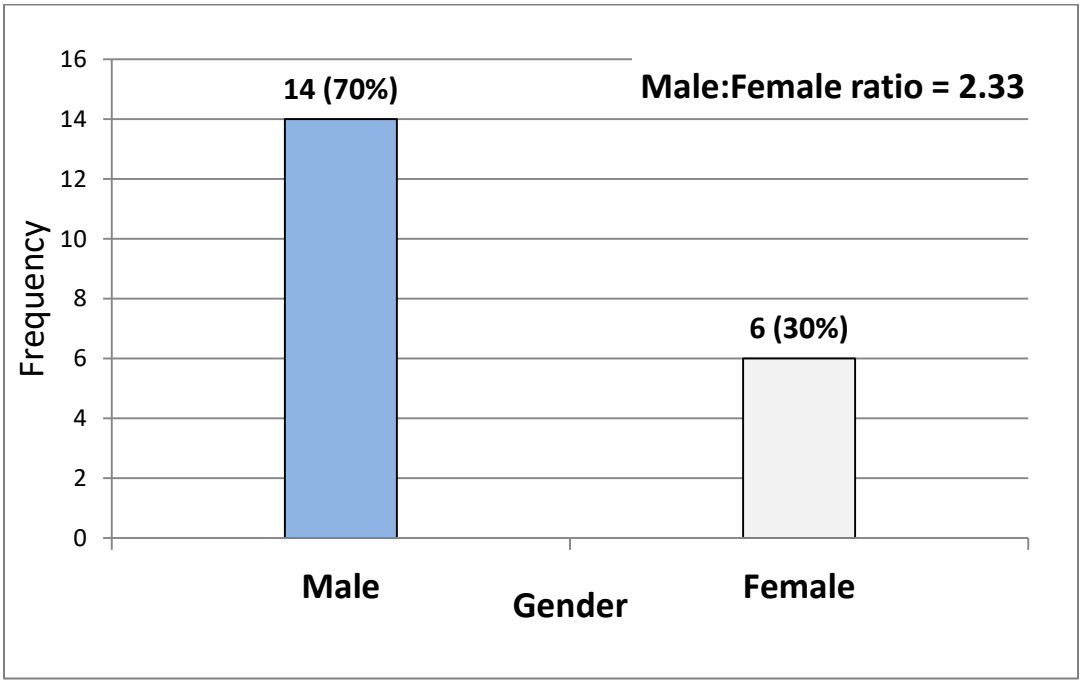

Figure 4. Gender distribution and ratio of the studied group

Table 3. Results of PCP according to Flynn criteria

Outcome	No.	%
Excellent	13	65.0
Good	4	20.0
Fair	0	0.0
Poor	3	15.0
Total	20	100.0

Table 4. Complications of surgery

Complication	No.	%
Pin tract infection	1	5.0
Transient Ulnar nerve palsy	1	5.0
Elbow stiffness	3	15.0
Total	20	100.0

4. DISCUSSION

The study of the problem of children's injuries remains relevant, because, they are more susceptible to injuries due to the fact that their bones and muscle are in developing process. Hence effective treatment and rehabilitation strategies are important to prevent long term complications and poor consequences which in turn improve the overall quality of life (4–6)

Despite the positive trend of reducing the morbidity of the child population in recent years as a whole, especially the levels of injuries, the consequences of injuries are quite serious - from temporary limitation of physical capacity to complications and permanent disability (7).

Various researchers have estimated that majority of intra-articular injuries of the upper limb in children are caused by injury to the bone structures of the elbow joint. Supracondylar fractures

of humerus are frequent in children and adolescents represent the commonest among these injuries in this population, furthermore, the extension supracondylar fractures are the vast common (1,7,8). Different treatment interventions are currently available; percutaneous pinning for displaced supracondylar fractures of the humerus in children has widely shown as an effective and safe procedure. It has been suggested as the standard operative method for displaced supracondylar humeral fractures (9). It has the advantage of being less than closed reduction and casting regarding the risk of compartment syndrome and loss of reduction of the fracture (10). Different studies assessed the outcomes of closed reduction and percutaneous fixation of humeral supracondylar fracture in children. It is well-known that this procedure is cost and time effective compared with open reduction and internal fixation which may accompanied by excessive soft tissue trauma, it needs prolonged surgery time, extended length of stay in the hospital and the more suture materials, however, in our country, few studies were conducted regarding this topic, therefore, the goal of our study is to fill part of the gap in this field and add scientifically sound conclusions to the growing literature about these procedures.

The objective of our study is to assess the outcomes closed reduction and percutaneous fixation performed as treatment method for group of Iraqi children with humeral supracondylar fractures. Therefore, we prospectively included 20 child patients complaining of humeral supracondylar fractures during the course of our study. They were 14 males and 6 females with predominance of males in a male to female ratio of almost 2.3 to one. Male predominance was also reported in previous studies; Ausó-Pérez et al. (11) performed a wide-ranging analysis of supracondylar fractures in children admitted to the emergency department in a single center in Spain and reported that supracondylar fractures are the most common childhood elbow fractures accounted for almost 18% of all pediatric fractures. Ausó-Pérez et al. (11) also observed a larger number of males compared to females among their studied group in a ratio of almost 1.6 to one (32 males / 20 females). Other studies found relatively higher numbers of males (1,12) However, Holt et al. found no significant difference in the incidence of these fractures across the gender (13), The gender variation in the incidence of these fractures could be attributed to the anatomical variation between both genders, therefore, it had been found that females were almost 6 months younger than males at the time of harboring the supracondylar fractures of humerus (14)

In our study we observed that 95% of the studied group presented had extension type fractures and only one patient (5%) had flexion type fractures. This result is congruent with the study carried out by Cekanauskas et al (15), Barr L.V. (1), Kim et al. (9) and Mazda et al. (8) who were all documented that the extension type is the most frequent type in vast majority of cases compared to flexion one in a rate reached up to 98%. This higher frequency of extension type can be attributed to the fact that typically fractures occur due to falls on an outstretched hand and hyperextension of the elbow joint (15).

After treatment and follow up period, the final outcome of our patients was good-excellent in 17 (85%) of cases we did manage, however, our findings consistent with the results of two earlier studies conducted by Tabak et al. (3) and Hannah et al. (16) where they reported an excellent and good outcomes in vast majority of their cases. Furthermore, a retrospective Iranian cohort study conducted by Parsa et al. (17) compared open versus closed reduction and pin fixation found no significant differences between the two methods in the range of motion of the fractured limb and radiographic angle at follow-up, but they found that closed reduction and pin fixation had shorter operation time compared to open method. Unfortunately 3 of our patients had poor outcomes and later on developed elbow stiffness, our finding was similar to that reported by Khan et al. who found that 65% of cases had excellent outcome, 20% with good and 15% had poor outcomes (18), from other point of view, Khan et al. reported cubitus varus in 6 patients (30%) and elbow stiffness in 10% , and the outcomes were excellent in 20%, good in 40%, fair in 10% and poor in 30%, This rate of poor outcomes and stiffness reported in our study was higher than that reported by Ababneh et al. (19) who documented poor outcomes in 8% of their cases.

5. CONCLUSIONS

Closed reduction and percutaneous pinning for displaced supracondylar humerus fractures in children is effective and safe procedure and it was cost effective and time preserving method that provide a stable fixation with good-excellent outcome. Lateral pins was preferable than cross in pins in stable fracture after reduction as it avoid the risk of ulnar nerve injury.

Therefore, we recommend using this method as a first option of treatment for closed supracondylar fractures in children as it avoids wound, fracture hematoma and possibility of more stiffness due to soft tissue dissection. However, we do not recommend this method for

cases that delayed for more than 7 days or those having severe swelling because in these cases it will be difficult to manipulate and may results in more stiffness. Further studies with larger sample size are intensively suggested for more clarification of the advantage and disadvantage of this method.

Ethical Clearance:

Ethical issues were taken from the research ethics committee. Informed consent was obtained from all parents of the children included in the study. Data collection was in accordance with the World Medical Association (WMA) declaration of Helsinki for the Ethical Principles for Medical Research Involving Human Subjects, 2013 and all information and privacy of participants were kept confidentially.

6. *REFERENCES:*

1. Barr L V. Paediatric supracondylar humeral fractures: Epidemiology, mechanisms and incidence during school holidays. J Child Orthop. 2014 Mar;8(2):167–70.
2. Khademolhosseini M, Abd Rashid AH, Ibrahim S. Nerve injuries in supracondylar fractures of the humerus in children: is nerve exploration indicated? J Pediatr Orthop B. 2013;22(2):123–6.
3. Tabak Y, Celebi L, Murath HH, Yağmurlu MF, Aktekin CN, Biçimoglu A. Closed reduction and percutaneous fixation of supracondylar fracture of the humerus and ipsilateral fracture of the forearm in children. J Bone Jt Surg Br Vol. 2003;85(8):1169–72.
4. Liebs TR, Lorance A, Berger SM, Kaiser N, Ziebarth K. Health-Related Quality of Life after Fractures of the Distal Forearm in Children and Adolescents—Results from a Center in Switzerland in 432 Patients. Children. 2022;9(10):1487.
5. Marson BA, Ikram A, Craxford S, Lewis SR, Price KR, Ollivere BJ. Interventions for treating supracondylar elbow fractures in children. Cochrane Database Syst Rev. 2022;9(6):22–30.
6. Murtezani A, Pustina A, BytyÇi C, Hundozi H. Rehabilitation of children after elbow injuries. Niger J Med. 2007;16(2):138–42.

7. Singh O, Gupta S, Din Darokhan MAU, Ahmad S, Charak SS, Sen A. Epidemiology of Pediatric Musculoskeletal Injuries and Their Pattern in a Tertiary Care Center of North India. Indian J Orthop. 2018;52(5):449–53.
8. Mazda K, Boggione C, Fitoussi F, Penneçot GF. Systematic pinning of displaced extension-type supracondylar fractures of the humerus in children: a prospective study of 116 consecutive patients. J Bone Jt Surg Br Vol. 2001;83(6):888–93.
9. Kim JW, Park KH, Oh CW. Tips and pitfalls of reduction and fixation in displaced supracondylar fractures in children. Vol. 5, Journal of Musculoskeletal Surgery and Research. 2021. p. 280–6.
10. Diesselhorst MM, Deck JW, Davey JP. Compartment Syndrome of the Upper Arm After Closed Reduction and Percutaneous Pinning of a Supracondylar Humerus Fracture. J Pediatr Orthop. 2014;34(2):e1–4.
11. Ausó JR, Rodríguez GM. Comprehensive Analysis of Pediatric Supracondylar Fractures in the Emergency Department; A Single Center Experience. Bulletin of emergency and trauma, 8(3), 142–147. https://doi.org/10.30476/BEAT.2020.83195. Vol. 8. 2020. p. 142–7.
12. Erika Alejandrina Barrón-Torresa, Juan Francisco Sánchez-Cruzb y JRCM. Clinical and epidemiological characteristics of humeral supracondylar fractures in paediatric patients in a Regional General Hospital. Cir Cir. 2015;83(1):29–34.
13. Holt JB, Glass NA, Shah AS. Understanding the Epidemiology of Pediatric Supracondylar Humeral Fractures in the United States: Identifying Opportunities for Intervention. J Pediatr Orthop. 2018;38(5):e245–51.
14. Kumar V, Singh A. Fracture supracondylar humerus: A review. Vol. 10, Journal of Clinical and Diagnostic Research. 2016. p. 1–6.
15. Cekanauskas E, Degliute R, Kalesinskas RJ. Treatment of supracondylar humerus fractures in children, according to Gartland classification. Vol. 39, Medicina (Kaunas, Lithuania). 2003. p. 379–83.
16. Dineen HA, Stone J, Ostrum RF. Closed Reduction Percutaneous Pinning of a Pediatric Supracondylar Distal Humerus Fracture. J Orthop Trauma [Internet]. 2019;33. Available from:

https://journals.lww.com/jorthotrauma/fulltext/2019/08001/closed_reduction_percutaneous_pinning_of_a.5.aspx

17. Parsa A, Esmaeili B, Moghaddam MH, Kashani FO, Moghaddam MD, Rezaeian A. Closed Reduction versus Open Reduction and Pin Fixation in Pediatric Type III Supracondylar Humeral Fractures. Int J Pediatr, Vol8,. 2020;8(7):11609–15.
18. Khan MS, Sultan S, Ali MA, Khan A, Younis M. Comparison of percutaneous pinning with casting in supracondylar humeral fractures in children. J Ayub Med Coll Abbottabad. 2005;17(2).
19. Ababneh M, Shannak A, Agabi S, Hadidi S. The treatment of displaced supracondylar fractures of the humerus in children: A comparison of three methods. Int Orthop. 1998;22:263–5.

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