

## Lateral Divergent Pinning Versus Lateral Parallel Pinning in Management of Supracondylar Fractures of the Humerus in Children

M.O.Hegazy, M.A.Meselhy and A.A.EL-Nabasy

Orthopaedic Surgery Dept., Faculty of Medicine, Benha Univ., Benha, Egypt

E-Mail: M.Mahdy@gmail.com

### Abstract

Supracondylar humerus fracture in children is a very common elbow injury. The commonly accepted treatment of type II and III supracondylar fractures of humerus in children is closed reduction with percutaneous pinning. Lateral pinning has an advantage of avoiding the possibility of iatrogenic ulnar nerve injury. This study was conducted to compare the stability of lateral divergent pinning and lateral parallel pinning in treatment of type II and type III supracondylar humerus. A prospective, randomized, single Centre, study was conducted at the Emergency Department of Benha university hospitals from March 2019 to November 2019. Thirty children with supracondylar humerus fracture Gartland type IIB and type III were treated with two techniques: lateral divergent (15 patients), and lateral parallel (15 patients). All of them were included for the study and analysis of results regarding functional outcome and graded according to Flynn's criteria and Baumann's angle. Thirty children were treated for displaced supracondylar fracture of humerus during the study period, 9 females and 21 males, and mean age was 5.1 years. The mean duration from admission to surgery was 17.3 hours, The mean follow-up duration was 3 months. In lateral divergent pinning group, 14 patients with excellent result and one good. In lateral parallel pinning technique 13 patients with excellent and 2 good. There was no statistically significant difference with regard to functional outcome between the two groups. Both methods produced satisfactory results in all cases.

**Keywords:** Supracondylar fracture humerus, Divergent, parallel, Lateral, Kirschner wires.

### 1. Introduction

Supracondylar cracks are the most well-known pediatric break. Humeral cracks are normal in the pediatric populace and record for practically 70% of elbow breaks. The occurrence tops between the ages of 5 - 8 years [20]. These breaks are either extension or flexion type with fluctuated system of injury. Augmentation type cracks represent 96-99% of all supracondylar breaks [3]. Supracondylar cracks are normally arranged dependent on the Gartland arrangement of characterization, where they are isolated into three sorts: Type I being non-dislodged, type II being uprooted yet with a flawless back cortex, and type III being uprooted and with no cortical contact [8].

Despite the fact that type I is commonly treated nonoperatively, type II and type III are by and large dealt with shut decrease and sticking so as to evade malunion [13]. Ideal pin design and the quantity of pins needed to give satisfactory crack soundness to keep up decrease and advance legitimate association, while limiting the danger of neurovascular injury remain issues of discussion [3].

The first method included the utilization of one parallel and one average pin embedded percutaneously yet a few creators have revealed iatrogenic ulnar nerve injury paces of up to 10% for average pin situation, and have upheld horizontal pin obsession alone to diminish this difficulty [16].

Despite the fact that these nerve wounds for the most part resolve inside a year, constant ulnar nerve paralysis has likewise been accounted for [18]. Additionally, creators of review clinical investigations have reasoned that pin inclusion through the parallel condyle alone, which maintains a strategic distance

from injury to the ulnar nerve, is as clinically powerful as crossed-pin addition through the average epicondyle and sidelong condyle in balancing out supracondylar humeral cracks [21].

The point of this work was to analyze the consequences of the horizontal disparate and the sidelong equal sticking in 30 kids under 10 years with Gartland types II and III supracondylar humeral cracks.

### 2. Patients and methods

This planned randomized-controlled preliminary was led in Benha college clinics during the period from March 2019 to November 2019 including 30 kids under 10 years with Gartland types II and III supracondylar humeral breaks, and a subsequent time of 3 months. The patients were isolated into two equivalent gatherings. Patients in bunch I were dealt with horizontal unique sticking, and those in bunch II were made do with sidelong equal sticking.

Patients booked for shut decrease and K wiring of supracondylar breaks of the humerus under broad sedation were type II or III supracondylar cracks of the humerus. Patients were under 10 years, and Consent was acquired from the youngster gatekeeper to partake in the examination. The rejection measures were open breaks, cracks with vascular injury, cracks with compartmental disorder, cracks with pre-employable ulnar nerve injury, and refusal to give an educated assent.

All the youngsters with associated supracondylar break with elbow were seen at the Emergency Department. They were evaluated for vascular and neurological status. Anteroposterior and sidelong radiographs were finished. All uprooted supracondylar

cracks were conceded, and harmed elbow was immobilized in support with elbow in 90 to 120 degrees of expansion. Height and ice pressure were exhorted. Medical procedure was arranged and method was chosen by arbitrary number produced by PC, and was wrapped safely to be opened at medical procedure time.

Careful methods were normalized regarding pin area, the pin size (1.6mm to2mm), dependability on table, position of elbow for pins situation and the post-employable course.

General sedation was utilized for all patients, no tourniquet was required. The decrease was done while keeping up steady footing with varus-valgus rectification controlling revolution of the crack by the average and sidelong humeral epicondyles. The elbow was then hyperflexed utilizing thumb pressure over the olecranon to lessen the break, and the lower arm was then completely pronated as this controls the average turn and with flexion secures the crack. The break was fixed either by the horizontal equal Fig (1) or the sidelong different (Fig 2) strategy as indicated by the randomization.

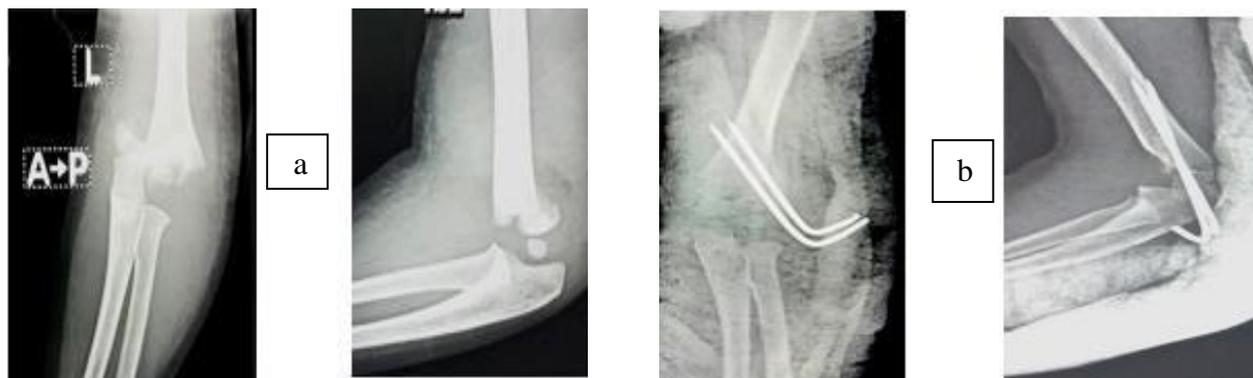


Fig (1) Male patient 3.5 years old with left supracondylar humerus fracture, lateral parallel technique a) preoperative x-ray, b) postoperative x-ray.



Fig (2) Male patient 8 years old with left supracondylar humerus fracture, lateral divergent technique a) preoperative x-ray, b) postoperative x-ray.

Elbow was immobilized with posterior slab with elbow in 90 to 120 degree of flexion depending upon the swelling and neurovascular status. All the patients were followed up at the orthopedic out-patient clinic and reviewed. Plaster slab was usually removed after 4 weeks. Radiographic evaluation was performed by antero-posterior and lateral radiographs of the elbow.

All the patients were evaluated at one week, two weeks, four weeks, six weeks, two months and three months. Neurovascular examination was performed preoperatively and immediate posts operatively and at one

week follow up. In both groups K wires were removed after four weeks. At the three months follow up children were evaluated for full function according to Flynn's criteria for grading involving the evaluation of carrying angle loss (cosmetic), flexion and extension loss. . Carrying-angle loss excellent (0°–5°), good (5°–10°), fair (10°–15°), and poor (>15°) when compared to normal side. Flexion loss and extension loss values according to Flynn's criteria excellent (0°–4°), good (5°–9°), fair (10°–15°), and poor (>15°) when compared to normal side [17] Table (1).

**Table (1)** Modified Flynn's criteria to evaluate outcome of treatment.

Parameters	Rating	Carrying angle loss	Flexion loss	Extension loss
<b>Results</b>				
	Excellent	0-4	0-4	0-4
<b>Satisfactory</b>	Good	5 to 9	5 to 9	5 to 9
	Fair	10 to 14	10 to 14	10 to 14
<b>Unsatisfactory</b>	Poor	>15	>15	>15

**Statistical analysis**

Data were statistically described in terms of mean - standard deviation (- SD). Comparison between the study groups was done using Mann-Whitney test, all data were compiled and calculated by SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA). Significance of difference was measured by determining P-value and value less than <0.05 was considered significant.

**3. Results**

The mean age at presentation was about 5.1 years (range: 1.5–9 years). The study included both sexes: 9 (30%) were females and 21 (70%) were males. The mode of trauma was fall to the ground in 19 patients, fall downstairs in 7 patients and fall from height in 4 patients. The study included 2 cases of flexion type, and 28 cases of extension type. The left side was in 18 cases, and the right side was in 12 cases. Gartland grade II was present in 3 cases, and Gartland grade III was present in 27 cases Table (2).

**Table (2)** Type, grade and side of fracture of the study group.

Type and side of fracture	The study group (No = 30)
<b>Type</b>	
<b>Flexion</b>	2(6.67%)
<b>Extension</b>	28(93.33%)
<b>Side</b>	
<b>Right</b>	12 (40%)
<b>Left</b>	18 (60%)
<b>Grade of fracture according to Gartland</b>	
<b>Grade II</b>	3 (10%)
<b>Grade III</b>	27(90%)

The carrying angle loss in parallel pinning group was in 13 patients excellent (86.67%), and 2 good (13.33%). In divergent pinning group, 14 were excellent (93.33%), and one good (6.67%). The mean loss in carrying angle in patients treated by divergent pinning was  $3.4 \pm 1.350$  (range: 20-60), while that in patients treated with parallel pinning was  $2.8 \pm 1.030$  (range: 20-50).

The extension loss in parallel pinning group was in 14 (93.33%) excellent, and one good (6.67%). In divergent pinning group, there were 15 (100%) excellent. The mean loss in elbow extension in patients treated with divergent pinning fixation was  $2.4 \pm 1.10$  (range: 00-40), while that in patients

treated with parallel pinning fixation was  $2.8 \pm 1.20$  (range: 20-60).

The flexion loss in parallel pinning group was in 14 cases (93.33%) excellent, and one good (6.67%). In divergent pinning group, there were 14 cases (93.33%) excellent, and one case good (6.67%). The mean loss in elbow flexion in patients treated with divergent pinning fixation was  $3.2 \pm 1.20$  (range: 20-60), while that in patients treated with parallel pinning fixation was  $3.1 \pm 2.10$  (range: 00-80).

The mean Baumann angle loss in the divergent pinning fixation group was  $2.3 \pm 1.630$  (range: 00-50) and in the parallel pinning fixation group was  $2.8 \pm 1.680$  (range: 00-50) Table (3).

**Table (3)** Statistical analysis of lateral divergent pin fixation and lateral parallel pin fixation.

Fixation	Lateral divergent pinning fixation (Mean $\pm$ SD) (n=15)	lateral parallel pinning fixation (Mean $\pm$ SD) (n=15)	P value (Mann-Whitney test)
<b>Parameters</b>			
<b>Carrying angle loss</b>	$3.4 \pm 1.35$	$2.8 \pm 1.03$	0.452
<b>Elbow extension loss</b>	$2.4 \pm 1.1$	$2.8 \pm 1.2$	0.805
<b>Elbow flexion loss</b>	$3.2 \pm 1.2$	$3.1 \pm 2.1$	0.723
<b>Baumann angle loss</b>	$2.3 \pm 1.63$	$2.8 \pm 1.68$	0.417

Comparing results of both techniques according to Flynn's criteria following lateral divergent pinning,

excellent results were found in 14 cases (93.33%), and good results in 1 case (6.67%). Following lateral

parallel pinning, excellent results were found in 13 cases (86.67%), and good results in 2 cases (13.33%) Fig (3).

Pin tract infection was present in one patient and treated by lateral pinning fixation. For this patient, pin site cleaning by removal of crusts, wires and repeated dressing

using Neomycin spray as local antibiotic and oral antibiotic (Amoxicillin-clavulanic acid) lead it to recover at the subsequent follow-up.

No neurovascular injury or deficit that required exploration was encountered. There was no case of compartment syndrome or Volkmann ischemic contracture on the last clinical review.

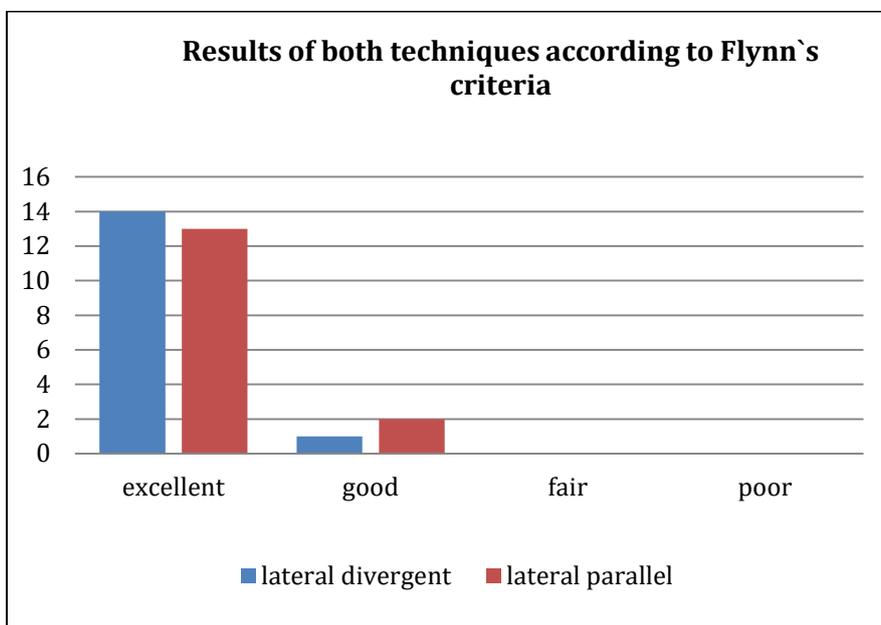


Fig (3) Results of both techniques according to Flynn's criteria.

Table (4) Complications of the fracture of the study group.

Complications of the fracture	The study group N = 30
Nil	29 (96.67%)
Pin tract infection	1 (3.33%)

4. Discussion

The main goal of surgery in pediatric supracondylar humerus fracture is the safe creation of a construct that is stable enough to prevent axial rotation and hyperflexion and extension of the distal fragment and thus avoid postoperative deformity [7], which has been reported to be as high as 17% [17].

Closed reduction with percutaneous pin fixation for the management of displaced or angulated supracondylar humeral fractures in children has become widely adopted, but optimal pin configuration remains controversial [5] and [15]. Open reduction is usually unnecessary, although it sometimes can be required to obtain complete reduction especially in cases in which the fracture cannot be reduced because of the presence of a vascular lesion [12].

In our study, the fractures that were treated using both techniques did not show fixation loss, the mean follow-up duration of the 30 patients was 3 months (range: 2.8 - 3.2 months). Above elbow slab were made for all the patients whom continued for 4 weeks duration post-operation. Twenty nine of them regained their full range of elbow motion after removal the slab through one week. One patient achieved full elbow

motion after removal above elbow slab through 2 weeks.

Malunion in the coronal plane was assessed both clinically by measuring the carrying angle at last follow-up and radiologically by measuring the Baumann angle at 12 weeks after treatment. Based on these clinical and radiological Parameters, we were not able to find any difference in the change of coronal and sagittal plane alignments of the distal fragment after treatment with the two methods of pin fixation.

Since the enrolment of both groups was randomized, and the standard protocol of reduction was applied for both groups, we considered the change of alignment in any plane at the end of the study period was due to loss of reduction during healing process in the cast. In other words, they reflect the stability of fixation in clinical setting. Therefore, we can consider that there was no difference in the stability of fixation provided by either the lateral divergent pinning or the lateral parallel pinning

There were no patients with a carrying-angle loss of 10° or more compared to the opposite elbow. More than 10 loss in carrying angle may lead to

development of cubitus varus deformity. The cubitus varus may need to be corrected not only for cosmetic appearance, but also to avoid tardy posterolateral rotatory instability of the elbow in future (Mazda et al., 2011). We found No iatrogenic neurovascular injuries during the study in patients treated with both techniques

All our patients had good nail or pulp perfusion, and in all the patients these findings were maintained throughout the period of traction, manipulation, pin fixation, and in slab. None of the patients in our series developed evidence of ischaemic contracture to suggest muscle necrosis at follow-up.

Lu et al. [8] in a prospective study from Feb. 2004 to Jun. 2010; 128 cases of supracondylar humerus fractures in children (96 boys and 32 girls) were treated by manipulative reduction and lateral percutaneous K-wire fixation, all these children were followed up from 2 to 36 months (16 months on average). According to Flynn evaluation standard, the result were excellent in 116 children (90.6% of the total patients), good in 11 (8.6%), fair in 1 (0.8%), no infection, no ischemic muscular atrophy and no nerve damage had been found during the treatment. They concluded that manipulative reduction and lateral percutaneous K-wire fixation of supracondylar humerus fractures in children is stable and reliable, easy to be operated, safe and effective and low cost, and it can also avoid the complication caused by conservative treatment and operation. It is a good treatment of supracondylar humerus fractures in children

Mulpuri and Wilkins K [7] showed that crossed pins do provide more torsional stability than do 2 lateral pins but do not offer significantly more torsional stability than do 3 lateral pins

Chakraborty et al. [4] reported a retrospective study of 92 children. 56 were fixed by medial and lateral crossing wires and 36 were fixed by 2 lateral wires, there 4 cases of iatrogenic ulnar nerve injury in crossing wires and 4 cases of radial nerve injury in 2 lateral wires. There were 4 cases of cubitus varus in crossing wires and 10 cases of cubitus varus in 2 lateral wires. 4 cases of ulnar nerve injury were explored.

Anwar et al. [2] reported a prospective study of 50 children, 25 were fixed by medial and lateral crossing wires and 25 were fixed by 2 lateral wires, as regard carrying angle loss according to Flynn,s criteria the results were excellent in 72% and good in 28% in both methods, the mean loss of elbow flexion and extension were 8.36 and 7.26 respectively. There was one case of iatrogenic ulnar nerve injury in crossing wires.

Maity et al. [10] reported a prospective study which was long term study between October 2007 and October 2010 of 160 children, 80 in each group. The follow up duration was 3 months. 30 of 160 children did not complete the follow up visits. reported that there was no significant difference between the two methods as regard results and complication.

Guy et al. [6] reported in a prospective study of 25 children were fixed by three lateral divergent wires the mean follow up period was 5 months, as regard Flynn's criteria excellent results was in 21 cases, good in 3 cases, and poor in one case.

Zhao et al. [21] performed a meta-analysis of randomized controlled trials included 521 patients to compare the risk of iatrogenic ulnar nerve injury caused by pin fixation, the quality of fracture reduction in terms of the radiographic outcomes, and function in terms of criteria of Flynn, and elbow range of movement, and other surgical complications caused by pin fixation, suggested that iatrogenic ulnar nerve injury was higher with the crossed pinning technique than with the lateral entry. There were no statistical differences in radiographic outcomes, function, and other surgical complications. They conclude that the medial and lateral crossed pinning fixation is more at risk for iatrogenic ulnar nerve injury than the lateral pinning technique.

## 5. Conclusion

There was a measurably inconsequential distinction between horizontal different and equal sticking method regarding soundness, term of bone recuperating, loss of decrease and neuro-vascular wounds. Different or equal pin obsession were compelling and safe in dodging iatrogenic ulnar nerve injury, and were proper alternatives for giving stable obsession of uprooted or calculated supracondylar humeral breaks in youngsters.

## References

- [1] J.M. Abzug, M.J. Herman, Management of supracondylar humerus fractures in childr.en: current concepts. *J Am Acad Orthop Surg*, vol. 20(2), pp.69-77,2012.
- [2] W. Anwar, N. Rahman, M.J. Iqbal Comparison of the two methods ofPercutaneous K -Wire Fixation in Displaced Supracondylar Fracture of Humerus in children. *J Postgrad Med Inst*,vol. 25(4), pp.356-61,2011.
- [3] B. Brighton, J.M. Abzug, C.A. Ho, Current strategies for the management of pediatric supracondylar humerus fractures: tips and techniques for successful closed treatment. *Instr Course Lect*, vol.65,pp.353-60,2016.
- [4] M.K. Chakraborty, P.R. Onta, B Sathian, Displaced supracondylar fracture of humerus in children treated with crossed pin versus lateralpin: A Hospital based Study from Western Nepal. *JCDR*, vol.5(6),pp. 1260-63,2011.
- [5] E.W. Edmonds, J.H. Roocroft, S.J. Mubarak, Treatment of displaced pediatric supracondylar humerus fracture patterns requiring medial fixation: a reliable and safer cross-pinning technique. *J Pediatr Orthop*, vol. 32.4,pp.346-

- 51,2011.
- [5] S.P. Guy, R.R. Ponnuru, S. Gella , Lateral entry fixation using three divergent pins for displaced paediatric supracondylar humeral fractures. *ISRN Orthop*,vol.13, pp.70-72,2011.
- [6] Howard, K. Mulpuri, M.F. Abel, The treatment of pediatric supracondylar humerus fractures. *J Am Acad Orthop Surg*, vol.20(5), pp.320–27,2012.
- [7] S. Leung, E. Paryavi, M.J. Herman, Does the modified Gartland classification clarify decision making? *J Pediatr Orthop*, vol.38(1),pp.22-26,2018.
- [8] X.Z. Lu, C.X. Hu , B.H. Liu , Manipulative reduction and lateral percutaneous K-wire fixation for treatment of supracondylar humerus fractures in 128 children. *ZhongguoGu Shang*, 10:872-4.
- [9] Maity, D. Saha ,D.S. Roy ,A prospective randomised, controlled clinical trial comparing medial and lateral entry pinning with lateral entry pinning for percutaneous fixation of displaced extension type supracondylar fractures of the humerus in children. *J Orthop Surg Res*,vol.32,pp.153-42,2012.
- [10] K. Mazda, C. Boggione, F. Fitoussi , Systematic pinning of displaced extension-typesupracondylar fractures of the humerusinchildren, From Robert Debré Hospital, Denis Diderot - Paris VII University, France, *JBJS(Br)*,vol. 83-B(6),pp.888-93,2011.
- [11] R.D. Muchow, A.I. Riccio, S. Garg , Neurological and vascular injury associated with supracondylar humerus fractures and ipsilateral forearm fractures in children. *J Pediatr Orthop*, vol. 35(2), pp.121-12,2015.
- [12] K. Mulpuri, H. Hosalkar, A. Howard , AAOS clinical practice guideline: the treatment of pediatric supracondylar humerus fractures. *J Am Acad Orthop Surg*,vol. 20(5), pp.328-30,2012.
- [13] K. Mulpuri , K. Wilkins , The treatment of displaced supracondylar humerus fractures: evidence-based guideline. *J Pediatr Orthop* , vol.32, pp.143-52,2012.
- [14] K. Prashant, D. Lakhota, T.D. Bhattacharyya, A comparative study of two percutaneous pinning techniques (lateral vs medial-lateral) for Gartland type III pediatric supracondylar fracture of the humerus. *J OrthopTraumatol*, vol.17(3), pp.223-29,2016.
- [15] H. Shtarker, M. Elboim-Gabyzon, E. Bathish , Ulnar nerve monitoring during percutaneous pinning of supracondylar fractures in children. *J Pediatr Orthop*, vol. 34(2),pp.161-65,2014.
- [16] D.L. Skaggs, M.W. Cluck, A. Mostofi, Lateral-entry pin fixation in the management of supracondylar fractures in children. *J Bone Joint Surg Am*, vol.86 (4), pp.702-7,2010.
- [17] M. Valencia, L. Moraleda, J. Díez-Sebastián , Long-term functional results of neurological complications of pediatric humeral supracondylar fractures. *J Pediatr Orthop*,vol.35(6), pp.606-10,2015.
- [18] N Vallila, A. Sommarhem, M. Paavola , Pediatric distal humeral fractures and complications of treatment in Finland: a review of compensation claims from 1990 through 2010. *J Bone Joint Surg. Am*, vol.97(6),pp.494–99,2015.
- [19] K.E. Wilkins , Supracondylar Fracture of the Distal Humerus. In: *Rockwood Fractures in Children*. 7th Ed. Philadelphia, Lippincott-Raven,vol. 4, pp.76-81,2010.
- [20] P. Woratanarat, C. Angsanuntsukh, S. Rattanasiri, Meta-analysis of pinning in supracondylar fracture of the humerus in children. *J Orthop Trauma*, vol.26(1), pp.48-53,2012.
- [21] J.G. Zhao, J. Wang, P. Zhang , Is Lateral Pin Fixation for Displaced Supracondylar Fractures of the Humerus Better Than Crossed Pins in Children? *Clin Orthop Relat Res*,vol.471,pp.2942–53,2013.