

1 **Introduction:**

2 Supracondylar humeral fractures are the most common elbow fractures in children which  
3 accounts for 3% of all paediatric fractures (1). Ninety eight percent of these fractures are  
4 extension type.

5 Based on Gartland classification, three types have been defined (2). Management of type  
6 III extension type fractures includes non-surgical and surgical treatments. Surgery would  
7 be closed reduction and percutaneous pin fixation as the first choice of treatment in the  
8 first 8 hours in which image intensifier is required (3, 4). If this method is not successful,  
9 open reduction and internal fixation using different approaches will be indicated.

10 **Methods**

11 We retrospectively reviewed 114 patients suffering type III extension type supracondylar  
12 humeral fractures. We included 98 patients who suffered closed fractures and type I  
13 Gustillo open fractures in which closed reduction were unsuccessful. Type I or II  
14 Gartland fractures, open fractures type II or III Gustillo, patients with poor skin condition  
15 and blisters as well as vascular damage were excluded from our study. Triceps sparing  
16 approach was used for open reduction and internal fixation. All surgeries were performed  
17 by one surgeon and the patients were followed up 12- 24 months and were assessed  
18 clinically and radiographically.

19 *Triceps-sparing approach:* Under general anaesthesia and in lateral decubitus position, a  
20 pneumatic tourniquet in proximal end of the upper limb was used. Tourniquet pressure  
21 was set at 50 mmHg more than patient's systolic pressure (about 155 to 190 mmHg) (5).

22 At first, using a posterior approach, ulnar nerve was explored and preserved. By means of  
23 this exposure through medial and lateral sides of triceps tendon, maintaining extensor  
24 mechanism intact, hematoma was washed out and posterior synovial tissue was removed.  
25 After identification of fracture line and fragments, reduction under direct vision was  
26 performed. Internal fixation was carried out using two or three 1.5-2mm crossing pins  
27 which is a strong construction biomechanically (6). In case of comminution of any  
28 column and in patients older than ten years old, two or more pins were used on each side.  
29  
30 For easy pin removal especially in medial side, the pin ends were left outside the skin.  
31 After irrigation with saline and inserting a drain, skin was closed and the elbow was  
32 splinted in 70-90° of flexion. Sutures were removed after 10 to 14 days.  
33 At 4 weeks after surgery, splint was removed. In case of radiologic union, the pins were  
34 removed: however, if there is any sign of delayed union, active range of motion was  
35 started with pins left in place to avoid stiffness and the pins were removed after healing.  
36 At 6, 12, 18 and 24 months follow up visits were performed.  
37 Generally speaking, the most important complication of this fracture is Cubitus varus  
38 due to malunion (7). Using X-ray, this deformity could be evaluated by Jones view in  
39 which direction of the X-ray beam is perpendicular to the distal humerus. In addition,  
40 Baumann angle measurements were compared with the contralateral side. Normal range  
41 of this angle is 9-26°. Basically, Baumann angle more than ten degrees or less than four  
42 degrees in comparison with the normal elbow reveals no varus and is acceptable (8).

43 Relationship of the anterior humeral line to the capitulum and rotational displacement  
44 were assessed on X-ray.

45 At follow ups, time of fracture union, elbow range of motion, presence of any malunion  
46 confirmed by abnormal Baumann Angle on X-ray, heterotopic ossification, neurovascular  
47 complications and local complications such as pin infection and pin loosening as well as  
48 wound dehiscence were evaluated.

49 **Results:** As it has been revealed on Table 1 and 2, mean age of our patients was 6.4 years  
50 old (3-12), boys to girls ratio was 2.06 and right to left side was 2.26. In 82% of patients  
51 fractures happened on dominant side and 7% of patients suffered type 1 Gustilo open  
52 fracture. The average time from injury to surgery was 50.16 hours.

53 Fracture union was confirmed radiologically at 4 and 6 weeks follow up in 57% and 41%  
54 of patients respectively and the rest (2%) healed 8 weeks after surgery.

55

56 The Mean time of follow up was 14.3 months (12 to 24). Elbow range of motion  
57 measurement was performed using a goniometry. Mean lack of extension was  $3.5^{\circ}$  and its  
58 maximum was  $15^{\circ}$  (0 to  $15^{\circ}$ ). Mean Baumann angle difference compared to the normal  
59 side was  $2.4^{\circ}$  (0- $6^{\circ}$ ).

60 The rate of complications was 19.3%, including, pin tract infections (7%), pin loosening  
61 (3%), heterotopic ossification (4%), and wound dehiscence (1%). There were 4 cases  
62 (4%) transient anterior interosseous nerve palsy, two of which were documented before  
63 surgery, the other two were noticed after surgery and all of them resolved after 3 to 10

64 weeks spontaneously. There were no major complications such as malunion, nonunion,  
65 vascular injury, nerve damage and deep infection.

66 **Table1: Characteristics of the patients.**

67 **Table 2: Results.**

## 68 Discussion

69 According to a systemic review performed by Mazzini et al there is no consensus for the  
70 most acceptable approach along with the least complications in supracondylar humerus  
71 fractures in children. (9). Terry Canale and James H.Beaty recommended using an  
72 anterior approach for extension-type supracondylar fractures and a posterior approach for  
73 flexion-type ones (8).

74 Skaggs and.Flynn also agrees with this concept mentioning direct visualization of the  
75 brachial artery and median nerve as well as the fracture fragments as some advantages of  
76 this approach (16). However, we believe using posterior approach allows us to reach and  
77 see the fracture site easily and fast, without any X-ray exposure and jeopardizing the  
78 neurovascular components and extensor mechanism, providing more acceptable surgical  
79 scar.

80 Aktekin et al compared the results of open reduction and percutaneous pinning using this  
81 triceps-sparing method in 23 cases with 32 patients who underwent closed reduction and  
82 percutaneous pinning (12). They concluded the preference of closed reduction to open  
83 reduction which is definitely the most acceptable conclusion.

84 Shawkat A also found very satisfactory results using the Triceps-sparing approach in 14

85 neglected pediatric supracondylar humerus fractures (13). Rizk AS obtained very  
86 satisfactory results using this approach in 15 children who had neglected displaced  
87 supracondylar and distal humeral fractures.

88 According to Sibly TF et al, compared to closed treatment, less than 10 degrees range of  
89 motion restriction happened after open reduction using posterior approach consisting of  
90 inverted V incision in Triceps. They concluded that posterior approach does not result in  
91 major loss of elbow range of motion (15).

92 Although some people believe in anterior approach in management of extension type  
93 supracondylar humerus fractures in children, using posterior approach provides us  
94 excellent visualization of fracture site without the need to  
95 exposure and possible jeopardizing anterior neurovascular elements. (13, 16)

96 Functional performance of elbow in all patients was good with no major complication,  
97 requiring application of competent skill and knowledge in treating these patients.

98 The limitation of our study was low number and lack of control group which should be  
99 considered to get more precise conclusions.

## 100 **Conclusion**

101 Triceps-sparing approach for open reduction and internal fixation of pediatric displaced  
102 supracondylar humeral fractures provides an easy access to fracture site and good  
103 exposure without using image intensifier. Leaving the elbow extensor mechanism intact,  
104 protection of Ulnar nerve and an acceptable surgical scar are the other advantages of this  
105 approach.

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