RESEARCH ARTICLE

Triceps-sparing Posterior Approach for Supracondylar Humeral Fracture in Children

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Abstract

Background: The most common pediatric elbow fracture is supracondylar humeral fracture which accounts for 60% of elbow fractures in children. The aim of this study was to evaluate the results of open reduction and internal fixation of type III supracondylar humeral fractures using a Triceps sparing posterior approach.

Methods: In total, 98 patients were evaluated from June 2007 to 2014.

Results: According to the results, the mean age of the patients was 6.4 years. The ratios of males to females and the right to left hand were 2.06 and 2.26, respectively. Totally, 82% of fractures happened in the dominant hand which was right. The patients underwent surgery within approximately 50.16 hours after injury. Anatomic reduction and internal fixation were performed under direct vision with no need for image intensifier. The mean time of follow-up was 14.3 months, and all fractures healed clinically and radiologically. Moreover, the maximum lack of an extension was 15° and the obtained mean was 3.5°. Additionally, the mean final Bauman angle difference with healthy elbow was determined at 2.4°. The rate of complications was 19.3%, including pin tract infections (7%), pin loosening (3%), heterotopic ossification (4%), and wound dehiscence (1%). Furthermore, there were 4 cases (4%) of anterior interosseous nerve palsy, two of which happened before surgery, and the other two following the surgery. All of these complications were resolved within 3 to 10 weeks spontaneously.

Conclusion: This approach helped preserve the extensor mechanism and ulnar nerve intact to have an acceptable skin scar esthetically along with satisfactory postoperative function.

Level of evidence: IV

Keywords: Gartland, Supracondylar humeral fractures, Triceps-sparing approach

Introduction

Supracondylar humeral fractures are the most common elbow fractures in children which accounts for 3% of all pediatric fractures (1). In total, 98% of these fractures are extension-type ones. Three types of fractures have been defined based on Gartland classification (2). Non-surgical and surgical treatments are regarded as the management strategies of type III extension-type fractures. The surgical technique in which the image intensifier is required includes the closed reduction and percutaneous pin fixation as the first choice of treatment in the first 8 hours (3, 4). On the other hand, open reduction and internal fixation using different approaches will be indicated if the aforementioned method is not successful.

Materials and Methods

In total, 114 patients suffering from type III extension-type supracondylar humeral fractures were

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investigated in this retrospective review. Moreover, 98 patients with closed fractures and type I Gustillo open fractures whose closed reduction was unsuccessful were included in this study. On the other hand, the patients with Gartland type I or II fractures, Gustillo type II or III open fractures, poor skin condition and blisters, as well as vascular damage were excluded from this study. Triceps sparing approach was utilized for open reduction and internal fixation. All surgeries were performed by one surgeon and the patients were followed up 12-24 months and assessed clinically and radiographically.

Triceps-sparing approach

A pneumatic tourniquet in the proximal end of the upper limb was employed under general anesthesia and in lateral decubitus position. Tourniquet pressure was set at 50 mmHg more than the patient's systolic pressure (about 155 to 190 mmHg) (5). At first, the ulnar nerve was explored and preserved using a posterior approach. Subsequently, the hematoma was washed out and posterior synovial tissue was removed by means of this exposure through medial and lateral sides of triceps tendon, maintaining extensor mechanism intact. After the identification of fracture line and fragments, a reduction under direct vision was performed in this study. Internal fixation was carried out using two or three 1.5-2mm crossing pins which is a strong construction biomechanically (6). In case of comminution of any column and in patients older than 10 years, two or more pins were used on each side.

The pin ends were left outside the skin to remove the pin easily, especially in the medial side. After irrigation with saline and inserting a drain, the skin was closed and the elbow was splinted in 70-90° of flexion. The sutures were removed after 10 to 14 days, and the splint was removed at 4 weeks after surgery. The pins were removed in case of radiologic union; however, if there was any sign of delayed union, active range of motion was started with pins left in place to avoid stiffness and were removed after healing. Follow-up visits were performed at 6, 12, 18, and 24 months. Generally, the most important complication of this fracture is Cubitus varus due to malunion (7). This deformity could be evaluated using X-ray by Jones view in which the direction of the X-ray beam is perpendicular to the distal humerus. In addition, Baumann angle measurements were compared with the contralateral side. The normal range of this angle is 9-26°. Basically, Baumann angle more than ten degrees or less than four degrees in comparison with the normal elbow revealed no varus and was acceptable (8). An X-ray was employed to assess the relationship between the anterior humeral line to the capitulum and rotational displacement. The time of fracture union, elbow range of motion, the presence of any malunion confirmed by abnormal Baumann Angle on X-ray, heterotopic ossification, neurovascular complications, and local complications, such as pin infection and loosening, as well as wound dehiscence were evaluated at follow-ups.

Results

According to the results in tables 1 and 2, the mean age

Table 1. Characteristics of the patients

P	Age	Sex	Side	Dominant	Open fx.G/A	Time to op.(hours)
1	5	M	R	Y	N	24
2	7	M	R	Y	N	48
3	7	M	L	Y	N	48
4	9	F	R	Y	N	48
5	3	F	R	Y	N	72
6	8	M	L	N	1	48
7	5	M	R	Y	N	72
8	7	M	R	Y	N	48
9	8	M	R	Y	N	48
10	4	M	R	Y	N	48
11	12	M	L	N	1	24
12	5	F	R	Y	N	72
13	11	F	R	Y	N	48
14	9	M	L	N	N	72
15	8	M	L	Y	N	48
16	10	M	R	Y	N	72
17	6	M	R	Y	N	48
18	3	M	R	Y	N	48
19	4	M	R	Y	N	72
20	12	M	L	N	N	48
21	9	M	R	Y	N	72
22	6	M	R	Y	N	72
23	7	M	R	Y	N	24
24	11	M	R	Y	N	24
25	5	M	L	N	N	48
26	4	M	R	Y	N	96
27	8	F	L	N	N	48
28	5	F	L	N	N	96
29	4	M	R	Y	N	24
30	7	M	L	Y	N	48
31	6	F	R	Y	N	96
32	9	F	L	N	N	24
33	10	M	L	N	N	72
34	5	M	R	Y	1	24
35	7	M	R	Y	N	24
36	4	M	R	Y	N	48
37	5	M	R	Y	N	48
38	8	F	L	Y	N	24
39	7	F	R	Y	1	48
40	6	M	R	Y	N	48
41	5	F	R	Y	N	72

Table 1 Continued.

42	8	F	R	Y	N	72
43	5	F	R	Y	N	24
44	8	F	R	Y	N	48
45	4	M	R	Y	N	48
46	6	F	R	Y	N	24
47	6	F	L	N	N	48
48	9	M	L	Y	N	72
49	6	M	R	Y	N	48
50	7	M	R	Y	N	72
51	5	M	L	N	N	48
52	8	M	L	Y	N	72
53	3	M	L	N	N	48
54	9	M	R	Y	N	48
55	5	M	L	N	N	72
56	4	M	L	N	N	48
57	7	M	R	Y	N	48
58	5	M	R	Y	N	72
59	4	M	L	Y	N	24
60	10	F	R	Y	N	48
61	7	M	L	Y	N	48
62	5	M	R	Y	N	48
63	3	M	R	Y	N	48
64	4	M	R	Y	N	48
65	6	F	R	Y	N	48
66	8	F	L	Y	N	72
67	10	M	R	Y	N	24
68	11	F	R	Y	1	48
69	6	F	R	Y	N	72
70	7	F	R	Y	N	48
71	4	M	R	Y	N	48
72	4	M	R	Y	N	48
73	6	M	R	Y	N	48
74	5	M	R	Y	N	24
75	4	M	L	Y	N	24
76	8	F	R	Y	N	24
77	5	F	R	Y	N	24
78	8	F	R	Y	N	48
79	9	M	L	Y	N	48
80	8	F	R	Y	N	72
81	4	M	R	Y	N	48
82	5	M	R	N	N	48
83	6	F	R	Y	1	48
84	3	F	R	Y	N	48
85	4	M	R	Y	N	48

Table 1 Continued.

86	5	M	L	N	N	24
87	10	M	R	Y	N	96
88	4	M	R	Y	N	48
89	3	M	L	N	N	48
90	8	F	R	Y	N	48
91	7	F	R	Y	N	48
92	6	F	L	N	N	48
93	8	M	L	Y	1	72
94	5	M	R	Y	N	48
95	8	M	L	Y	N	48
96	6	M	R	Y	N	48
97	5	M	R	Y	N	48
98	7	F	R	Y	N	48

Table 2. Results

P	Union. wks	Follow up. months	Lim. of motion Deg.	Buamann Angle diff	Complication
1	4	12	0	2	N
2	6	12	0	0	N
3	4	18	0	0	N
4	6	18	5	4	Pin tract inf.
5	4	12	0	2	N
6	6	18	10	2	N
7	4	12	5	4	N
8	6	18	10	0	H. ossification
9	4	12	5	4	ant.int.o.n. palsy
10	4	18	0	0	N
11	6	24	10	4	Pin tract inf.
12	4	12	0	4	N
13	6	18	0	0	Pin tract inf.
14	6	18	5	2	N
15	6	18	0	4	N
16	4	18	5	2	N
17	4	12	5	2	N
18	4	12	0	4	N
19	4	12	0	2	N
20	6	24	10	4	Pin tract inf.
21	6	12	0	2	N
22	6	12	0	2	N
23	6	18	5	3	N
24	6	24	0	4	H. ossification
25	4	12	5	3	N
26	4	12	0	2	N
27	6	18	10	4	Ant.int.o.n. palsy

Table 2 Continued.

28	6	12	0	0	N
29	4	12	0	6	N
30	6	12	10	3	N
31	6	12	0	0	N
32	6	12	5	2	N
33	6	18	10	4	Pin loosening
34	4	12	0	2	N
35	4	12	15	2	H. ossification
36	4	12	0	0	N
37	6	12	0	3	N
38	4	18	10	2	N
39	6	12	0	4	N
40	6	12	10	4	N
41	4	12	0	0	N
42	4	18	15	2	N
43	4	12	0	0	N
44	6	12	0	4	N
45	4	12	0	4	N
46	4	12	0	2	N
47	6	12	5	4	N
48	6	18	10	3	Pin loosening
49	4	12	0	4	N
50	6	18	10	3	N
51	4	12	0	6	N
52	8	18	10	6	N
53	4	12	0	0	N
54	6	12	10	2	Wound dehiscence
55	4	12	0	3	N
56	4	12	0	2	N
57	4	12	10	0	N
58	4	12	0	2	N
59	4	12	0	3	N
60	6	24	10	4	Pin tract inf.
61	6	12	0	1	N
62	4	24	0	3	N
63	4	12	0	2	Ant.int.o.n. palsy
64	4	12	0	2	N
65	4	12	0	4	Ant.int.o.n. palsy
66	6	24	0	0	N
67	6	18	10	0	N
68	6	12	5	4	N
69	4	12	0	0	N
70	6	12	5	2	N
71	4	12	0	0	N

Table 2 Continued.

72	4	18	10	0	N
73	4	12	5	0	N
74	4	12	0	0	N
75	4	12	0	6	N
76	4	12	0	2	N
77	4	12	0	4	N
78	8	24	10	0	Pin tract inf.
79	6	12	10	3	H. ossification
80	4	12	5	3	N
81	4	12	0	0	N
82	4	12	0	0	N
83	6	18	5	6	N
84	4	12	0	2	N
85	4	12	0	0	N
86	4	12	0	4	N
87	6	24	15	2	Pin loosening
88	4	12	0	0	N
89	4	12	0	4	N
90	6	12	0	3	N
91	4	12	10	4	N
92	4	12	5	3	N
93	6	18	10	0	N
94	4	12	0	4	N
95	6	12	0	4	N
96	4	12	0	2	N
97	4	12	10	2	N
98	6	24	0	4	Pin tract inf.

of patients was 6.4 years old (age range: 3-12) with the male/female and right to left side ratios of 2.06 and 2.26, respectively. In 82% of patients, the fractures occurred in the dominant side and 7% of patients suffered from Gustilo type 1 open fracture. The average time from injury to surgery was 50.16 hours. Fracture union was confirmed radiologically at 4 and 6 weeks follow-up in 57% and 41% of patients, respectively, and the rest (2%) healed 8 weeks after surgery.

The mean time of follow-up was 14.3 months (range: 12-24). Furthermore, the elbow range of motion measurement was performed using a goniometry. The mean lack of an extension was 3.5° and its maximum was obtained at 15° (range: 0-15°). Additionally, the mean Baumann angle difference was 2.4°, compared to the normal side (range: 0-6°). The rate of complications

was 19.3%, including pin tract infections (7%), pin loosening (3%), heterotopic ossification (4%), and wound dehiscence (1%). Furthermore, there were 4 (4%) cases of transient anterior interosseous nerve palsy, two of which were documented before surgery, and the other two were noticed after surgery. Additionally, all of them resolved after 3 to 10 weeks spontaneously. There were no major complications, such as malunion, nonunion, vascular injury, nerve damage, and deep infection.

Discussion

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

In the same line, Skaggs and Flynn agree with this concept mentioning direct visualization of the brachial artery and median nerve as well as the fracture fragments as some advantages of this approach (10). However, the posterior approach allows the authors to reach and observe the fracture site easily and fast, without any X-ray exposure and jeopardizing the neurovascular components and extensor mechanism which provide more acceptable surgical scar.

Aktekin et al. compared the results of open reduction and percutaneous pinning using this Triceps-sparing method in 23 cases with 32 patients who underwent closed reduction and percutaneous pinning (11). They showed the preference of closed reduction to open reduction which was definitely the most acceptable conclusion.

Shawkat A. also found very satisfactory results using the Triceps-sparing approach in 14 neglected pediatric supracondylar humerus fractures (12). Rizk AS. obtained satisfactory results using this approach in 15 children who had neglected displaced supracondylar and distal humeral fractures.

According to Sibly TF et al., compared to closed treatment, less than 10 degrees of the range of motion restriction happened after open reduction using a posterior approach consisting of inverted V incision in Triceps. They concluded that a posterior approach did not result in a major loss of elbow range of motion (13).

Although some people believe in the anterior approach during the management of extension-type supracondylar humerus fractures in children, the utilization of the posterior approach provides us excellent visualization of fracture site without the need to exposure and possible jeopardizing anterior neurovascular elements (10, 12).

Functional performance of elbow in all patients was good with no major complication requiring the application of competent skill and knowledge in treating these patients. The limitations in this study included the small sample size and lack of control group which should be considered in further studies to get more precise conclusions.

Functional performance of elbow in all patients was good with no major complication requiring the application of competent skill and knowledge in treating these patients. The limitations in this study included the small sample size and lack of control group which should be considered in further studies to get more precise conclusions.

Triceps-sparing approach for open reduction and internal fixation of pediatric displaced supracondylar humeral fractures provides easy access to the fracture site and good exposure without using image intensifier. The other advantages of this approach include the intactness of the elbow extensor mechanism, protection of ulnar nerve, and presence of an acceptable surgical scar.

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