

Are percutaneous pinning the best treatment for Gartland type III supracondylar humeral fractures in children?

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Abstract. *Background:* Supracondylar humeral fractures are the most frequent fractures of the elbow in children. Gartland type III fractures require a surgical treatment. The preferred management is closed reduction and percutaneous pinning with K-wires. *Methods:* We have treated 15 patients (mean age 6,5 years) with Gartland type III fractures. In 14 patients the percutaneous reduction with K-wires was possible but in 1 case the open reduction was necessary due to the irreducibility of the fracture. In all cases a cycle of rehabilitation was performed. *Results:* All patients have been evaluated using Flynn's criteria with a mean follow-up of 24 months. All cases resulted excellent except the one that required open reduction, that resulted good. *Conclusions:* Percutaneous pinning is at our days the gold standard of treatment but open reduction must always be considered mandatory when an anatomical closed reduction is not possible. Rehabilitation is also fundamental though the young age of the patients. (www.actabiomedica.it)

Key words: supracondylar humeral fracture, percutaneous pinning, children fracture

Introduction

Children supracondylar humeral fractures represent 7.5% of paediatric fractures (1-2) and are the most frequent elbow fractures (3), with a high incidence in children from 5 to 8 years old (4).

The management of this kind of fractures is still controversial (5).

These fractures identify some predisposing anatomical conditions. Kocher believed that fractures occur in a "locus minoris resistentiae" (5). The particular laxity of the elbow in children facilitates the hyperextension mechanism that implies the majority of the fractures. In more than 90% of the cases, the pathogenesis is an "indirect extension" like a fall on the palm of the hand with the elbow in hyperextension and more rarely a "direct extension" trauma of the elbow in which the coronoid favours the fracture (6). In the remaining cases it occurs for "flexion", that

is for a direct trauma on the olecranon or on the posterior face of the elbow. The majority of these fractures are caused by a fall from a height of about two meters (i.e., from Monkey Barr, or from slides and swings) (7), but a small percentage of them can occur after a fall on the ground level (i.e., bicycle or skateboard) (8).

The muscular insertion of the triceps plays an important role in the displacement of the fracture. The most used classification was reported by Gartland (9) who describes 3 types of supracondylar fractures. Gartland type III fractures require a surgical treatment and the preferred management, in our opinion, is closed reduction and percutaneous pinning with K-wires.

The aim of our study was to evaluate the clinical and cosmetic outcome in children treated in our unit for Gartland type III fracture at two years of follow up.

Materials and methods

In this study we evaluate at two years of follow up 15 children (min 19 max 31 months), 6 female and 9 male with a mean age of 6,5 years (min 3-max 11) who underwent surgery for Gartland type III fractures between July 2007 and August 2010.

The patients went to our Emergency Service after a high-energy trauma involving the upper limb in association with pain and functional limitation. In 80% of our subjects fracture, the traumatic mechanism was a fall from “inflatables games” with an “indirect extension”, like a fall on the palm of the hand with the elbow in hyperextension. The remains 20% had a bike accident or a skateboard fall. All of them, coming in the emergency room, underwent to the same protocol based on a preliminary clinical examination and X-ray exams. The radiographs showed a type III fracture (Fig. 1) according to Gartland classification and the patients were immediately leaded to the operating room. A long arm posterior plaster splint was applied to reduce pain while waiting for the operation; monitoring the appearance of eventual neurovascular deficit. All fractures were treated in emergency, from minimum 1 h to max 8 h after trauma (minimum time required for preoperative exams and a safe anesthesia).

In the operating room the first step was achieving reduction under general anaesthesia and fluoroscopy control. After the closed reduction the treatment was percutaneous fixation with 2-4 Kirschner wires (Fig. 2) under fluoroscopy control.

Postoperatively the operated arm was immobilized with elbow splint and one day after surgery the patient was discharged. Ten days after surgery the patient started controlled active mobilization and the Kirschner wires were removed 4 weeks after surgery. K-wires tracts were managed every 2-3 day with medications in order to control infections.

Clinical evaluation at two years of follow up was performed using Flynn's criteria (10). Moreover, all patients underwent radiographycal evaluation to study the closure of growth plates and to investigated Baumann's angle (normal range 9°–26°).

Reduction Maneuver and Surgical Technique

The patients were positioned supine on a fracture table that facilitates the use of image intensifier. Fracture reduction was always obtained by two surgeons. After a sufficient manual traction of the forearm, the elbow is bend pushing the distal stump of the fracture from posterior to anterior position; the reduction is



Figure 1. The radiographs taken showed a type III fracture according to Gartland classification

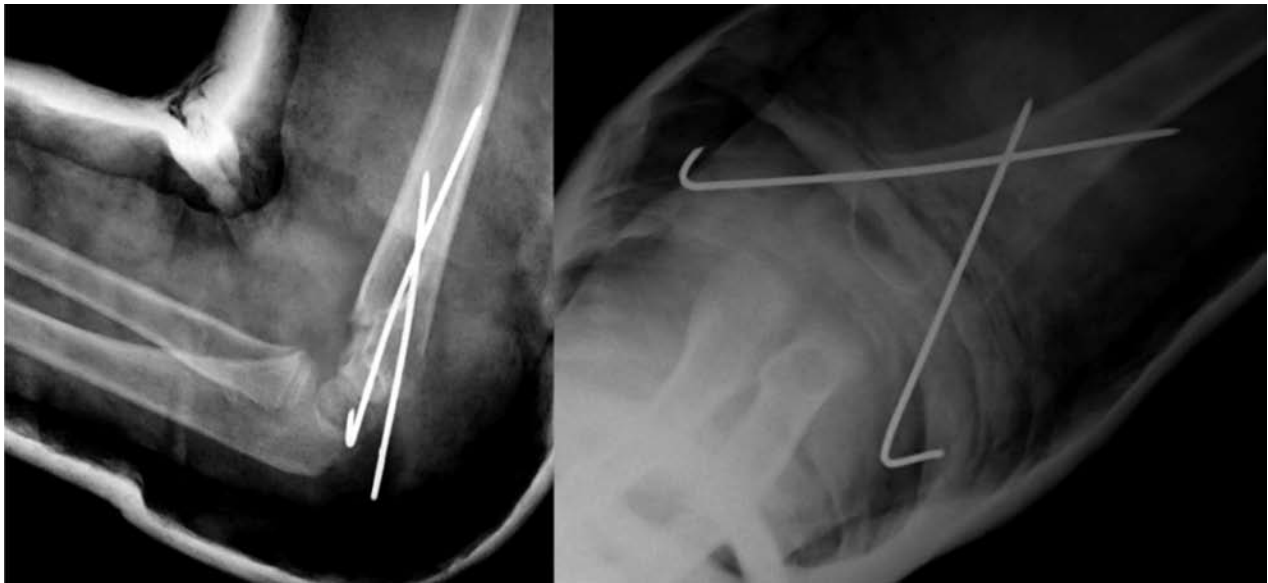


Figure 2. Closed reduction and percutaneous fixation using 2 Kirschner wires under fluoroscopy control

maintained keeping the elbow flexed and the forearm pronated. Fluoroscopy checks are then performed in the antero-posterior (AP), lateral (LL), and Jones views, rolling the C-arm, without the risk of losing the obtained reduction. Once a satisfactory reduction is obtained, percutaneous pinning is performed with two crossed or slightly divergent K-wires (1.5-2 mm), from the base of the lateral condyle to the medial cortex of the fracture's proximal fragment.

The reduction is then X-rays checked in AP and LL projection with the elbow in extended position, and the stability of the synthesis is evaluated performing passive flexion-extension movements.

In our cases, the reduced fractures were stabilized using Kirschner wires ranging in size 1.4 - 2.0 mm depending on the patient's bone size. In 9 cases, 2 crossed k-wires were sufficient, in 4 cases 3 crossed k-wires were needed and only in 2 case 4 crossed k-wires were used, depending on the fracture stability during the operation.

In one case open reduction was necessary because of the irreducibility of the fracture. In this case was made a small lateral incision through skin, subcutaneous tissue, brachioradialis and triceps. The condyles are exposed and accurate toilette of the fracture is performed. The fixation is then obtained with two K

wires introduced with the same percutaneous pinning technique.

For all the patients, at the end of the operation, a long arm 90° posterior plaster splint was applied for 25 days. Attention was played for neurovascular deficit control after surgery. In order to reduce the risk of local vascular disorders, the elbow should be placed within the cast at an angle of 90°. After 25 days, we reviewed all the children, removed the cast, made an X-ray check, removed the two or more K-wires, and started a functional rehabilitation. The results were evaluated after 2 months, 6 months, and 1 year.

Results

We evaluated 15 patients with Gartland type III fractures at two years of follow up (18-26 months). All the patients performed an X-ray control (Fig. 3) which shown a complete healing of the fracture for all the subjects. The Flynn classification was used in order to collect the overall outcome and to check if patients had valgus-varus deviations. None of the subjects showed impairment of the elbow joint R.O.M. at the end of rehabilitation (Fig. 4). Three patients who didn't attend the rehabilitation cycle at three month



Figure 3. X-ray control at two years of follow up

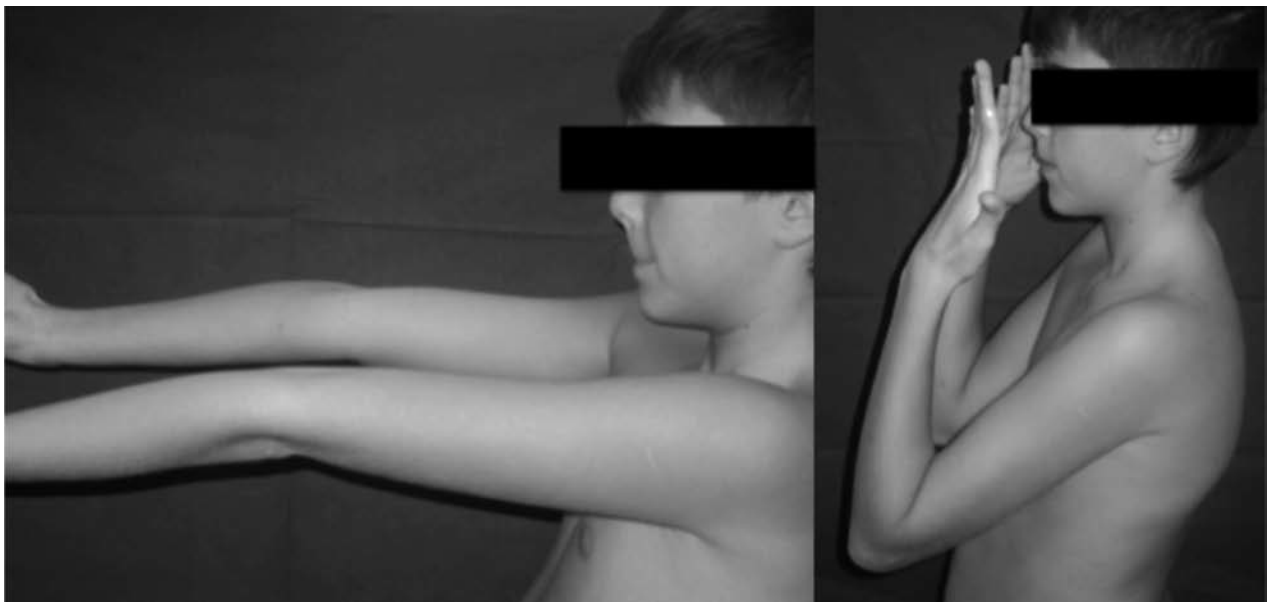


Figure 4. Complete ROM during the clinical examination at two years of follow up

from operation reported a deficit of pronosupination and of flexo-extension of the elbow. For this reason they underwent a new and later intensive cycle of rehabilitation. At final follow-up these three patients as well resulted excellent on the basis of Flynn criteria.

The Baumann joint angle was collected: the average value was 15° (range 10° - 27°), supporting the reference normal values of 9° - 26° range (Fig 5). The obtained results, according to Flynn's criteria, were classified as very good 93% and good 17% (the one who

Table 1. Patients data

Patients	Sex	Age	N° of K-wires	Mechanism of injury	Time to surgery	Follow up
M.F.	F	7	2	Fall from an inflatable	6	30
C.R.	M	3	2	Fall from an inflatable	2	24
S.M.	F	7	2	Fall from an inflatable	3	30
L.M.	M	3	ORIF 2	Fall from a swing	4	24
G.C.	M	7	2	Direct elbow trauma, fall at school	6	31
T.C.	M	9	2	Direct fall on the arm	8	28
A.F.	M	6	2	Direct elbow trauma, fall from a slide	1	21
F.D.	F	4	3	Direct elbow trauma	3	19
M.V.	F	7	3	Fall from an inflatable	4	24
C.R.	M	11	3	Fall with hyperextension of the elbow	4	20
L.P.	M	6	3	Fall from an inflatable	8	31
P.S.	M	7	4	Fall from an inflatable	5	29
G.L.	F	5	2	Direct elbow trauma	3	24
R.Z.	F	7	2	Fall with hyperextension of the elbow	8	24
F.T.	M	8	3	Fall from an inflatable	6	20

required open reduction). Patients did not show significant clinic symptoms or complain about pain. One patient had a soft tissue reaction around the K wires with a poor esthetics outcome. We did not have infections, pins loosening, or loss of reduction during the follow up who need second surgery as completion of the procedures. We did not observe any involvement of the ulnar nerve, or Volkmann syndrome cases.

Discussion

Controversy exists about the type of treatment and the optimal timing for surgery in supracondylar humeral fractures in children. These fractures are often burdened by a high percentage of complications. It is very important to evaluate the integrity of neurovascular bundles as these lesions present the highest risk of neuro-vascular complications of all paediatric fractures (11). For this reason these lesions are often treated in emergency. However in some author's opinion, if there is no life or limb risk, patients arriving in the Emergency Department after midnight can safely undergo surgery the day after (12). In case of neurovascular deficit the open reduction after exploration of all the structures becomes mandatory (12). Clinical examination should provide investigation of radial pulse. Fractures with "warm" hand, even if the radial pulse is absent, are not likely to have any permanent

vascular injury and present a normal recovery after reduction and stabilization. On the other hand, in case of a "cold" hand with no pulse treatment must be done in emergency (12).

Neurological evaluation should include not only the ulnar and median nerves, but also the radial nerve with its interosseous branch.

X-rays are normally performed in the antero-posterior and lateral view always comparing with contralateral. The oblique views might be done if the fracture is in doubt. Baumann's angle can be evaluated in the antero-posterior view as reported in literature (4).

Different theories exist about the optimal treatment of these fractures (13). Marquis et al. (4, 14) believe that a conservative treatment of these lesions still can be done with an olecranon K-wire traction or with screw and traction. Conservative treatment of Gartland type III fractures implies prolonged hospitalization with a difficult position to maintain for the little patient in traction with a higher risk of cubitus valgus. Conservative treatment is indicated in patients whose parents refuse surgery or in patients who can't undergo surgery. These authors believe that overhead skeletal traction is a safe and accurate method to treat these fractures in hospitals where crossed wire fixation is not possible because of the lack of resources.

Most Authors (9, 12, 15-18) recommend pinning or open reduction of the fracture. In most of our cases a closed reduction was possible with stable fixation

using crossed Kirschner wires and, in our opinion, open reduction becomes mandatory when closed reduction results unsuccessful.

In our experience the more stable condition is given by the use of two crossed K-wires rather than the two parallel K-wires (19,20) introduced in the radial side to reduce the possible complication of ulnar nerve damage. Such risk can be reduced introducing the ulnar wire just above the homonymous sulcus. It is also true that sometimes in young children these bony landmarks cannot be palpated because of edema. Taco Gosens (21) prefer a mini open procedure for the ulnar K-wire to prevent iatrogenic ulnar nerve injury. Even the introduction of the 2 radial wires finds two different techniques: the parallel introduction and the divergent one, considered the most biomechanically stable of the two (22, 23).

However Mehlman (16) recommends the lateral position, Fawler and De Pellegrin (17-18) prefer the prone position for greater ease of fracture reduction. They use rolled up sheet placed proximal to the fracture as a fulcrum; this reduces the risk of iatrogenic neurovascular damage. We use the supine position largely described by many authors in literature.

All 15 cases didn't report iatrogenic neurovascular damage or major complications such as infections or wound dehiscence. Only in two cases there was an inflammation of the skin in correspondence of the k-wires, resolved when the wires were removed. The incidence of infection in cases of K-wires fixation in pediatrics age is about 2% for major infections (24) and usually associated with poor compliance with pin site care (25).

After surgery a long arm posterior plaster splint at 90° was worn. Plaster was maintained for 25 days to reduce the possible elbow stiffness. All the patients underwent an X-ray control before remove the k-wires.

There is no agreement about necessity of subjecting the little patients to a rehabilitation cycle after removal of the wires, considering the result comparable after one year (24). Nine patients underwent one months of rehabilitation. In our experience 3 patients who didn't perform this cycle of rehabilitation, at 3 months follow-up had a deficit of range of motion in flexion-extension of the elbow. Only after a later cycle

of rehabilitation they completely recovered the range of motion.

Long-term complications of these fractures are stiffness with deficit of range of motion and deformity such as valgus or varus deformities (13).

Reports of valgus deformity following supracondylar elbow fractures are rare and its incidence ranges from 0.9 to 8.6 per cent depending on the author (13). The average incidence of varus deformity as reported in literature is 30% (13). The pathogenesis of angular deformities of the elbow after supracondylar fractures of the humerus is not clear. Growth disturbance is now no longer considered as the main cause of angular deformity of the carrying angle. Nearly all authors now agree that angular deformity in the coronal plane is the result of an uncorrected reduction of the fracture (21, 22). In our study we reported no case of malangulations or valgus deformity support the surgeon to the choice of CRIF (Closed Reduction Internal Fixation) for Gartland type 3 fracture of supracondylar humerus fracture. Despite the limited number of subjects recruited, the total absence of infectious complications and growth disorders shows how this kind of surgical procedure can be adopted for clinical practice without excessive risk.

Even though a direct comparison with conservative treatment cannot be undertaken in this study, our data support with evidence how the CRIF with K-wires treatment can give to the surgeons and the patients a better security about the correct fracture healing. The last follow-up step should be undertaken after the end of the growth process even if the excellent clinical outcome gives us a good feeling about the absence of growth complications.

Conclusions

Our study confirms the good results of closed reduction and crossed k-wires fixation in Gartland type III fractures as reported in literature (5-10). Anatomical reduction is mandatory when, due to the failure of closed reduction maneuvers, open reduction is necessary. Despite the patients' young age, a rehabilitation program is necessary to achieve excellent results in terms of complete range of motion recovery.

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