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Neurovascular Abnormalities in Gartland III Supracondylar Fractures in Children

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Rezumat

Tulburări vasculonervoase în fractura supracondiliană de humerus Gartland III la copii

Cea mai frecventă leziune traumatică a cotului din cadrul ortopediei pediatrice este fractura supracondiliană de humerus. Deplasarea posterioară a fragmentului distal se poate asocia cu angulație, dar și cu deplasare laterală sau medială, precum și cu rotația fragmentului distal intern sau extern. În acest studiu am comparat două grupe de pacienți, ambele prezentând fractura supracondiliană de humerus grad III conform clasificării Gartland. Scopul studiului a fost să evidențiem dacă reducerea în focar închis a acestui tip de fractură și fixarea sa percutană cu brose creează sau nu tulburări vasculonervoase, și, de asemenea, să identificăm dacă există diferențe în frecvența apariției tulburărilor vasculonervoase în funcție de tipul manevrei aplicate pentru reducere (reducere cu antebrațul în supinație sau reducere cu antebrațul în pronație). Studiul a fost prospectiv și s-au adăugat fiecărui grup pacienți până s-a atins un număr de 40 bolnavi pentru fiecare grup. Nu s-au observat diferente în apariția tulburărilor vasculonervoase între cele două metode, iar modificările apărute au fost rapid reversibile ceea ce ne-a permis să tragem concluzia că ambele metode de reducere sunt sigure și corecte.

Cuvinte cheie: fractura supracondiliană de humerus, tulburări vasculonervoase Gartland

Abstract

The most common elbow injuries in pediatric trauma practice are supracondylar fractures of the humerus. Posteriorly displaced fractures may be angulated or displaced medially or laterally with associated internal or external rotation. We compared two groups of patients, each with grade III supracondylar fractures after Garland. The goal of this study was to see if reduction and pinning maneuvers create neurovascular abnormalities and if there are any differences in terms of neurovascular consequences for reducing grade III Gartland supracondylar fractures of the humerus using reduction in supination or pronation of the forearm. We formed two study groups based on the reduction method used. Concretely: patients who needed reduction in pronation were included in the first group and patients who needed reduction in supination were included in the second group. Patients were added to each group until every group reached 40, to have equal and comparable groups. No statistically significant differences on clinical outcome and neurovascular complications appeared between the two methods of closed reduction. We can say that both methods used are correct.

Key words: supracondylar humeral fracture, neurovascular abnormalities Gartland

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Introduction

Supracondylar distal humeral fractures are one of the most common skeletal injuries in children. The current treatment of choice is closed reduction and percutaneous pin fixation

for Gartland type III fractures. The mechanism is usually by falling on the outstretched hand, the force being applied indirectly to the distal humerus, moving it back.

Posterriorly displaced fractures may be angulated or displaced medially or laterally with associated internal or external rotation.

The displacement is difficult to asses on x-rays. Indirect signs (fracture by extension) are:

- on a lateral view x-ray an internal rotation displacement will produce a concave image of the anterior metaphyseal edge and a convex image of the posterior metaphiseal edge;
- external displacement will produce a biconcave image – the "fishtail" sign *(Fig. 1)*.

It is estimated that they represent 65% of all elbow fractures in children and are associated with significant complications including neurovascular injuries, delay in consolidation, myositis ossificans or compartment syndrome (1-4). However, in children, a minimally invasive approach by closed reduction is preferred and, if considered necessary, depending on the category of fracture by percutaneous fixation with Kirschner wires (4,5).

A supracondylar fracture, especially type III Gartland, invariably presents a degree of swelling and full flexion of elbow causes loss of radial artery pulse (5), while elbow extension decreases vascular compression and allows easy evaluation of displacement angle both clinically and radiologically (6-11). Therefore, examination of the affected upper limb must assess any neurovascular damage. It is estimated that nerve injury occurs in 5 to 9% of cases.

Vascular status should be assessed by distal pulse palpation but also by measuring the distal capillary refill time at the fingers of the affected extremity. Also you can use pulse oximetry or Doppler sonogram (3,6).

Associated neurovascular abnormalities (3):

- Nerves: median, radial, ulnar, anterior interosseous;
- It is usually manifested by neuropraxia;
- Posterolateral displacement may lead to median nerve injury;
- Posteromedial displacement may lead to radial nerve injury;
- Sometimes, in type III the brachial artery may be injured.
- Compartment syndrome.

Gartland classified supracondylar fractures into 3 types. They are:

- Type I – Undisplaced;
- Type II – Displaced, but posterior cortex is intact;
- Type III – Displaced but posterior cortex is not intact.

The distal fragment may be displaced in one of the 2 possible ways:

– Posteromedial;
– Posterolateral.

Treatment (2,8,10,11)

- Type I

above elbow plaster immobilization for 3 weeks

- Type II

Can be treated with plaster immobilization, but the elbow flexion needed to maintain reduction (> 100 degrees) can lead to impaired circulation.

- Type III

Closed reduction and percutaneous fixation is the standard treatment

Open reduction is rarely necessary

- Medial approach is preferred;
- Anterior S shaped incision if vascular repair is necessary.

Material and Method

The study was conducted within the Orthopedics Clinic of The Clinical Emergency Hospital for Children "Gr Alexandrescu", Bucharest, Romania.

We conducted a prospective study on 80 cases in which we included patients who presented to the emergency service between 29.11.2009 - 15.12.2010.

We included in this study all patients with Gartland III type fracture. The exclusion criteria was supracondylar closed humeral fracture grade I or II Gartland, open supracondylar fracture of any degree.

Patients with neurovascular abnormalities at the time of admission were also excluded.

The goal of this study was to see if reduction and pinning manoeuvres create neurovascular abnormalities and if there are any differences in terms of neurovascular consequences for reducing grade III Gartland supracondylar fractures

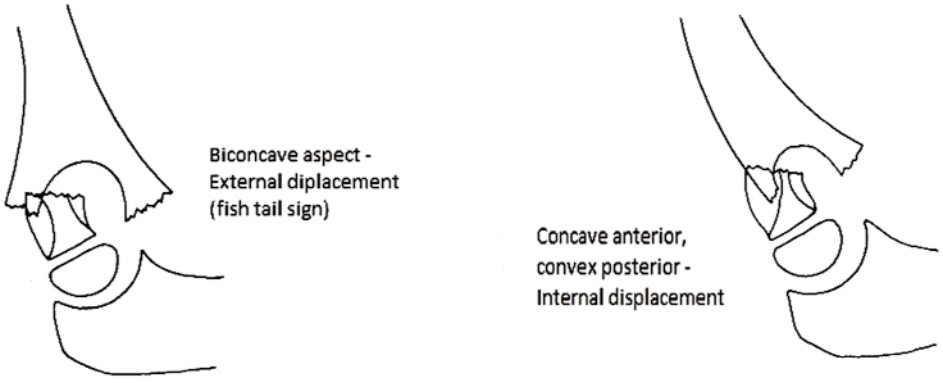

Figure 1. *Radiographic appearance for external rotation displacement A, and internal rotation displacement B*

of the humerus using reduction in supination or pronation of the forearm.

We formed two study groups based on the reduction method used. Concretely: patients who needed reduction in pronation were included in the first group and patients who needed reduction in supination were included in the second group. Patients were added to each group until every group reached 40, to have equal and comparable groups.

Both groups were treated by closed reduction and percutaneous fixation with Kirschner wires, within 6 hours from injury.

Patients were followed for a minimum of 3 months after surgery. P-value < 0.05, with a confidence interval of 95 %.

Two equal groups were created to limit the degree of freedom and to exclude type I error (null hypothesis is true but the study finds it false).

The procedure consisted of:

1. Immobilisation in a maximum of 80 degrees elbow flexion at presentation;
2. Orotracheal intubation anesthesia;
3. Closed reduction;
4. Percutaneous fixation with Kirschner wires.

The followed postoperative parameters were:

- Presence of distal capillary pulse;
- Capillary refill time;
- Presence of paraesthesia;
- Finger function (flexion / extension of the fingers, flexion / extension of thumb, abduction / adduction of the fingers, abduction / adduction of the thumb);
- Radiological control after 1 day, 1 week, 3 weeks;
- Elbow mobility 3 months after the injury.

Parameters were introduced in a table to draw conclusions.

Results

24 h after surgery:

1. 5 (12.5%) patients in the group treated in supination and 4 (10%) patients in the group treated in pronation the capillary pulse was found difficult to record using a pulse oximeter, meaning that it displayed values varying >20%.
2. Capillary refill time was reduced by >50% in 1 patient (0.02%) pertaining to the supination-treated group and 2 patients (0.05%) from the pronation-treated group.
3. Paresthesia occurred in 4 patients (10%) from the supination - treated group and 6 patients (15%) from the pronation - treated group.
4. Finger function was affected in 1 patient in the group treated in supination and 1 patient in the group treated in pronation.

72 h after surgery:

The neurovascular signs and symptoms appearing just postreductional disappeard in all these patients. Capillary refilling time had normalized, paraesthesia disappeared. In one pacient the thumb extension inability persisted, but the check-up after 7 days showed that the mobility of the thumb became normal.

3 months postoperatively:

In the supination-treated group 3 patients (7%) had an elbow flexion <90 degrees and 3 (7%) a maximum extent of - 45 degrees.

In the pronation-treated group 5 patients (12.5%) had an elbow flexion <90 degrees and 1 (2.5%) a maximum extent of - 45 degrees. Control after three months could not detect differences between the active and passive mobility, the two sectors of mobility being perfectly superposable.

Radiographic evaluation after 1 year postoperatively showed excellent or very good results in 38 patients (95%) from the supination group and 39 patients (97.5%) from the pronation group. It is possible that these percentages will become higher, increasing after a longer period of time postoperatively.

Clinical evaluation after 1 year

All patients were satisfied with the result and use of their elbow. Criteria of normal mobility were: elbow flexion +130/140 degrees; elbow extension 0 / + 5 degrees.

Discussion

As we showed in introduction material we appreciate that orthopedic reduction followed by fracture percutaneous fixation is the best treatment method for grade III supracondylar humeral fractures and we recommend that closed surgery be used as much as possible. Local conditions (swelling of the elbow, moving bone fragments that are in intimate contact with neurovascular formations) may predispose to complications.

Both after reduction in supination and after the reduction of the fracture with pronated forearm, changes may occur in capillary pulse, capillary refilling time or tingling in the fingers may be seen, but these are transient and do not change the final result of treatment. To identify the occurrence of any vascular disorder in the first 24 hours postoperatively we recommend a pulse oximeter to be placed on a finger of the affected limb. If important pulse reading variations appear we recommend removal of the cast and placing the elbow in a plaster cast in a more extended position. This is possible because the percutaneously fixed fracture has no risk of secondary displacement.

Incomplete abduction / adduction of fingers II - V, and difficulty in thumb extension can also be found. If the disappearance of all manifestations of neurovascular nature like capillary pulse changing and paresthesia are found in all patients up until a maximum 72 hours after treatment, abduction or extension limitations recover completely, but after a longer period of time. In our series we found complete recovery of finger mobility within 3 months after orthopedic reduction.

In terms of mobility of the elbow this is influenced more by immobilization in a plaster cast than the reduction

maneuvers, and there are no major differences between the reduction in forearm supination and pronation forearm reduction. We do not think that physiotherapy treatment to combat mobility disorders at the elbow is needed because postreductional check-ups carried out one year after injury show a completely compensated sector of mobility with restitutio ad integrum.

Conclusions

Although neurovascular complications may be present after closed reduction, the fact that they are limited and transient fully entitles us to believe that for grade III supracondylar fracture closed reduction is the choice. Open surgery is reserved for cases of open fractures or those where neurovascular manifestations are already present at first presentation.

We have not seen differences between postreductional evolution of cases who underwent closed reduction with the forearm in supination compared to the cases in which reduction was performed with the forearm in pronation. We conclude that closed reduction is applicable regardless of the type of distal fragment displacement.

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