

## ORIGINAL PAPERS

# Supracondylar humerus fractures with associated vascular trauma in children

J. Merino Pérez<sup>a,\*</sup>, I. Ibor Ureña<sup>a</sup>, M.T. Rodríguez Bustabad<sup>b</sup>, O. Campos Alonso<sup>a</sup>, G.M. Elorriaga Sagarduy<sup>a</sup> and J.I. Vicinay Olabarria<sup>a</sup>

<sup>a</sup>Department of Orthopedic and Trauma Surgery, Cruces Hospital, Baracaldo, Vizcaya, Spain

<sup>b</sup>Department of Angiology and Vascular Surgery, Cruces Hospital, Baracaldo, Vizcaya, Spain

Received August 29, 2008; accepted December 1, 2008

Available on the internet from May 6, 2009

### KEYWORDS

Arteriography;  
Supracondylar humeral fracture;  
Vascular injury;  
Children

### Abstract

**Introduction:** Supracondylar humerus fractures have higher complication rates than any other pediatric fracture. The management of the associated vascular injuries is still a moot point.

**Purpose:** To analyze the outcomes of patients with supracondylar fractures and absent or decreased radial pulse.

**Materials and methods:** Retrospective study of 205 children with a displaced supracondylar fracture between 2002 and 2006.

**Results:** Of the 205 children with a supracondylar fracture, 11 had no radial pulse on admission. Six of the 11 children recovered it further to closed reduction and fixation with Kirschner wires. One of the 11 had no pulse following reduction and immobilization and 4 patients that presented with an ischemic hand required open reduction of the fracture and artery examination further to an angiographic assessment. In the last follow-up visit, none of them showed any problems.

**Conclusions:** Initial treatment for children with supracondylar fractures and no radial pulse must be closed reduction. Arteriography is the most appropriate pre- and intraoperative diagnostic tool to define the lesion and plan the surgery. Fracture reduction and blood supply restoration are important for limb salvage and avoidance of potential sequelae.

© 2008 SECOT. Published by Elsevier España, S.L. All rights reserved.

\*Corresponding author.

E-mail: josumerino@hotmail.com (J. Merino Pérez).

**PALABRAS CLAVE**

Arteriografía;  
Fractura supracondílea  
humeral;  
Lesión vascular;  
Niños

**Fracturas supracondíleas humerales con traumatismo vascular en niños****Resumen**

*Introducción:* Las fracturas supracondíleas humerales presentan tasas de complicaciones más altas que cualquier otra fractura pediátrica. El tratamiento de las lesiones vasculares asociadas sigue siendo controvertido.

*Objetivos:* Analizar el resultado de los pacientes con fracturas supracondíleas y pulso radial ausente o disminuido.

*Material y métodos:* Estudio retrospectivo en 205 niños con fractura supracondílea humeral desplazada entre 2002 y 2006.

*Resultados:* De los 205 niños con fractura supracondílea, 11 no tenían pulso radial en el momento del ingreso. Seis de los 11 niños lo recuperaron tras la reducción cerrada y fijación con agujas Kirschner. Uno no tenía pulso después de la reducción e inmovilización, y 4 pacientes que presentaban una mano isquémica requirieron reducción abierta de la fractura y exploración arterial tras la valoración angiográfica. Ninguno de ellos tuvo problemas en la última revisión.

*Conclusiones:* El tratamiento inicial para los niños con fracturas supracondíleas y sin pulso radial debe ser la reducción cerrada. La arteriografía es la prueba diagnóstica preoperatoria e intraoperatoria más adecuada para definir la lesión y planificar la cirugía. La reducción de la fractura y la restitución de la vascularización son importantes para el salvamento de la extremidad y evitar posibles secuelas.

© 2008 SECOT. Publicado por Elsevier España, S.L. Todos los derechos reservados.

**Introduction**

Supracondylar humeral fractures account for 17.9% of all fractures in children aged 0-16<sup>1</sup> and present with higher complications rates than any other pediatric fracture. The purpose in treating these injuries is achieving normal function and alignment of the elbow joint, preventing potential sequelae.

The approach to displaced fractures is usually challenging, especially in the presence of neurovascular lesions. Vascular compromise may result in sequelae that may range from vascular claudication to Volkmann's ischemic contracture and, in some cases, gangrene and subsequent amputation.

Diagnosis and treatment of supracondylar fractures associated to vascular trauma are considered a surgical emergency and their approach remains controversial. Some authors suggest performing an arteriogram to define the nature and extent of the vascular lesion to be able to plan an effective treatment<sup>2-4</sup>. Other authors claim that the arterial lesion is always located at the fracture site and that carrying out an arteriogram only delays surgical treatment, worsening prognosis. Some even state that in 4% of cases an arteriogram results in secondary complications<sup>5,6</sup>.

The aim of this study is to describe the different epidemiological parameters of children with humeral supracondylar fractures in our environment and analyze the outcome of cases associated to a vascular lesion.

**Materials and methods**

This is a retrospective study of 205 children with a displaced Gartland type II and III supracondylar fracture, treated in our department between January 2002 and January 2006.

Of all subjects, only 11 presented with decreased or absent radial pulse on initial presentation to the emergency room. A record was made of the patients' age, sex, mechanism of injury, neurovascular examination, method of treatment and post-operative evolution.

In order to evaluate the presence of pain, claudication, range of motion and neurovascular status of the affected limb, only patients requiring vascular surgery associated to the treatment of a supracondylar fracture were included in the final review.

**Results**

Of the 205 children with a displaced supracondylar humeral fracture, 11 presented with an absence of radial pulse on presentation to the emergency room. Seven of these had a well-perfused hand, whereas in the other 4 the hand was ischemic.

All fractures were radiologically diagnosed as closed displaced Gartland type II and III supracondylar fractures; mean follow-up was 2 years (range: 2-6 years). In all cases, the mechanism of injury was a fortuitous fall, either at home or while being engaged in some recreational activity.

Mean age at the time of fracture was 7.25 years (range: 4-12 years). Seven subjects were male and the left elbow was the more severely affected (81.8%).

Initial treatment consisted in plaster cast immobilization and surgical preparation. Once in the O.R., general anesthesia was applied and closed fracture reduction and fixation was performed in 10 of the 11 children. Only one of the patients with an ischemic hand was transferred to the angiography unit, without attempting to perform a closed reduction. Diagnosis was intimal tear, so he was subjected

to an open reduction, vascular examination and performance of a bypass.

In 6 of the 7 children with a pulseless limb but with a perfused hand, closed reduction and percutaneous fixation were sufficient to restore radial pulse; they were discharged within 24-48 h. The remaining patient not only failed to recover radial pulse, but developed ischemia in the affected limb, which prompted us to carry out an intraoperative arteriogram, which showed an arterial spasm that required performance of a bypass.

Of the 4 patients with no radial pulse and an ischemic hand, 3 were subjected to closed reduction and, since no improvement was observed, an arteriogram and an arterial exploration were performed in addition to internal fixation (fig. 1).

The arteriogram performed in 5 of the 11 patients with a vascular lesion, revealed an arterial spasm in 4 of them and an intimal tear in another (fig. 2). In one patient, arterial spasm was secondary to entrapment of the artery at the fracture site. Once a release was performed and papaverine was administered, vascularization improved. Arterial spasms and the intimal tear required performance of a bypass with the internal saphenous vein (table 1).

Follow-up was carried out by the vascular surgery and trauma departments. No infections, malunions or varus deformities were found. All patients are currently asymptomatic, with a similar anconeal range of motion to the healthy limb and with no symptoms of claudication.

As regards neurologic lesions, it must be said that only one out of the 11 patients presented with a lesion of the radial nerve associated to the vascular trauma. At 9 months,

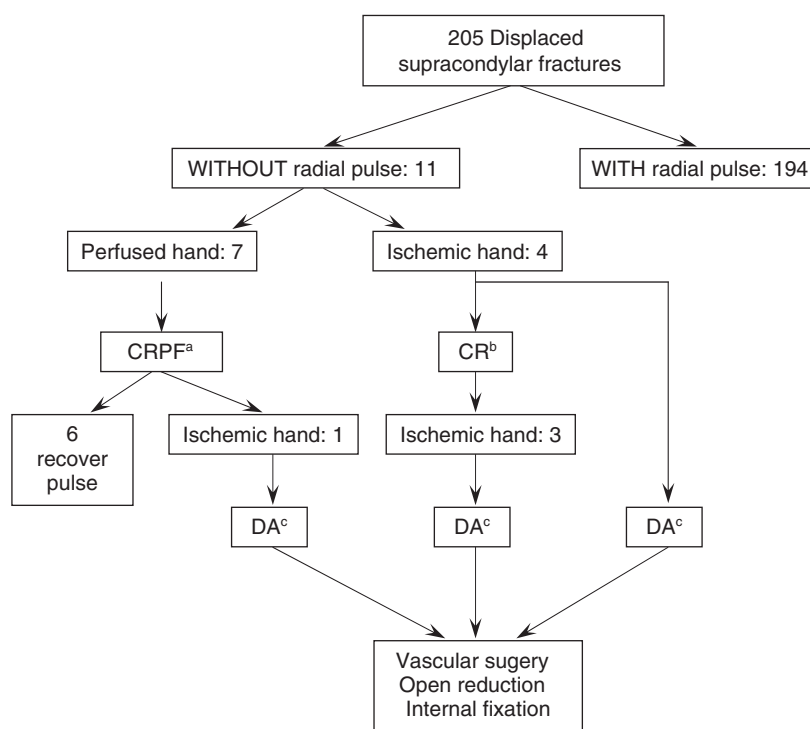
recovery was complete. Of the 194 patients with supracondylar fractures who did not have an associated vascular lesion, only 18 (9.27%) presented with neurological impairment. Nerves affected were the radial nerve in 8 cases, the ulnar nerve in 7 and the median nerve in 3.

## Discussion

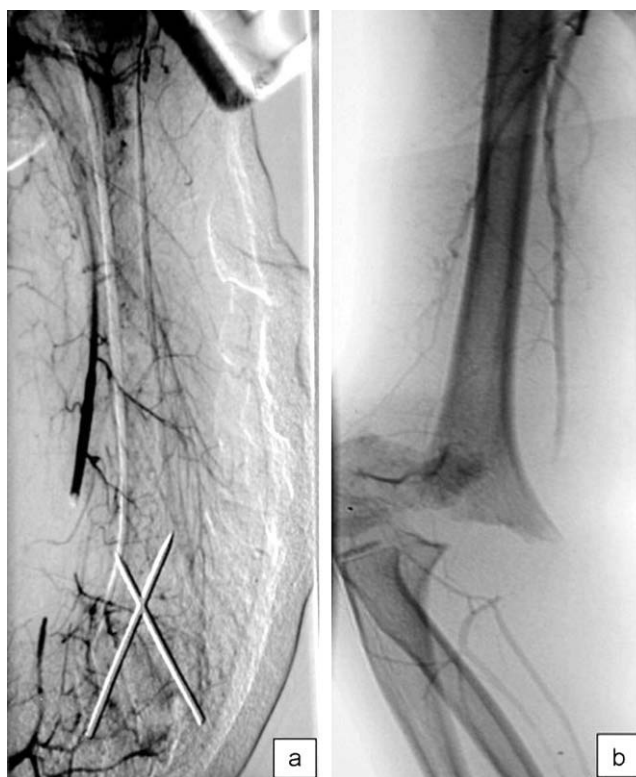
Displaced supracondylar fractures may be associated to a vascular or a nerve lesion. Careful analysis of patients' medical history together with an exhaustive physical examination are essential for diagnosis as they may avert performance of unnecessary tests such as echo-Doppler<sup>8</sup>, a technique that does not have enough sensitivity or specificity and which does not provide as much information as an arteriogram.

In our study we did not find a direct relationship between signs of ischemia and the type of arterial lesion<sup>9</sup>: laceration, intimal dissection, contusion, section, compression or spasm. The absence of pulse has been the most useful sign to confirm the presence of vascular trauma<sup>5,10,12</sup>. However, this is need not cause concern since it could be merely a transient spasm secondary to the trauma.

Immobilization is necessary following examination. Flexing the elbow beyond 90 degrees after a supracondylar fracture may be difficult and risky if the elbow is swollen and painful. In our view, the elbow is best immobilized in a flexed position, but the angle of flexion chosen should be the most comfortable one for the patient, without forcing flexion beyond 90 degrees.



**Figure 1** Evolution of the fractures treated in our hospital; CRPF: closed reduction and percutaneous fixation; CR: Closed reduction; DA= diagnostic arteriogram.



**Figure 2** a. Supracondylar fracture reduced causing an occlusion of the brachial artery above the fracture site; filling of collateral arteries; b. Arteriogram performed prior to fracture reduction. Tapering and occlusion of proximal artery, with filling of peripheral branches.

**Table 1** Arterial lesions

Patient	Age	Sex	Arterial lesion	Treatment
1	12	Male	Spasm	Bypass
2	5	Male	Spasm following entrapment	Papaverine release
3	8	Female	Spasm	Bypass
4	4	Male	Intimal dissection	Bypass
5	7	Male	Spasm	Bypass

Initial systematic treatment<sup>11</sup> by means closed reduction and percutaneous fixation with Kirschner wires in the most appropriate therapeutic option, recommended by all the studies reviewed<sup>2,4-6,9,11,12</sup>. This type of fixation permits elbow extension and does not require a circumferential cast. In this study, 10 de los 11 children with an associated vascular lesion were treated in this way. In 6 of them, radial pulse was restored almost immediately.

Controversy arises when radial pulse is not restored. Some authors<sup>5-7</sup> consider that performance of an arteriogram is not only unnecessary, since the arterial lesion is always located at the fracture site, but also detrimental for prognosis. They argue that an arteriogram delays fracture reduction, lengthens ischemic time and may be associated to iatrogenic complications like

adverse reactions to the contrast medium, an arterial lesion at the catheter insertion point or transient pulse loss.

Other authors<sup>2-4</sup> believe that an arteriogram is useful to confirm vascular lesions, define their nature and extent thereby assisting the surgeon in planning the arterial reconstruction. In some cases, it helps unveil mild lesions that affect the intima and that, if untreated, may develop into more serious entities.

In our experience, an arteriogram is necessary for evaluating the most severe cases since it makes it possible to better treat vascular lesions. The delay induced by performance of an arteriogram is largely compensated for by the benefit afforded by an accurate diagnosis of the lesion, which prevents more serious secondary complications. There are several references in the literature<sup>5,6,9</sup> on the

risks entailed by a conservative attitude vis-à-vis a serious vascular trauma. The most usual complications include alterations in limb development, ischemia associated to exercise, claudication symptoms and intolerance to coldness.

Vascular repair is associated with a high incidence of complications such as reocclusion and residual stenosis. Although we had a few cases of residual stenosis in ultrasound follow-up studies, our patients did not present with any kind of symptoms.

With respect to associated neurological lesions, according to the literature their incidence ranges between 2 and 60%. In our series, the incidence of neurological complications, sensory for the most part, was 9.2% and all patients fully recovered from them within one year.

In summary, initial treatment of displaced supracondylar fractures in the child, associated to an absence of radial pulse, should consist in closed reduction and stabilization with Kirschner wires. An arteriogram is the most appropriate diagnostic tool to define the lesion and plan the procedure. In children, supracondylar fractures associated with an absence of distal pulse in a hand that becomes ischemic once the reduction has been performed require an immediate vascular examination to prevent the grievous sequelae that could be provoked by a conservative attitude.

### Conflict of interests

The authors have declared that they have no conflict of interests.

### References

1. Cheng JC, Ng BK, Ying Sy, Lan PK. A 10 year-study of the changes in the pattern and treatment of 6,493 fractures. *J Pediatr Orthop*. 1999;19:344-50.
2. Luria S, Sucar A, Eylon S, Fichas-Mizrachi R, Berlatzky Y, Anner H, et al. Vascular complications of supracondylar humeral fractures in children. *J Pediatr Orthop B*. 2007;16:133-43.
3. Friedman RJ, Jupiter JB. Vascular injuries and closed extremity fractures in children. *Clin Orthop Relat Res*. 1984;188:112-9.
4. Makin GS, Howard JM, Green RL. Arterial injuries complicating fracture or dislocations: the necessity for a more aggressive approach. *Surgery*. 1966;59:208.
5. Copley LA, Dormans JP, Davidson RS. Vascular injuries and their sequelae in pediatric supracondylar humeral fractures: toward a goal of prevention. *J Pediatr Orthop*. 1996;16:99-103.
6. Shaw BA, Kasser JR, Emans JB, Rand FF. Management of vascular injuries in displaced supracondylar humerus fractures without arteriography. *J Orthop Trauma*. 1990;4:25-9.
7. Vasi LR. Diagnosis of vascular injury in children with supracondylar fractures of the humerus. *Injury*. 1988;19:11-3.
8. Minkowitz B, Busch MT. Supracondylar humerus fractures. Current trends and controversies. *Orthop Clin North Am*. 1994;25:581-94.
9. Garbuz DS, Leitch K, Wright JG. The treatment of supracondylar fractures in children with an absent radial pulse. *J Pediatr Orthop*. 1996;16:594-6.
10. Edean ED, Veldenz HC, Schwarcz TH, Hyde GI. Recognition of arterial injury in elbow dislocation. *J Vasc Surg*. 1992;16:402-6.
11. De las Heras J, Durán D, De la Cerda J, Romanillos O, Martínez-Miranda J, Rodríguez-Merchán EC. Supracondylar fractures of the humerus in children. *Clin Orthop Relat Res*. 2005;432:57-64.
12. Sabharwal S, Tredwell SJ, Beauchamp PD, Mackenzie WG, Jakubec DM, Cairns R, et al. Management of pulseless pink hand in pediatric supracondylar fractures of humerus. *J Pediatr Orthop*. 1997;17:303-10.