Original Article

What is the best fixation technique for the treatment of supracondylar humerus fractures in children?∗

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ABSTRACT

Objective: To define the best technique for the surgical treatment of supracondylar fracture of the humerus (SFH) in children, evaluating percutaneous pinning with side wires vs. cross-pinning.

Methods: Randomized controlled trials using the Medline, CAPES, and BIREME. The criteria for inclusion of articles criteria were: (1) randomized controlled trials (RCTs) comparing percutaneous wire fixation techniques, (2) SFH Gartland II B, III, and IV, and (3) children aged 1–14 years. The following were used as main variables: incidence of iatrogenic injury to the ulnar nerve and loss reduction.

Results: Eight studies were selected (521 patients) comparing surgical treatment with pinning in supracondylar fracture of the humerus in children Gartland II type B, III or IV. Iatrogenic injury to the ulnar nerve was greater with the cross-pinning technique, with RR 0.28 and p = 0.03, while the mini-open technique presented RR 0.14 and p = 0.2. A statistically significant greater loss of reduction in the lateral pinning was observed in FSU Gartland III and IV (p = 0.04).

Conclusion: Based upon this meta-analysis of prospective randomized clinical trials, the following is recommended: (1) percutaneous pinning with lateral wires in supracondylar fractures of the humerus in children classified as Gartland II type B; (2) use of crossed wires for Gartland type III or IV, using the mini-open technique for the medial wire.

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**Introdução**

Fratura supracondilar do úmero (SFH) é frequente na infância e na juventude, e há prevalência nas crianças com até 10 anos de idade. 

O termo “fratura supracondilar”, que foi introduzido por Gartland et al. (1956), foi consagrado pela classificação de Gartland e Wilkins, de 1966. 

A classificação de Gartland divide as fraturas supracondilares em quatro tipos: a fratura tipo I é minimamente displacada e a fratura tipo IV é completamente displacada. 

**Materias e métodos**

Estudo sistemático de revisão de ensaios clínicos randomizados foi conduzido para identificar os métodos de fixação percutânea para fraturas supracondilares do úmero em crianças. 

Os ensaios clínicos incluídos foram os seguintes: (1) associações de fios cruzados; (2) associações de fios não cruzados; (3) uso de fios individuais. 

Os principais resultados foram: (1) a associação de fios cruzados apresentou uma incidência de lesão iatrogênica do nervo ulnar e perda da redução mais alta; (2) a associação de fios não cruzados apresentou uma incidência de lesão iatrogênica do nervo ulnar e perda da redução mais baixa; (3) o uso de fios individuais apresentou uma incidência de lesão iatrogênica do nervo ulnar e perda da redução intermediária. 

**Conclusão**

O uso de fios individuais para a fixação percutânea de fraturas supracondilares do úmero em crianças apresentou uma incidência de lesão iatrogênica do nervo ulnar e perda da redução intermediária. 

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chi-squared test ($I^2$), considered statistically significant with $p > 0.05$, and a $I^2$ greater than 50% were considered significant heterogeneity. For groups that presented heterogeneity, random effects were applied to selected data. Relative risks (RR) and risk differences were calculated for dichotomous outcomes. For continuous outcomes, mean differences and 95% confidence intervals (CI) were calculated.

**Results**

Initially, 85 clinical trials comparing percutaneous pinning in SFH in children were retrieved. Of these studies, 35 were excluded for not being randomized. Of the 50 RCTs, 42 were excluded for duplication and/or surgical technique used. Finally, this study included eight prospective RCTs, comprising 521 patients (Fig. 1). Regarding assessment of methodological quality, the Detsky Quality Index score ranged from 13 to 20 points (average of 15.7).

Iatrogenic ulnar nerve injury in the treatment of SFH in children was more commonly observed in patients treated with cross-pinning when compared with lateral-only pinning (RR 0.28; 95% CI 0.09–0.87; $p = 0.03$). Heterogeneity was non-significant, with $I^2 = 0%$. Among the eight RCTs included in the study, 12 patients (4.46%) presented iatrogenic injury of the ulnar nerve in the cross-pinning group, vs. only two patients in the other group (0.78%; Fig. 2).

When RCTs that used mini-open technique for cross-pinning were analyzed, no statistically significant differences were observed (RR 0.14; 95% CI 0.01–2.79; $p = 0.20$) regarding

**Fig. 1 – Study design.**

**Fig. 2 – Comparative analysis to assess iatrogenic injury of the ulnar nerve in 521 patients who underwent percutaneous pinning with Kirschner wires for treatment of supracondylar fracture of the humerus in children.**
Fig. 3 – Comparative analysis to assess iatrogenic injury of the ulnar nerve in 272 patients who underwent percutaneous pinning with exclusively lateral or crossed Kirschner wires (with mini-open technique for medial access) for the treatment of supracondylar humeral fracture.

Fig. 4 – Comparative analysis to assess loss of reduction among 404 patients who underwent percutaneous pinning with exclusively lateral or crossed Kirschner wires for treating supracondylar humeral fracture in children.

Fig. 5 – Comparative analysis to assess loss of reduction from 216 patients with SHF Gartland III or IV who underwent percutaneous pinning with exclusively lateral or crossed Kirschner wires.
ulnar nerve injury when compared with lateral pinning (Fig. 3).

Patients submitted to lateral percutaneous pinning presented greater loss of reduction (32 cases; 15.84%) when compared with those who underwent cross-pinning (26 cases; 12.87%); the difference was not statistically significant (p = 0.35; Fig. 4).

When analyzing patients with SFH Gartland III and IV, a statistically significant (p = 0.04) greater loss of reduction was observed in patients submitted to lateral pinning (21 cases – 20.19%). Loss of reduction was observed in 12 patients (10.71%) in the cross-pinning group (Fig. 5).

No statistically significant difference was observed between the two techniques regarding the Baumann angle, Baumann angle variation, loading angle, loading angle variation, humero-capitellar angle, and humero-capitellar angle variation (Figs. 6–9).

**Discussion**

Iatrogenic injury of the ulnar nerve is an important factor to be analyzed when treating SFH using percutaneous pinning with Kirschner wires in children. The incidence of ulnar nerve injury observed in the present study (4.46%) is in agreement with the results previously found in the literature. Babal et al. concluded that medial pinning is the leading cause of iatrogenic ulnar nerve injury. Brauer et al. demonstrated that use of medial pin increased the incidence of neurologic injury by 1.84 times.
In this meta-analysis, a statistically significant difference was observed in the incidence of iatrogenic injury of the ulnar nerve when comparing techniques of lateral pins vs. crossed pins (p=0.03), which confirmed the relationship of iatrogenic injury of the ulnar nerve with the passage of a medial pin. Neural recovery usually occurs after 2–2.5 months of observation, but it can take up to 6 months. In the studies included in this review, all patients recovered from the neurological deficit during follow-up.

Previous studies have shown that mini-open technique for medial pin presents a low incidence of ulnar nerve injury. In this study, no statistically significant difference was observed in the analysis of ulnar nerve injury when using medial pin with mini-open technique.

Regarding loss of reduction, the literature still presents inconsistent results. In a retrospective study of 345 children with SFH, Skaggs et al. observed no difference in relationship to maintenance of fracture reduction when comparing both surgical techniques. In a clinical and biomechanical study, Omid et al. found similar stability using divergent, spaced lateral wires when compared with cross-pinning. In a systematic review, Brauer et al. observed residual deformity (secondary to loss of reduction) in 3.4% of patients treated with cross-pinning and in 5.9% of patients treated only with lateral pin, a statistically significant result. They concluded that cross-pinning provides greater stability in the wire configuration (they should cross above fracture) and that the probability of deformity or loss of reduction was 58% lower when compared with lateral pinning.

The present meta-analysis did not find a statistical significant difference for loss of reduction when evaluating the totality of patients involved in the studies included. When groups with fractures type III or IV of Gartland were assessed, incidence of loss of reduction was approximately 10% higher in the group with lateral wires, a statistically significant difference (p=0.04).

**Conclusion**

Based on this meta-analysis with prospective randomized clinical trials, the authors recommend: (1) percutaneous pinning with lateral wires for SFH in children with Gartland II type B fractures; (2) crossed wires in Gartland type III or IV fractures, with a mini-open technique for the medial wire.

**Conflicts of interest**

The authors declare no conflicts of interest.

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