Delayed treatment of supracondylar elbow fractures in children


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Summary
Background: Supracondylar fractures are the most common elbow fractures in children and are usually treated on an emergency basis, using percutaneous pinning. However, the treatment is often delayed in areas where healthcare resources are scarce.
Hypothesis: Delaying treatment does not influence the perioperative complication rate.
Materials and method: We retrospectively reviewed the medical charts of 89 children aged 2 to 15 years in whom surgery for extension-type supracondylar elbow fractures was delayed by more than 48 hours. The 53 boys and 36 girls with a mean age of 6 years 9 months had severe fracture displacement (28 stage III and 61 stage IV according to Lagrange and Rigault classification scheme). Mean time to treatment was 4.5 days (range: 2–17 days). Open reduction and crossed K-wire fixation via the posterior approach were performed in all 89 patients. Postoperative complications and sequelae were collected. Functional outcomes were evaluated using Flynn’s criteria.
Results: Outcomes were satisfactory in 74 (83.2%) of patients. Postoperative complications occurred in 13 (14.6%) patients and consisted of surgical site infection (n = 7, 7.8%), iatrogenic nerve injury (n = 3, 3.4%), and reoperation (n = 3, 3.4%). At last follow-up after a mean of 5 months, three (3.4%) patients had cubitus varus and one had a recurrent fracture due to mas-saging. Elbow motion was limited in 11 (12.4%) patients. No case of compartment syndrome was recorded.
Discussion: Despite an average time to surgery of 4.5 days, the outcome was satisfactory in 83% of cases. Delayed treatment was not associated with an increased rate of perioperative complications.
Level of evidence: Level IV, retrospective study.
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Introduction
Supracondylar elbow fractures are classically treated on an emergency basis, using a variety of orthopaedic and surgical...
methods. Emergency percutaneous pinning is usually advocated [1,2]. In developing countries, however, treatment delays are common [3,4]. In our experience in Côte d’Ivoire, the time to treatment is often longer than 48 hours.

The objective of this retrospective study was to assess functional outcomes after delayed treatment of supracondylar elbow fractures in children. Our working hypothesis was that delayed treatment had no effect on the rate of perioperative complications.

Materials and method

From 2000 to 2008, 137 children underwent surgery for supracondylar elbow fractures at the paediatric surgery department of the Yopougon teaching hospital, Côte d’Ivoire. We retrospectively reviewed their medical charts to identify patients with a time to surgery longer than 48 hours and regular follow-up for longer than 3 months. We excluded patients with flexion-type fractures, compound fractures, vascular complications, surgery within 24 hours post-injury, and missing data.

Eighty-nine patients were included, 53 (59.55%) boys and 36 (40.45%) girls (male-to-female ratio: 1.47). Mean patient age was 6 years 9 months (range: 2–15 years). According to the Lagrange and Rigault classification scheme [5], 28 (31.4%) fractures were stage III and 61 (68.6%) stage IV. Nerve injury manifesting as paresthesia was present in seven patients; the median nerve was involved in three, the ulnar nerve in one, and the radial nerve in one, while in the remaining two patients the injury site was not reported. Time to surgery was defined as the time from emergency-room admission to entry into the operating room. Mean time to surgery was 4.5 days (range: 2–17 days).

General anaesthesia was used in all 89 patients. Surgery was consistently performed with the patient in the lateral decubitus position and the elbow on a pad. After placement of a tourniquet at the root of the limb, a median posterior skin incision was made on the midline. The ulnar nerve was isolated and placed in a noose. The fracture site was exposed via the medial and lateral paratricipital approach and the fracture was then reduced under visual control of both distal humeral columns. Crossed K-wires fixation was performed, using a slow-rotation power drill (Fig. 1). Stability of the reduction was assessed. The wires were then bent back and cut short under the skin. The wound was closed in two planes on a suction drain with a continuous intradermal suture. After removal of the tourniquet, the arm was placed in a posterior splint with the elbow flexed at 90°. On the third postoperative day, the drain was removed and a long-arm cast was applied. After 45 days, the cast and wires were removed.

Time to union was 45 days. We recorded hospital stay length and postoperative complications (iatrogenic nerve injury, infection, compartment syndrome, malalignment, joint stiffness, neurological deficit, and myositis ossificans). The functional outcome was assessed using Flynn criteria [6]. Excellent, good, and fair outcomes were considered satisfactory (Table 1).

Results

At last follow-up after 5 months on average (range: 3–62 months), the outcome was excellent in 47 (52.8%) patients, exposed via the medial and lateral paratricipital approach and the fracture was then reduced under visual control of both distal humeral columns. Crossed K-wires fixation was performed, using a slow-rotation power drill (Fig. 1). Stability of the reduction was assessed. The wires were then bent back and cut short under the skin. The wound was closed in two planes on a suction drain with a continuous intradermal suture. After removal of the tourniquet, the arm was placed in a posterior splint with the elbow flexed at 90°. On the third postoperative day, the drain was removed and a long-arm cast was applied. After 45 days, the cast and wires were removed.

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**Figure 1** Stage IV supracondylar elbow fracture in a 2-year-old girl treated surgically on the fifth day post-injury; a: preoperative anterior view; b and c: postoperative anterior and lateral view. Note the absence of forward displacement of the distal humerus.

<table>
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<tr>
<th>Table 1</th>
<th>Grading system developed by Flynn et al. [6].</th>
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<tr>
<td>Outcome</td>
<td>Loss of carrying angle (°)</td>
</tr>
<tr>
<td>Satisfactory</td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>0–5</td>
</tr>
<tr>
<td>Good</td>
<td>6–10</td>
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<tr>
<td>Fair</td>
<td>11–15</td>
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<tr>
<td>Unsatisfactory</td>
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<td>Poor</td>
<td>&gt; 15</td>
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good in 16 (18%), fair in 11 (12.4%), and poor in 14 (15.7%). Thus, 74 (83.2%) patients had satisfactory outcomes (Fig. 2).

Mean hospital stay length was 8.1 days (range: 2–19 days). Postoperative complications occurred in 13 (14.6%) patients, consisting of skin wounds in seven (7.8%), iatrogenic nerve injury in three (3.4%), and reoperation in three (3.4%). The nerve injuries involved the ulnar nerve in two cases and the radial nerve in one case. All iatrogenic and trauma-related nerve injuries resolved within 3–4 months. Three patients with inadequate fracture reduction required reoperation. In the medium term, three (3.4%) patients had cubitus varus deformity, including two with more than 15° of angulation. Corrective osteotomy of the humerus was performed in these two patients. Restricted range of motion was noted in 11 (12.4%) patients including seven with loss of more than 25° of extension and four with loss of more than 15° of flexion. In one patient, massages prompted by the elbow stiffness led to a recurrent fracture, which was treated with a long-arm cast. No case of compartment syndrome was recorded.

Discussion

The limitations of our study were related to the retrospective design and absence of a comparison group of patients treated without delay. The fracture type and treatment method were the same in all patients. Also, all patients were re-evaluated despite the often-unfavourable social conditions.

Extension-type supracondylar fractures are the most common elbow fractures in children. Classically, prompt reduction and percutaneous pinning is the method of choice [1,2,6–8]. The 83.2% rate of satisfactory outcomes in our study is similar to that of 88% reported by Tiwari et al. [3], but lower than those of 95 to 100% obtained after percutaneous pinning [8,9].

Figure 2 Clinical appearance in the same patient 3 years and 1 month after surgery. There is no mal-alignment or loss of flexion: a: anterior view; b: lateral view.

The optimal timing of surgery for uncomplicated displaced supracondylar fractures remains controversial [7,10,11]. Prompt reduction on an emergency basis is usually advocated, as the absence of oedema initially facilitates fracture reduction and decreases the risks of perioperative complications (compartment syndrome, infection, and iatrogenic nerve injury) and conversion to open surgery [7,11]. However, several studies indicate that delayed treatment does not increase the morbidity rate [10,12]. Delayed treatment is common in developing countries. Thus, Tiwari et al. in India [3] and Abdullah et al. in Turkey [13] reported mean treatment delays of 4 and 6 days, respectively. In Pakistan, Shakir et al. [4] found that 52% of patients first used traditional methods. According to Chai (cited by Tiwari et al. [3]), 15% of Malaysian patients were seen late. In our practice, treatment delays can be explained by socio-cultural beliefs, which lead to the use of traditional practices. In addition, chronic staff shortages, insufficient availability of adequate equipment, and repeated organizational difficulties in the operating room increase the risk of treatment delays. Delayed treatment of supracondylar fractures leads to an increase in hospital stay length, resulting in additional costs for the parents, whose financial resources are often limited. Treatment delays combined with the unavailability of image amplifiers require that we use open surgery in all patients with displaced supracondylar fractures. Reported approaches include the posterior, medial, lateral, anterior, and both medial and lateral approaches. We used the posterior approach, which allows a visual assessment of reduction quality, ensures proper wire positioning, and decreases the risk of iatrogenic ulnar nerve injury. Disadvantages of the posterior approach consist of a higher risk of infection, unbecoming scars, and decreased elbow motion range [14]. All 89 patients in our study were treated by a senior surgeon. Nevertheless, fracture reduction was often difficult to achieve, particularly in the younger patients, as previously reported [15].

Among patients treated with emergency percutaneous pinning, 3 to 46% require conversion to open surgery [14,16]. Several studies found no increased risk of conversion to open surgery when treatment was delayed by more than 8 hours [7,11] or 12 hours [10,17]. Gupta et al. [16] reported a 6% conversion rate in patients with a treatment delay of 12 hours, whereas Walmsley et al. [18] found that delaying treatment by 12 hours increased the conversion rate from 11.2 to 33%. According to Loizou et al. [1], the conversion rate increased from 11.1 to 22.9% when treatment was delayed. Yildirim et al. [2] reported that closed reduction was no longer feasible after 32 hours. We agree with others [1–3,13,18,19] that the need for open surgery increases with the time to treatment. Monitoring has been advocated in the event of delayed treatment [20]. Abdullah et al. [13] recommended axial traction applied using tape, open reduction, and percutaneous pinning after traction via a transosseous pin. A disadvantage of this strategy is the longer hospital stay length. Allowing malunion to occur then performing a corrective osteotomy has also been advocated [21]. In our population, some of the patients had incipient callus formation, which did not affect the outcomes, as these were governed by the quality of the reduction.

An accurate evaluation of the effects of delayed treatment on perioperative complications and functional...
outcomes in patients with supracondylar elbow fractures would require a prospective randomised trial. However, such a trial would raise ethical challenges [10].

In our study, the rate of postoperative complications (infections, iatrogenic nerve injury, and cubitus varus) was consistent with earlier data [3,7,9,18]. Neither Melhman et al. [7] nor Walmsley et al. [18] found any significant difference in postoperative complication rates between patients treated immediately and those whose treatment was delayed.

The infection rate ranges from 2 to 6.6% after percutaneous pinning [22]. Surgical site infections occurred in 7.8% of our patients and were treated with local care and appropriate antibiotic therapy. None of our patients developed osteitis. Bamrungthi et al. [14] reported a 5.5% rate of infectious complications after surgery via the posterior approach and El-Adl et al. [9] an 8.6% rate after percutaneous pinning. Melhman et al. [7] found no differences across their groups. In every case, the infection was superficial and resolved fully.

Iatrogenic nerve injuries occur in about 6% of supracondylar elbow fractures and predominantly involve the ulnar nerve. They occurred in 3.4% of our patients. The main mechanism was probably traction on the nerve during reduction manoeuvres. The case of radial nerve injury was probably attributable to the medial wire, which travelled through the cortex over more than 1 cm. Tiwari et al. [3] found no cases of iatrogenic nerve injury among patients treated with a mean delay of 4 days.

Restricted range of motion is common after open reduction via the posterior approach [21]. Loss of flexion may be ascribable to inadequate reduction and loss of extension to contractures or fibrous scars in the distal triceps muscle. In our patients, physical therapy was prescribed after 3 months, although the appropriateness of this measure remains controversial. The limited duration of follow-up may explain the 12.4% rate of restricted range of motion in our study. Prolonged follow-up is in order, as spontaneous activities engaged in by children contribute to restore elbow function.

Cubitus varus is the most common residual abnormality after extension-type supracondylar fractures in children [22]. The rate in our study was 3.4% compared to 6% [3] and 11% [4] in two other studies of patients treated via the posterior approach. Cubitus varus was related neither to the approach nor to the type of fixation. Kohler et al. [23] reported that cubitus varus could occur with all types of treatment. The underlying mechanism may involve either persistent rotation of the distal humerus after fracture reduction or inadequate reduction.

**Conclusion**

Our study in children with supracondylar elbow fractures showed an 83.2% rate of satisfactory outcomes despite delayed treatment. Delayed treatment is common in developing countries. In our population, delays were not associated with increases in the perioperative complication rates. The high prevalence of elbow stiffness indicates a need for prolonged follow-up, as motion range tends to improve over time.

**Disclosure of interest**

The authors declare that they have no conflicts of interest concerning this article.

**References**


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