Outcomes of Gartland type III supracondylar fractures treated using Blount’s method

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ABSTRACT

Background: Supracondylar fractures of the elbow with major displacement are usually treated by surgical pinning and less often non-operatively as described by Blount. The objective of this study was to assess the clinical and radiological outcomes of Gartland type III supracondylar fractures treated at least 3 years earlier using Blount’s method.

Hypothesis: Blount’s method produces good outcomes after more than 3 years when used to treat Gartland type III supracondylar fractures of the humerus.

Methods: A single-centre retrospective study was done in paediatric patients who were seen within 24 hours after sustaining a Gartland type III supracondylar fracture then re-evaluated at least 36 months after treatment. Closed reduction was performed either in the operating room under general anaesthesia or in the radiology suite under procedural sedation. The upper limb was then immobilised for 4 weeks using the cuff-and-collar method described by Blount (mean elbow flexion, 134°). The child was evaluated and radiographs obtained at the outpatient clinic on days 7 and 14. Functional outcomes were assessed using the 1962 SoFCOT criteria and Flynn’s criteria and the radiological outcome using Baumann’s angle, the humero-condylar angle, and distal fragment rotation. From 2009 to 2013, 22 patients met the inclusion criteria. Mean follow-up was 57 months.

Results: Clinical outcomes assessed using the 1962 SoFCOT criteria were very good in 15 patients and good in the remaining 7 patients. The rate of satisfactory outcomes according to Flynn’s criteria was 100%. At last follow-up, mean Baumann’s angle was 68°, mean humerocondylar angle was 42°, and 2 patients had residual rotation of the distal fragment.

Conclusion: This work confirms the effectiveness of Blount’s method for treating Gartland type III supracondylar fractures. We advocate routine first-line treatment of these fractures using Blount’s method in the absence of vascular compromise and instability.

Level of evidence: IV, retrospective study.

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1. Introduction

Extension supracondylar fractures of the distal humerus are the most common elbow fractures in paediatric patients. The usual mechanism is an indirect impact responsible for posterior displacement with an extra-articular fracture line through both columns of the distal humerus [1,2].

In France, supracondylar fractures are usually described using the Lagrange-Rigault classification [3]. Internationally, however, the Gartland classification as modified by Wilkins is the reference standard [4,5]. Gartland type III fractures (Lagrange-Rigault grade 4) are defined as major posterior displacement with loss of contact between the two bone fragments. These fractures carry a high risk of complications and residual functional impairments in the event of inadequate reduction.

Given the major displacement in Gartland type III fractures, routine surgical treatment with pinning has been advocated to ensure stable reduction [6]. However, pinning carries a risk of nerve injury and infection and fails to completely eliminate the risk of joint stiffness and secondary cubitus varus displacement [3,7,8]. Blount described a non-operative treatment method [1] based on the stabilising effect of the posterior perosteum, enhanced if needed by the triceps muscle [9–11]. Studies of outcomes of Blount’s method are limited by short follow-up durations, and few include patients with Gartland type III fractures [8,9,12]. In our department, Blount’s method is often used to treat supracondylar fractures of all types.

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1877-0568/© 2017 Elsevier Masson SAS. All rights reserved.
The objective of this study was to assess the clinical and radiological outcomes of Gartland type III supracondylar fractures treated at least 3 years earlier using Blount’s method. The working hypothesis was that Blount’s method produces good outcomes after more than 3 years when used to treat Gartland type III supracondylar fractures of the humerus.

2. Material and method

2.1. Patients

A single-centre retrospective study was conducted in paediatric patients managed over the 4-year period from December 2009 to December 2013. We identified patients admitted on an emergency basis within 24 hours after a supracondylar fracture that was type III in the Gartland classification as modified by Wilkins. A follow-up of at least 36 months was required. We did not include patients with Gartland type I or II fractures, anteriorly displaced fractures, or compound fractures (Gustillo II or III).

From December 2009 to December 2013, 33 paediatric patients were managed for Gartland type III fractures. Among them, 24 received first-line treatment using Blount’s method after closed reduction. The remaining 9 had complications requiring first-line percutaneous pinning and were therefore not included in the study (Fig. 1). Of the 24 patients treated using Blount’s method, 2 were lost to follow-up, leaving 22 patients for the study (Table 1).

<table>
<thead>
<tr>
<th>Table 1</th>
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<tbody>
<tr>
<td>Characteristics</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td><strong>Side of fracture</strong></td>
</tr>
<tr>
<td>Left</td>
</tr>
<tr>
<td>Right</td>
</tr>
<tr>
<td><strong>Time from injury to treatment</strong></td>
</tr>
<tr>
<td>&lt; 6 h</td>
</tr>
<tr>
<td>&gt; 6 h</td>
</tr>
<tr>
<td><strong>Place where reduction was performed</strong></td>
</tr>
<tr>
<td>Operating room</td>
</tr>
<tr>
<td>Emergency room</td>
</tr>
</tbody>
</table>
Of the 22 study patients, 2 had an ipsilateral fracture of the distal radius, which was managed non-operatively using a resin cuff to maintain the wrist in flexion, after reduction if needed, before reduction of the elbow fracture. Mean initial hospital stay length was 1.7 days (range: 0–3 days) and mean cuff-and-collar immobilisation time was 4.3 weeks (range: 3–8 weeks) depending on the radiological findings. Mean elbow flexion during immobilisation was 134° (range: 117°–148°). Mean follow-up was 57 months (range: 36–72 months).

2.2. Technique

Once the diagnosis was confirmed by antero-posterior and lateral radiographs of the elbow, closed reduction was performed under fluoroscopic guidance, either in the operating room under general anaesthesia or in the radiology suite under procedural sedation (intrarectal nalbuphine, 0.3 mg/kg, followed by intrarectal midazolam, 0.2 mg/kg combined with equimolar nitrous oxide/oxygen). The patient was supine with the injured upper limb resting on the image amplifier.

Closed reduction was performed in three steps as described by Blount in 1955: gentle gradual traction along the axis of the limb (with countersupport by an aide) to correct any translation in the coronal plane, correction of any rotational displacement by supination or pronation, and flexion at 120° while applying pressure to the distal humerus to correct the displacement in the sagittal plane.

In the event of poor vascular tolerance (no pulse, capillary refill time > 3 s) or instability of the reduction in 120° flexion, the treatment method was to be changed. Anteroposterior and lateral fluoroscopic images were obtained to assess the reduction. Reduction was considered achieved if the medial and lateral columns of the distal humerus were aligned in the coronal and sagittal planes.

Once reduction was achieved, the upper limb was immobilised using a tubular foam bandage positioned around the wrist and the neck (with a space of two fingerbreadths between the skin and the knot) to maintain the elbow at 120° of flexion (Fig. 2) [10].

Anteroposterior and lateral radiographs of the elbow were then obtained. The limb was examined for evidence of vascular complications (absent pulses, sensory-motor impairments in the three territories of the hand) after the reduction.

Patients who underwent reduction under sedation in the radiology suite were monitored for 2 hours. Criteria for home discharge were absence of severe pain, ischaemia (absent pulses, cyanotic or pale fingers, moist skin), sensory-motor impairments, and poor tolerance of the cuff-and-collar system. The parents were instructed about monitoring their child for vascular and nervous complications and providing local care at the antecubital fossa. Patients who had the reduction performed in the operating room under general anaesthesia were admitted to the surgery ward for 12 to 24 hours of post-anaesthesia monitoring.

The patients were evaluated at the outpatient clinic on days 7 and 14, when anteroposterior and lateral radiographs of the elbow were obtained to look for secondary displacement.

The limb was immobilised for 4 weeks. No physical therapy was prescribed at the end of this period. Sports activities were resumed after 2 months.

2.3. Evaluation

Functional outcomes were assessed based on the 1962 SoFCOT functional criteria [13] (Table 2), Flynn’s criteria [14] (Table 3), joint range of motion, sports resumption, persistent pain, and satisfaction of the parents and child.

Three radiological criteria were assessed after reduction then at last follow-up: Baumann’s angle (normal: 64°–81°) [15,16], the humerocapitellar angle (normal: 30°–45°; evaluates anteversion of the distal humerus), and distal fragment rotation [17]. On the lateral radiograph, distal fragment rotation was quantified according to Gordon et al. [17] as the proximal metaphysis displacement at the fracture site divided by the width of the fragment at the fracture site and multiplied by 100 (Fig. 3); the result was expressed as a percentage.

The following complications were recorded: skin complications, compartment syndrome, vascular and neurological complications, and secondary displacement requiring surgical treatment.

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**Table 2**

1962 SoFCOT criteria.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>Normal elbow Normal function but: slight range of motion restriction; slight muscle weakness; persistent axis malalignment &lt; 10° OR Axis malalignment 10° to 20°</td>
</tr>
<tr>
<td>Good</td>
<td>Range-of-motion restriction &gt; 20° OR Axis malalignment &gt; 20°</td>
</tr>
<tr>
<td>Fair</td>
<td>Residual paralysis</td>
</tr>
</tbody>
</table>

**Table 3**

Flynn’s criteria [14].

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Loss in carrying angle = cosmetic outcome (in degrees)</th>
<th>Loss in elbow range of motion = functional outcome (in degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfactory</td>
<td>0–5</td>
<td>0–5</td>
</tr>
<tr>
<td>Excellent</td>
<td>6–10</td>
<td>6–10</td>
</tr>
<tr>
<td>Good</td>
<td>11–15</td>
<td>11–15</td>
</tr>
<tr>
<td>Fair</td>
<td>&gt; 15</td>
<td>&gt; 15</td>
</tr>
</tbody>
</table>

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**Fig. 2.** Collar-and-cuff immobilisation method described by Blount.
No patient experienced post-reduction vascular or neurological complications, compartment syndrome, or non-union. In 1 patient, whose closed reduction was anatomical, secondary displacement on day 15 required surgical treatment; no further complications occurred.

4. Discussion

This work reports the outcomes of the largest cohort to date of paediatric patients followed-up for nearly 5 years after the treatment of a Gartland type III supracondylar fracture using Blount’s cuff-and-collar immobilisation. The results confirm our working hypothesis by showing excellent clinical and radiological outcomes (both bone healing and satisfactory functional outcome in 100% of patients).

In previous studies, Blount’s method was found inadequate in 20% to 25% of patients with Gartland type III fractures. However, follow-up was only 6 months to 3 years [8,9,12]. A single study, by Kimpké et al. [9] showed excellent outcomes, but the Gartland types are not specified in the report. The better outcomes in our study are probably ascribable to the longer follow-up, which allowed remodelling and/or a gradual increase in motion range. This possibility is supported by the finding of residual distal rotation in 11 patients after reduction but in only 2 patients at last follow-up. Thus, bone remodelling during growth provides some measure of correction of rotational displacement. Consequently, the persistence of moderate distal rotation (< 50°) on the post-reduction radiographs may be acceptable. In accordance with this view, Persiani et al. [18] pointed out the beneficial effects of bone remodelling on the anatomical and functional outcomes.

In our study, there was a single failure (4%) and no patient experienced complications. The complication rate is consistent with earlier reports [9,10] and lower than the rates usually reported after first-line surgical treatment (Table 5).

Cubitus varus deformity did not develop in any of our patients, despite being reported as the main complication, with rates ranging from 3% to 57% [16,22–24]. The resulting loss is cosmetic rather than functional [16,25]. None of our patients experienced compartment syndrome, which was rare in earlier studies of Blount’s method (0% to 0.3%) [22,24,26,27].

Non-operative treatment protects the patient against the complications inherent in surgery. Thus, after pinning, Bashyalet al. [21] reported ulnar nerve palsy in 0.2% of cases, infection in 1%, pin migration in 1.8%, and pin breakage in 0–3%. Another advantage of Blount’s method is that no second surgical procedure for pin removal is necessary.

Of our 22 patients, 2 were managed in the emergency room under procedural sedation then monitored during a brief hospital stay. This is now the most widely used protocol and is currently being evaluated prospectively in our centre.

The main limitation of this study is the risk of bias due to the retrospective design and treatment by several surgeons. In addition, the radiographic results should be interpreted with caution given the frequently limited quality of the radiographs, particularly those

Table 4
Number (%) of patients in each category determined by Flynn’s criteria.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Cosmetic criteria</th>
<th>Functional criteria</th>
<th>Overall score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>13 (59%)</td>
<td>20 (91%)</td>
<td>12 (55%)</td>
</tr>
<tr>
<td>Good</td>
<td>9 (41%)</td>
<td>2 (9%)</td>
<td>10 (45%)</td>
</tr>
<tr>
<td>Fair</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

3. Results

The 1962 SoFCOT criteria at last follow-up indicated a very good outcome in 15 patients and a good outcome in the remaining 7 patients (Table 2). Thus, no patient had a fair or poor outcome. Table 4 reports the assessment according to Flynn’s criteria. At last follow-up, all patients had resumed normal physical activities for their age. Weather-related pain was reported by a single patient at last follow-up.

The radiographs after reduction showed anatomical reduction in 11 patients and residual rotation of the distal fragment in the remaining 11 patients. Mean rotation was 24° (range, 5°–50°). At last follow-up, 2 patients had persistent distal fragment rotation (10% and 5%, respectively). In these 2 patients, the 1962 SoFCOT criteria indicated a very good and a good outcome, respectively, and Flynn’s criteria a very good functional outcome and a good cosmetic outcome.

At last follow-up, mean Baumann’s angle was 68° (range: 63°–82°) and mean humerocondylar angle was 42° (range: 32°–50°). No reliable and reproducible method is available for measuring Baumann’s angle on an anteroposterior view of the elbow at 120° of flexion. Consequently, a comparison of Baumann’s angle after reduction and at last follow-up was not feasible.

Table 5
Frequency of revision after Blount’s method in previous studies.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Technique</th>
<th>Mean follow-up (range)</th>
<th>Revision for secondary displacement (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flynn et al. [14]</td>
<td>Closed reduction + percutaneous pinning (n = 52)</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>Yaokreh et al. [19]</td>
<td>Closed reduction + Pinning (n = 33)</td>
<td>10.3</td>
<td></td>
</tr>
<tr>
<td>Yaokreh et al. [20]</td>
<td>Open reduction + Pinning (n = 25)</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>Bashyal et al. [21]</td>
<td>Open reduction + Pinning (n = 89)</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Closed reduction + Pinning (n = 622)</td>
<td>40 weeks (2–619)</td>
<td></td>
</tr>
</tbody>
</table>
obtained initially, which complicated the measurements. Finally, the small sample size of 22 patients is also a limitation.

5. Conclusion

This work confirms our hypothesis that Blount’s method used to treat Gartland type III supracondylar fractures is effective in producing very good functional outcomes with a negligible risk of complications and a short hospital stay [28]. Given the absence of invasive procedures and of potential complications related to pinning, we use Blount’s method for the first-line treatment of Gartland type III fractures, in the absence of vascular compromise and provided the reduction is stable. When these conditions are not met, surgery remains the standard of care.

Disclosure of interest

The authors declare that they have no competing interest.

References