Surgical management for late presentation of supracondylar humeral fracture in children

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ABSTRACT

Purpose. To report the results of surgical management for late-presenting displaced supracondylar fractures of the humerus in children.

Methods. Between February 2002 and June 2003, 40 children (mean age, 7 years) with late presentation (range, 2–12 days) of displaced supracondylar humeral fractures were prospectively recruited. Gentle closed manipulation under image intensification was attempted in all patients, except one with a compound open fracture. Manipulation was successful in 25 patients and percutaneous skeletal stabilisation with Kirschner wires was performed. The remaining 15 patients were treated with open reduction and Kirschner wire fixation, using a mediolateral approach.

Results. The mean delay in presentation was approximately 4 days. No patients presenting more than 7 days after injury had the fracture reduced by closed manipulation. The mean hospital stay was 41 hours. At the final follow-up (mean, 18 months), 88% of the patients had a satisfactory result, according to Flynn’s criteria.

Conclusion. Operative treatment for late presentation of supracondylar humeral fractures in children is effective. It minimises the risk of complications and the need for continuous traction or corrective osteotomy.

Key words: bone wires; humeral fracture; surgical procedures, operative

INTRODUCTION

Supracondylar fractures are the commonest fractures around the elbow in children. They are difficult to reduce, often have reduction loss, malunion, stiffness, neurological and vascular complications. Immobilisation in cast has been the standard treatment for undisplaced fractures, but for displaced fractures it remains controversial. Closed reduction and percutaneous pinning provides the best cosmetic and functional results. However, some fractures are irreducible by closed means. Open reduction and
pinning is therefore recommended for supracondylar fractures and for those with vascular injury or compound fracture.\textsuperscript{8–11} Late presentations, defined as more than 2 days after injury, are commonly treated by continuous traction, with consequent prolonged hospitalisation.\textsuperscript{12,13} Alternatively, they are allowed to malunite and treated later by corrective osteotomy.\textsuperscript{14} A higher incidence of stiffness, neurological and vascular complications, and failure of closed reductions are encountered in late-presenting cases, particularly after repeated manipulations.\textsuperscript{15–18} Operative interventions risk further stiffness and myositis ossificans. Continuous traction has the disadvantages of prolonged hospitalisation, resort to frequent radiographic analyses, and inadequate reduction.

We prospectively evaluated the results of operative treatment (closed reduction and pinning or open reduction and pinning) for late-presenting displaced supracondylar humeral fractures in children.

**MATERIALS AND METHODS**

Between February 2002 and June 2003 inclusive, 27 boys and 13 girls aged up to 12 (mean, 7) years who presented with a late-presenting (at least 2 days) displaced supracondylar fracture of the humerus were included. Children presenting with a vascular injury or extensive swelling with or without blisters were excluded, as were those with other fractures or head injury.

There were 37 extension-type and 3 flexion-type fractures; 3 Gartland type II and 37 Gartland type III fractures. The left side was involved more often than the right side (25 vs 15). One patient had an open fracture (Gustilo grade II). Fall while playing and fall from a height were the predominant modes of injury. The mean delay in presentation was approximately 4 days, while the mean delay in surgery was 4.5 days. In 20 patients the delay was 2 to 4 days, in 15 it was 5 to 7 days, and in 5 it was 8 to 12 days. Most (29) patients had received either manipulation without general anaesthesia or massage by a traditional bonesetter. The reasons for presenting late were referral (n=24), lack of transport (n=7), and ignorance (n=9).

Detailed examination of the neurological and vascular status of the limb was performed. The limb was splinted and elevated and the vascularity monitored. With the patient supine, a single surgeon performed closed reduction under general anaesthesia and image intensifier facilitation. Longitudinal traction was applied to disengage the fragments. The forearm was then pronated or supinated to correct rotation, and gentle pressure was applied on the olecranon while maintaining the precise forearm rotation and traction. Once 90° flexion was achieved, the forearm was pronated (for posteromedial displacement) or supinated (for posterolateral displacement). The elbow was then flexed to 130° and examined using an image intensifier.\textsuperscript{3} If closed reduction was successful within one or 2 attempts, percutaneous skeletal stabilisation with Kirschner wires was carried out. If unsuccessful, open reduction and internal fixation with Kirschner wires was performed, using a mediolateral (triceps-sparing) approach (Figs. 1 and 2).\textsuperscript{19–21}

Most patients were discharged the next day; the mean hospital stay was 41 hours. All patients were followed up 3 weeks later to remove the wires and splintage, and then monthly. Active range of movement exercises and activities of daily living were encouraged. At the final follow-up, the range of movement and carrying angle of the elbow were measured with a goniometer and graded according to Flynn’s criteria.\textsuperscript{22} Neurological examination was performed and the patients were asked if they had any symptoms related to the elbow. Anteroposterior and lateral radiographs of the elbow were obtained.

**RESULTS**

The mean follow-up period was 18 (range, 12–24) months. Patients were graded according to the Flynn’s criteria (Table 1). The mean Baumann angle was 77° in the affected elbow and 73° in the normal elbow. Complications encountered are shown in Table 2. Three patients had poor results with significant limitation in the range of movement. One (with an open fracture) had stiffness resulting from extensive soft tissue scarring (loss of both flexion and extension by 20°), another had an anterior bony block (loss of...
Closed reduction could be achieved in 25 (64%) of the 39 patients. None of the 3 patients presenting more than 7 days after injury achieved closed reduction. 15 patients underwent open reduction; one with an open fracture and the others following failed closed reductions.

Two patients had cubitus varus due to technical errors: one had comminution of the medial supracondylar ridge unnoticed during closed reduction and skeletal stabilisation, such that the reduction was not sustained. Another ensued due to inadequate fixation; one of the wires was too close to the fracture, leading to a loss of reduction.

Four patients had neurological involvement: 2 had radial nerve palsies, one had a median nerve palsy after massage by a traditional bonesetter, one had an ulnar nerve palsy following open reduction and Kirschner wire fixation (due to an intra-operative error). All recovered completely within 3 months.

Two patients had avascular necrosis of the trochlea (Fig. 3): one had a grade-III flexion-type fracture treated with closed reduction and percutaneous skeletal stabilisation with crossed wires. This patient had no change in carrying angle or range of movement at the 18-month follow-up. Another, who underwent open reduction and Kirschner wire fixation did not regain full range of movement; at the 24-month follow-up, he had a loss of extension by 20° but flexion was comparable to the normal elbow. Myositis ossificans, Volkmann’s ischaemic contracture, or pin tract infection were not encountered.

**DISCUSSION**

Late presentation of displaced supracondylar humeral fracture in a child is common in developing countries. It is usually treated with continuous skin or skeletal traction, with unavoidable prolonged hospitalisation, or allowed to malunite and then corrected by osteotomy at a later stage. Its prognosis is unfavourable if the child presents more than one day after injury.16 15% of 132 Malaysian children with supracondylar fractures were reported to present late.24 According to the Flynn’s criteria, our patients had fewer poor results (12.5% vs 25%), more excellent results (42.5% vs 0%), and endured shorter hospital stays (14 days vs 41 hours) than another study.13

Closed reduction and cast immobilisation is not feasible in late-presenting supracondylar humeral fractures as the injury is usually associated with severe swelling that obstructs the safe flexion needed
to maintain reduction in a cast. Skin or skeletal traction requires a prolonged hospital stay, and not all fractures presenting late are amenable by traction alone. Both modalities of traction are associated with a high incidence of cubitus varus.

We consider operative treatment the best option for such late-presenting fractures. Satisfactory range of movement has been reported in late-presenting patients after open reduction. Some authorities prefer letting the fracture malunite and later performing a corrective osteotomy, to avoid myositis ossificans and stiffness. We achieved satisfactory results using surgical treatment, also without myositis ossificans.

64% of our patients’ fractures underwent successful closed reduction and were fixed percutaneously. The failed closed reduction rate was higher than in other series reporting fresh fractures. All our patients who presented after a week underwent open reduction. The healing of a metaphysis in children is fast; presence of soft tissue callus by the end of the first week renders the fracture irreducible.

Stiffness is a major concern in late-presenting fractures. Delay in treatment and repeated manipulations lead to a non-pliable soft tissue sleeve, the so-called ‘hard swelling’. In soft tissue healing, macrophages (the cells responsible for triggering fibrosis), appear within 2 days and result in stiffness, which decreases the success rate of closed reduction. Nonetheless, stiffness can be minimised by decreasing trauma to the soft tissues by ensuring that only one or 2 gentle manipulations are performed.

In cases of failed closed reduction or open fracture, open reduction through mediolateral incisions can provide adequate exposure of both supracondylar ridges and enable their accurate alignment to prevent cubitus varus. Irreducible fresh fractures usually have soft tissue interposed at the fracture site. Removal of the interposed soft tissue can be performed under limited exposure, allowing closed reduction using image intensification. In late cases involving failed closed reduction, adequate exposure is needed for release of the fibrosed soft tissues and removal of the callus, as soft tissue is less pliable with callus at the fracture site. Although the posterior approach provides an adequate exposure, it results in scarring of posterior soft tissues and increases elbow stiffness in the presence of already scarred anterior soft tissues. A mediolateral approach provides an adequate exposure while avoiding scarring of intact posterior soft tissues. In none of our patients was stiffness attributed to postoperative soft tissue scarring. This approach is technically easy and produces inconspicuous surgical scarring.

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**Table 1**
Overall grading of patients according to the Flynn’s criteria*

<table>
<thead>
<tr>
<th>Grading</th>
<th>Cosmetic factor (carrying angle loss)</th>
<th>Functional factor (range of movement loss)</th>
<th>Overall No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfactory</td>
<td>0°–5°</td>
<td>0°–5°</td>
<td>35 (87.5%)</td>
</tr>
<tr>
<td>Excellent</td>
<td>0°–5°</td>
<td>0°–5°</td>
<td>17 (42.5%)</td>
</tr>
<tr>
<td>Good</td>
<td>6°–10°</td>
<td>6°–10°</td>
<td>12 (30%)</td>
</tr>
<tr>
<td>Fair</td>
<td>11°–15°</td>
<td>11°–15°</td>
<td>6 (15%)</td>
</tr>
<tr>
<td>Unsatisfactory</td>
<td>&gt;15°</td>
<td>&gt;15°</td>
<td>5 (12.5%)</td>
</tr>
</tbody>
</table>

* The lower of the 2 grading was taken as the overall grading; an elbow with a varus deformity was considered poor.

**Table 2**
Complications

<table>
<thead>
<tr>
<th>Complications</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stiffness (range of movement loss &gt;15°)</td>
<td>3</td>
</tr>
<tr>
<td>Cubitus varus (carrying angle loss &gt;15°)</td>
<td>2</td>
</tr>
<tr>
<td>Nerve palsies</td>
<td>4</td>
</tr>
<tr>
<td>Avascular necrosis of trochlea</td>
<td>2</td>
</tr>
<tr>
<td>Pin tract infection</td>
<td>0</td>
</tr>
<tr>
<td>Compartment syndrome/Volkman’s ischaemic contracture</td>
<td>0</td>
</tr>
<tr>
<td>Myositis ossificans</td>
<td>0</td>
</tr>
</tbody>
</table>

**Figure 3** Radiographs showing avascular necrosis of the trochlea. Resorption of the trochlea is seen (arrow).
Avascular necrosis of the trochlea is known to occur even after undisplaced fractures or sprains around the elbow.\textsuperscript{30,31} One of our patient had a reduced range of extension because the trochlea had been absorbed to such an extent that it caused proximal migration and impingement of the olecranon above the olecranon fossa of the humerus.

The present study has the limitation of lacking a control group treated with other modalities, as well as patient numbers that were too small to establish a treatment protocol. Our results can only be compared with one other study reporting the treatment of exclusively late cases with continuous traction.\textsuperscript{13}

Attempting closed reduction under general anaesthesia and image intensification is justified in cases presenting as late as a week, before resorting to open reduction. Continuous traction does have a place in the management of late presentation of supracondylar fractures; only properly selected cases should be treated surgically.

## CONCLUSION

Surgical treatment for fractures presenting late can provide satisfactory results, with a short hospital stay. We recommend closed reduction and percutaneous skeletal stabilisation for displaced supracondylar humeral fractures in children presenting up to 7 days after injury. Open reduction and internal fixation by a mediolateral (triceps-sparing) approach is a safe and effective alternative, if closed reduction fails.