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Supracondylar extension fracture of the humerus in children

MANIPULATIVE REDUCTION, IMMOBILISATION AND FIXATION USING A U-SHAPED PLASTER SLAB WITH THE ELBOW IN FULL EXTENSION

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We present a method of manipulative reduction, immobilisation and fixation using a U-shaped plaster with the elbow in extension for extension-type supracondylar fractures of the humerus in children. When the elbow is in full extension, both the extensor and the flexor muscles are neutralised during manipulative reduction and the carrying angle can be easily assessed thus preventing cubitus varus, the most common complication.

In order to evaluate the efficiency of this method, we compared the clinical results of the new method with those of conventional treatment. In a group of 95 children who sustained an extension-type supracondylar fracture of the humerus, 49 were treated by the new method and 46 by the conventional method, reduction and immobilisation in a plaster slab with the elbow in flexion.

Reduction and immobilisation were easily achieved and reliably maintained by one manipulation for all the children treated by the new method. In 12 children treated by the conventional method, the initial reduction failed and in seven secondary displacement of the distal fragment occurred during the period of immobilisation in plaster. All required a second or third manipulation. Of the 46 children, 28 (60.9%) had developed cubitus varus at a mean follow-up of 4.6 years when treated by the conventional method. None of the children treated by the new method developed cubitus varus. The mean score, according to the Hospital for Special Surgery (HSS) elbow scoring system, was 91 points using the new method and 78 with the conventional method. The results were statistically significant with regard to the incidence of cubitus varus and the elbow score ($p < 0.01$) suggesting that the new method is reliable and gives a satisfactory outcome.

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The extension type of supracondylar fracture of the humerus is the most common, occurring in 95% of cases. About one-third show little or no displacement and in these treatment is simple. The remainder is associated with varying degrees of major displacement which is difficult to treat.[1-6] For most cases, manipulative reduction and immobilisation in a plaster slab is the procedure of choice, but early and late complications can occur. Cubitus varus is the commonest of the late complications. In some series it has been reported in up to 60% of cases.[5-9] Although changes in the carrying angle rarely affect function, even slight alteration can be clinically obvious and cosmetically undesirable.[5-9] When the elbow is in extension, both the extensor and the flexor muscles are mechanically neutralised and the carrying angle can be judged accurately, clinically and radiologically. We postulated that a method of manipulative reduction, immobilisation and fixation using a U-shaped plaster slab with the elbow in full extension would allow the displaced fragment to be easily reduced and retained after reduction.

We have used this method randomly along with conventional management in children with displaced supracondylar fractures and now present a comparison of the results.

Patients and Methods

A series of 98 consecutive children was treated for the extension type of supracondylar fracture of the humerus with a major displacement. All the fractures were considered to be Gartland type III.[10] The mean age of the patients was four years and six months (2 to 14). The mean delay between injury and treatment was four hours (1 to 50). Three children who had extreme swelling of the elbow, forearm and hand were treated by skeletal traction and were excluded from the study. We treated the children conventionally (46 children, group I) or by the extension method

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Fig. 1

Photograph showing lidocaine (2 to 5 ml) being injected into the haematoma on the dorsum of the fracture site.

(49 children, group II). In group I, there were 25 boys and 21 girls and in group II, 27 boys and 22 girls.

Operative technique. Manipulative reduction was usually carried out under local anaesthesia with 2 to 5 ml of lidocaine (20 g/l) injected into the dorsal aspect of the haematoma at the site of the fracture (Fig. 1). If the child was unco-operative a sedative was also used. Regional anaesthesia by a brachial plexus block was sometimes necessary if the swelling of the elbow was too severe.

In group I reduction and immobilisation were undertaken with the elbow in flexion, usually greater than 90°, and the displaced fragment fixed by a single posterior plaster-of-Paris slab.

In group II we used the extension method. Manipulative reduction and immobilisation were undertaken with the elbow in full extension and supination. Fixation was achieved by using an additional anterior plaster slab as well as a posterior plaster slab. The latter was wide enough to encircle 75% of the circumference of the arm and the forearm, extending from the axilla to a point just proximal to the metacarpal heads using 10 to 12 layers of plaster. The thinner anterior slab of 6 to 8 layers covered two-thirds of the anterior surface of the arm and forearm. Both were applied directly to the skin and fixed by a three-inch cotton elastic bandage with care taken to ensure that it was not too tight. In cross-section, there were two gaps of 1 to 2 cm between the slabs which together form a U-shape (Fig. 2). The plaster was then moulded by the surgeon to obtain 20° to 30° of valgus at the elbow while it was setting (Fig. 3).

The U-shaped plaster was able to compensate for swelling of the soft tissues because of the gaps between the slabs. As the swelling diminished an additional cotton elastic bandage was used to tighten the slabs.

After immobilisation in plaster the child was encouraged actively to flex and extend the fingers. The parents were warned of the danger of the plaster becoming loose or of severe swelling during the first week. If either of these occurred, the child was sent to hospital immediately for review. A radiograph was taken at three weeks. If there was satisfactory formation of callus the plaster was removed and the child allowed to exercise the elbow actively within the limits of comfort. If not, immobilisation in plaster was continued for a further one to two weeks.

Postoperative management. One of the aims of the treatment was to restore the normal carrying angle, which we considered to be more important than anatomical reduction of the fragments both clinically and radiologically. In group I, it was difficult to determine medial or lateral angulation by radiography because of the flexed position of the arm

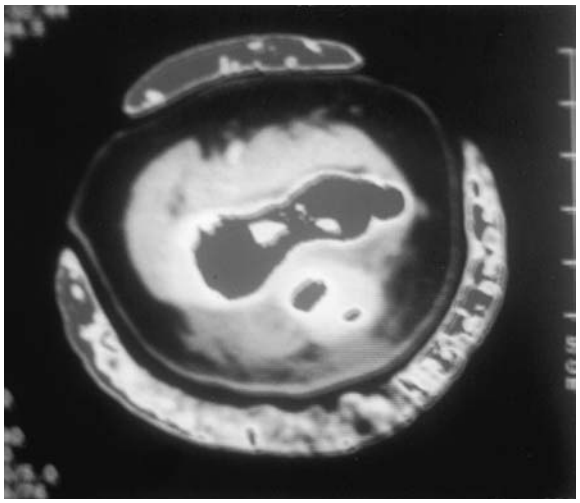

Fig. 2

MRI showing the plaster fixation in cross-section. There are two gaps of 1 to 2 cm between the slabs and together they form a U-shape.

Fig. 3

Photograph showing the position of the patient while the plaster sets: the elbow is held in 20° to 30° valgus.

after reduction and immobilisation, particularly before the appearance of the centres of ossification. In group II, clinical and radiological assessment of the carrying angle was easy since the arm was extended.

Follow-up. All the children in the study were able to return for clinical and radiological evaluation and interview. The mean follow-up was 4.6 years (3 to 7). The surgeon carrying out the follow-up examination was unaware of which method had been used to reduce and fix the fracture.

Clinical examination involved a careful assessment of the carrying angle, the range of movement of the elbow, forearm and hand, and the neurovascular status. A questionnaire was used to assess pain and function, compared with the normal elbow, in activities of daily living and in specific usages, and satisfaction with the procedure.

Anteroposterior and lateral radiographs of the elbow were taken after reduction, at 1 and 3 weeks, at 3 and 6 months, at 2 years, and at the last follow-up. This allowed us to determine whether alignment and apposition had been achieved, whether the fracture had united, or the presence of delayed union or malunion, and whether there was persisting deformity of the elbow in terms of an abnormal carrying angle.

The HSS elbow score[11] was calculated from the data derived from the examination and the questionnaire. This score and the incidence of cubitus varus in both groups were analysed statistically.

Results

Failure of reduction and early complications. In group I, 12 children showed medial angulation and persistent displacement after reduction. Secondary redisplacement occurred in seven children. A second or third manipulation was required in all 19 patients. In group II, mild residual displacement occurred in seven. This was corrected by adjusting the U-shaped plaster fixation without formal remanipulation. There were no cases of secondary redisplacement in group II. There were no severe nerve or vascular complications in either group. The swelling of the soft tissues in group I, however, was more severe than in group II, especially in those children who required repeated manipulation.

Clinical and radiological evaluation. There was little difference in the range of movement of the elbow, forearm and hand between the two groups at the final clinical examination. No case of myositis ossificans, Volkmann's contracture, or palsy of the ulnar or median nerves was noted in either group. The main difference was the high incidence of cosmetic deformity in group I. Clinical and radiological examination showed that 13 children had a reduction of the carrying angle and 28 had developed cubitus varus. This deformity caused considerable worry and dissatisfaction to their parents. In group II, one child had a reduced carrying angle of less than 5°; but none presented with cubitus varus. In group I the mean elbow score was 78 points and in group II it was 91 points. The differences between the two groups were statistically significant with regard to the incidence of cubitus varus and the elbow score ($p < 0.01$).

Radiographs taken early after reduction with the elbow in the flexed position did not give reliable information about the quality of reduction in group I. In group II, they were able to confirm reliably the clinical assessment as to whether a successful reduction had been achieved.

Discussion

In this randomised study, reduction and immobilisation with the elbow extended achieved better clinical results than the conventional method.

We believe that from a biomechanical point of view the extended elbow is a good position for treating supracondylar fractures. When the elbow is in extension, the force of the triceps is parallel to the axis of the centripetal force acting on the central point of the elbow. The forces from the flexor muscles are small in this position (Fig. 4a). When the elbow is flexed, however, the forces from the flexor muscles are acting at right angles to the forearm and the centripetal force is zero. In this position, the powerful action of the flexor muscles can cause difficulty in reduction and immobilisation of the fracture (Fig. 4b).

An important objective of treatment is to correct medial angulation and avoid cubitus varus. Remodelling will not correct angular deformities even in young children. Residual reduction of the normal carrying angle or a cubitus varus deformity results from failure to correct medial angulation of the distal fragment. It is difficult to detect angulation in radiographs with the elbow flexed, whereas this is easy in the fully extended elbow, both clinically and radiologically (Fig. 5).

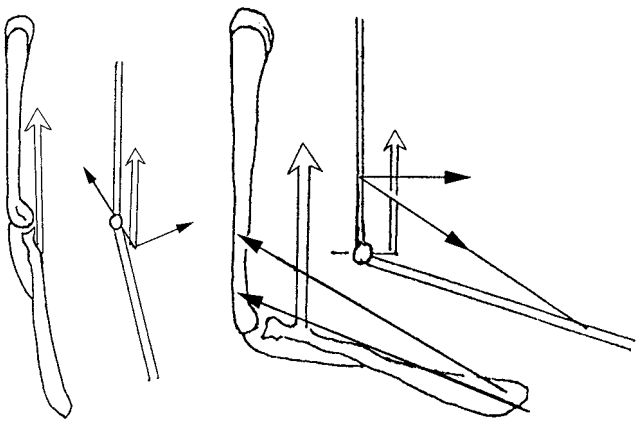

Fig. 4a Fig. 4b

Diagrams showing the effect of the extensor and flexor muscles at the elbow a) in extension and b) in flexion.

Fig. 5a

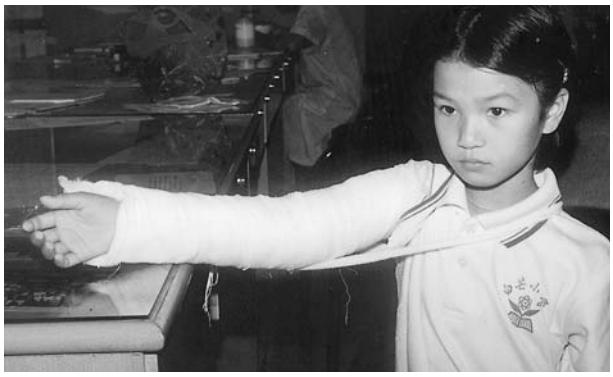

Fig. 5b

Fig. 5c

Fig. 5d

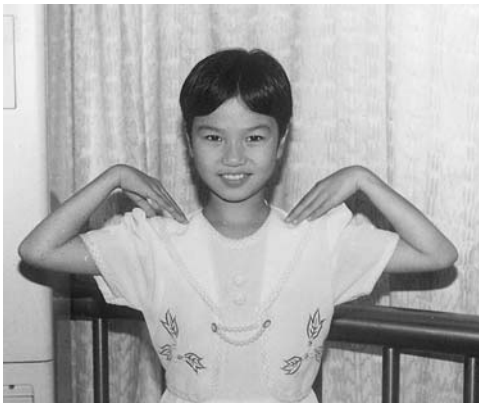

Fig. 5e

Figure 5a – Lateral and AP radiographs showing a supracondylar extensional fracture of the humerus before treatment. Figure 5b – Photograph showing the arm after reduction by a single manipulation and immobilisation with the elbow in extension using a U-shaped plaster. Figure 5c – AP and lateral radiographs showing satisfactory position and early union at three weeks, when the plaster was removed and active exercise of the elbow begun. Figures 5d and 5e – Photographs showing d) a normal carrying angle and e) flexion of the elbow to over 150°, six weeks after injury.

The extension method allows satisfactory reduction to be obtained, and mild residual displacement can be corrected by adjusting the plaster, without the necessity for further manipulation.

The normal carrying angle is easy to obtain, thereby avoiding cubitus varus or excessive valgus deformity. Vascular or nerve damage is avoided. The U-shaped plaster can compensate for soft-tissue swelling, and provide satisfactory fixation of the fracture. Assessment of the correct alignment of the elbow is easy both clinically and radiologically. The method is suitable for the treatment of all varieties of supracondylar fracture of the humerus in children and adults, except for those with a severe open fracture and/or vascular injury.

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