CHILDREN’S ORTHOPAEDICS

Synthetic versus plaster of Paris casts in the treatment of fractures of the forearm in children

A RANDOMISED TRIAL OF CLINICAL OUTCOMES AND PATIENT SATISFACTION

Fractures of the forearm (radius or ulna or both) in children have traditionally been immobilised in plaster of Paris (POP) but synthetic cast materials are becoming more popular. There have been no randomised studies comparing the efficacy of these two materials. The aim of this study was to investigate which cast material is superior for the management of these fractures. We undertook a single-centre prospective randomised trial involving 199 patients with acute fractures of the forearm requiring general anaesthesia for reduction. Patients were randomised by sealed envelope into either a POP or synthetic group and then underwent routine closed reduction and immobilisation in a cast. The patients were reviewed at one and six weeks. A satisfaction questionnaire was completed following the removal of the cast. All clinical complications were recorded and the cast indices were calculated. There was an increase in complications in the POP group. These complications included soft areas of POP requiring revision and loss of reduction with some requiring re-manipulation. There was an increased mean padding index in the fractures that lost reduction. Synthetic casts were preferred by the patients.

This study indicates that the clinical outcomes and patient satisfaction are superior using synthetic casts with no reduction in safety.

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Fractures of the forearm are the most common form of paediatric orthopaedic trauma.1 Displaced fractures are traditionally managed by closed reduction under anaesthetic and stabilisation in a cast, usually composed of plaster of Paris (POP). Newer synthetic casting materials have been developed that set with water in similar times to POP with the proposed benefits of decreased weight with increased strength and water resistance.3 Initial concerns in the orthopaedic community included decreased malleability leading to higher rates of loss of reduction5 and the risk of skin damage from the rough surface.

To date there is no randomised study comparing the use of POP with synthetic casts in the management of paediatric fractures of the forearm. Our aim was to complete a single centre randomised controlled trial to compare the clinical outcomes and patient satisfaction following closed reduction and cast immobilisation of fractures of the forearm in children using both materials.

Patients and Methods

Between March 2009 and August 2011 a total of 201 patients presented to our Emergency Department with a displaced fracture of the forearm (radius or ulna or both) requiring closed reduction and immobilisation. These formed the basis of this prospective study. Exclusion criteria included pathological/open fractures, fractures requiring internal fixation and patients who were not available for local follow-up. The patients were randomised using a sealed envelope to a POP (Gypson; BSN Medical Pty Ltd, Mt Waverly, Australia) or synthetic (Scotchcast Plus; 3M, St Paul, Minnesota) cast group. One patient in each group withdrew, leaving a total of 199 patients whose details are shown in Table I. The patients underwent a standardised closed reduction and full cast immobilisation dependent on the configuration by a consultant, accredited orthopaedic registrar or resident. Casts were not split prophylactically. All patients had the same padding under the cast: Wet n’ Dry (3M). Routine follow-up was undertaken at one and six weeks. Management was supervised by seven orthopaedic consultants (including one author, PJC) or attending surgeons who were blinded to the patient’s involvement in the study. The decision to...
undergo a re-manipulation was dictated by routine criteria including degree of deformity, the potential for remodelling, the anatomical site of fracture and parental concern.

The primary outcome measures were rate of complications and patient satisfaction. Complications were recorded from the notes and radiographs with calculation of the cast and padding indices as well as maintenance of reduction (Fig. 1).6,7 One author (MI) performed all radiological measurements. Patient satisfaction was assessed using a questionnaire (1 lowest to 5 highest) that was completed at the time of removal of the cast. The questionnaire was constructed using terminology that was easily understood by a paediatric population (Table II). The questions were not age-dependent, and the questionnaire was generally completed by patients and parents combined.

**Statistical analysis.** This study had ethical approval and the patients or their parents/guardians gave informed consent. Statistical analysis was performed using the Mann–Whitney U test and Fisher’s exact test on Stata Intercooled v10.1 for Windows (StataCorp LP, College Station, Texas).
two patients developed skin complications. One, who had included as a single complication. In the synthetic group times with a wet cast, which was changed, and this was breakage. In the POP group one patient returned several ther care of their cast, usually for areas of softening or skin problems following removal of the cast 0 2 Total complications 33 11

Table IV. Mean cast and padding index results for the two groups

<table>
<thead>
<tr>
<th>Cast index</th>
<th>Padding index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plaster 0.77 (0.58 to 1.03)</td>
<td>0.17 (0.06 to 1.00)</td>
</tr>
<tr>
<td>Synthetic 0.80 (0.62 to 1.01)</td>
<td>0.18 (0.06 to 0.57)</td>
</tr>
<tr>
<td>p-value 0.03</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Table V. Mean cast and padding index comparing casts that lost reduction versus reduction maintained

<table>
<thead>
<tr>
<th>Cast index</th>
<th>Padding index</th>
</tr>
</thead>
<tbody>
<tr>
<td>All casts (lost reduction) 0.79 (0.65 to 1.03)</td>
<td>0.2 (0.09 to 1.00)</td>
</tr>
<tr>
<td>All casts (reduction maintained) 0.80 (0.58 to 1.01)</td>
<td>0.17 (0.06 to 0.57)</td>
</tr>
<tr>
<td>p-value 0.03</td>
<td>0.036</td>
</tr>
</tbody>
</table>

Table VI. Loss of reduction requiring further procedure rate comparing applicators of cast (POP, plaster of Paris)

<table>
<thead>
<tr>
<th>Loss of reduction requiring further procedure</th>
<th>Total casts</th>
<th>Loss of reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant 1 (1 POP) 28</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Registrar 7 (4 POP, 3 synthetic) 144</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>Resident 1 (1 synthetic) 16</td>
<td>6.3</td>
<td></td>
</tr>
</tbody>
</table>

gone swimming in the cast, had irritation in the cubital fossa when the cast was removed at six weeks. The other had a minor pressure area in the cubital fossa that did not require treatment.

The mean cast and padding indices are shown in Table IV. The cast and padding indices in the nine patients who required a further procedure due to loss of reduction were compared with those in whom reduction was maintained (Table V). This demonstrated that the padding index was predictable for loss of reduction (p = 0.036) but cast index was not (p = 0.77).

A total of nine patients required re-manipulation. The rate of loss of reduction requiring a further procedure was also calculated according to the grade of surgeon who applied the cast. Although significantly more casts in both groups were applied by trainee surgeons and residents than by consultants or attending surgeons (p < 0.001), a non-significant trend towards lower rates of loss of reduction by more experienced personnel was noted, but there was no significant difference in the proportion of casts in which reduction was lost when considering the status of the treating doctor (p > 0.3) (Table VI).

Satisfaction surveys were completed by 57 patients (64%) in the POP group and 83 (76%) in the synthetic group and the results are shown in Figure 2.

Discussion

Closed reduction and immobilisation of fractures of the forearm (radius, ulna or both) in a cast is one of the most commonly performed procedures by orthopaedic surgeons who treat children. POP was the mainstay of treatment until the recent increase in the use of synthetic casts. There has been little research comparing the use of POP and synthetic casts in the management of paediatric fractures of the forearm. The only other similar randomised study was published by Kowalski, Pitcher and Bickley. They reviewed fibreglass versus POP in short arm and leg casts and found that fibreglass was preferred by patients in both groups and that there was a higher rate of further care in the POP group. Others have found that synthetic casts are more durable but are associated with higher costs.

We initially planned to study 300 patients, but independent early statistical assessment indicated significant differences in relation to overall patient satisfaction and no statistical difference in loss of reduction rates between the two groups, therefore we took the decision to end the study after 201 patients had enrolled. This explains the minor difference in the numbers of randomised patients in the two groups. The power of the study, however, was maintained.

We have confirmed that there is a higher rate of further care for patients treated with POP compared with synthetic casts. The costs associated with this extra maintenance involve increased time for the patient and families to attend for cast care including time off work, school and travel costs. Extra costs are also incurred by the healthcare system with further clinic attendances and the cost of
additional cast material and staff time. Sawyer et al\textsuperscript{2} reported that extra cast care in a US Emergency Room cost $126,374 for 168 unplanned presentations by patients with paediatric fractures of the forearm. The use of synthetic casts might decrease these costs.

There is anxiety that synthetic casts may be more difficult to mould, leading to a higher rate of loss of reduction. We found that both the cast and padding indices were slightly greater in the synthetic group (0.80) compared with the POP group (0.77), but this did not equate to a higher rate of loss of reduction. The cast and padding indices for synthetic casts were similar to those reported in other studies.\textsuperscript{7,9} It is noteworthy that the cast indices were well under the threshold described for satisfactory maintenance of reduction of 0.84.\textsuperscript{10}

We found not only that synthetic material performed better than POP but that it was also preferred by patients. This preference was significant for all categories surveyed including overall satisfaction. Many reasons for this were given including the light weight and indestructible nature of the cast, the ability to withstand water spills and the many colours available. Although there was one complication involving the skin in a patient with a synthetic cast due to swimming, anecdotal evidence suggests that many patients in the synthetic group had their casts immersed in water either swimming or bathing without evidence of skin complications.

Loss of reduction was also found to be dependent on the experience of the person applying the cast irrespective of the casting material that was used. Fully trained orthopaedic surgeons had the lowest rate of re-reduction (3.6\%) compared with trainees or registrars (4.9\%) and less experienced residents (6.3\%). This confirms that technical expertise is required for the safe management of fractures by closed reduction and supports the concept of a learning curve for the application of a cast.

We found that the padding index was significantly higher in casts in which the reduction had been lost, although there was no difference in the cast index. Other studies have indicated that both these indices are useful in predicting loss of reduction. We found some limitations in the use of these measurements especially in patients with marked post-operative swelling, which reduces the padding index. The effect of obesity should be considered; western countries report that 25\% of the population between the ages of five to 16 years are overweight or obese and this would influence the cast index, with forearms becoming rounder rather than oval in the transverse plane.\textsuperscript{11}

In summary, we found that the application of a synthetic full cast following the closed reduction of a displaced paediatric forearm fracture under anaesthetic was more reliable and gave higher patient satisfaction than a POP cast. In addition, the position of the fracture was maintained equally well in the two groups, confirming the safety of synthetic casting in maintaining reduction of these fractures.

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References


