EARLY PLASTER TREATMENT FOR FRACTURES OF THE FEMORAL SHAFT IN CHILDHOOD

MOTOTSUGU SUGI, WILLIAM G. COLE

From The Royal Children's Hospital, Melbourne

A protocol for the treatment of fractures of the middle third of the femur by the early application of a hip spica has been evaluated in 191 children aged 10 years or less. Children without other injuries spent only a few days in hospital for the application and later removal of the spica.

At all ages, anterior angulation of less than 20° and valgus angulation of less than 15° were accepted at the one-week review. Acceptance of shortening varied with the age of the child and the stage of treatment, but was 10% or less of the femoral length at the time of spica removal. At late review leg-length discrepancy was rare and clinically insignificant.

This method of treatment was simple and effective. It dramatically reduced the cost of care and freed a number of children's hospital beds.

The traditional method of treatment for fracture of the femoral shaft in a child has been to use traction in hospital for the four to six weeks until the fracture has healed (Shapiro 1981). The time in hospital can be reduced by applying a hip spica or cast-brace after about 10 days when the fracture is sticky (Gross et al. 1983). A more dramatic way of reducing the period in hospital is to apply a spica as an outpatient and allow the entire care to be undertaken at home, with regular review at a clinic (Irani, Nicholson and Chung 1976). In 1977, a protocol for the early treatment of femoral fractures in childhood by hip spica was adopted at The Royal Children's Hospital, Melbourne. We report the details of this protocol and the early and late results in 191 children.

METHODS

Selection of cases. All children aged 10 years or less with fractures at or below the junction of the upper and middle thirds of the femur are considered for treatment by an early spica. Fractures of the proximal femur are excluded because of the danger of developing coxa vara, as are older children because of their size and weight. Children with severe multiple injuries and cases of suspected child abuse are also excluded. A parent or guardian must be available to care for the child at home.

Initial procedures. When the child is first seen a femoral nerve block is given and standard radiographs are obtained (Grossbard and Love 1979). Hamilton Russell skin traction is used until the spica can be applied, at the next convenient theatre time, or when the child has fully recovered from such complications as a mild head or abdominal injury.

Application of the spica. Under general anaesthesia, the child is placed on a hip spica prop. An assistant holds the ankle in one hand and the calf in the other and a long leg cast is applied with the knee flexed 40° to 60°, the plaster being moulded to correct angulation. When the plaster has set, longitudinal traction is applied to the calf section of the cast to correct any shortening, but no attempt is made to achieve an end-to-end reduction of displaced transverse fractures. The position is checked with an image intensifier and when this is satisfactory the leg cast is extended into a one-and-a-half hip spica, or, for infants, a double spica, with the hip flexed so that heel and buttock are level. We accept up to 20 mm of shortening, 20° of anterior angulation, and 15° of valgus angulation, but no posterior angulation or varus (Irani et al. 1976). Rotation is judged clinically; the foot should be in slight lateral rotation. The plaster under the sole of the foot is removed so that plantarflexion against it cannot cause shortening (Irani et al. 1976), and the spica is then reinforced.

After-care. The child is nursed on a Bradford frame to allow easy turning and toilet care, and is allowed to return home when fit, usually the following day. A Bradford frame and a trolley on castors are supplied and the parents are shown how to care for the child. The frame may be used on the child's bed or floor at home and the trolley provides some mobility.
Table I. Radiographic shortening at various stages of treatment of femoral fractures by the early spica method

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Number of children</th>
<th>Shortening (median and range in mm)</th>
<th>Pre-reduction</th>
<th>Post-reduction</th>
<th>At one week</th>
<th>At removal of spica</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>8</td>
<td>11 (0-18)</td>
<td>4 (0-13)</td>
<td>8 (0-11)</td>
<td>9 (0-12)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>38</td>
<td>15 (0-36)</td>
<td>5 (0-17)</td>
<td>9 (0-21)</td>
<td>10 (0-20)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>15 (0-31)</td>
<td>5 (0-12)</td>
<td>9 (0-18)</td>
<td>10 (0-18)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>39</td>
<td>20 (0-31)</td>
<td>6 (0-19)</td>
<td>11 (4-32)</td>
<td>13 (6-28)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>21 (7-27)</td>
<td>6 (0-15)</td>
<td>11 (6-21)</td>
<td>11 (6-18)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>22 (0-43)</td>
<td>6 (0-18)</td>
<td>14 (0-24)</td>
<td>14 (7-23)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>13</td>
<td>23 (7-42)</td>
<td>6 (0-18)</td>
<td>15 (2-18)</td>
<td>14 (6-21)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>11</td>
<td>26 (12-42)</td>
<td>9 (3-17)</td>
<td>20 (8-24)</td>
<td>20 (6-25)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>14</td>
<td>28 (2-54)</td>
<td>9 (0-23)</td>
<td>16 (7-28)</td>
<td>18 (7-36)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>35 (16-48)</td>
<td>13 (2-22)</td>
<td>16 (10-18)</td>
<td>18 (10-27)</td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>191</td>
<td>18 (0-54)</td>
<td>6 (0-23)</td>
<td>10 (0-32)</td>
<td>12 (0-36)</td>
<td></td>
</tr>
</tbody>
</table>

The child is reviewed one week after the injury. If radiographs are satisfactory the child is then reviewed three or five weeks later for removal of the plaster. During most of the period of study, children were re-admitted for plaster removal but our current practice is to do this in the outpatient clinic. When clinical and radiographic union are present, mobilisation is started. Review continues until good clinical recovery has been achieved.

PATIENTS

A total of 191 children with fractures of the femur were treated by the early spica method within seven days of injury, between July 1977 and December 1981, and 180 children were reviewed four and a half to eight years later. This period of review was selected as being well beyond the two-year period during which most remodelling of bone occurs (Reynolds 1981). The 11 children who were not included in the late review lived at a distance. They were representative of the main group and their exclusion did not influence the results.

RESULTS

There were 133 boys and 58 girls with a median age of five years and an age distribution as shown in Table I. Of the 180 reviewed injury occurred as a result of a fall in 131 children, a motor vehicle accident in 38, a bicycle accident in eight and a crushing injury in three. Twenty-five children had mild head or abdominal injuries or fractures of the arm or the ipsilateral tibia. The femoral fractures were spiral in 113, transverse in 40 and oblique in 38 children.

A hip spica was applied during the first day in 142 cases and the second day in 36. All the 13 children who had a spica applied on the third, fourth or fifth day had associated injuries. In all, 86% of the children were discharged by the fourth day, all the children who remained in hospital for longer than three days having associated injuries which required further observation, for two weeks or less in 23 cases and longer in only two. Of the 171 patients who were re-admitted for removal of the spica 91% returned home within two days.

Shortening. Radiographic shortening did not differ significantly between children with spiral, transverse or oblique fractures. This shortening was recorded for yearly age groups (Table I). The values are expressed as median value and range because the results did not show a normal distribution. Shortening was always considerably less after reduction of the fracture but increased a little during the following week and then remained unchanged during the remaining time in plaster. The shortening at the time of spica removal increased with age from a median of 9 mm in one-year-old children to 18 mm in 8-to 10-year-old children, but this was in proportion with size, representing from zero to 10% of femoral length.

Leg-length difference at late review was measured by using blocks. Seven children had from 6 to 13 mm shortening but neither they nor their parents were aware of this. All these children were aged seven years or more at the time of injury and four of them were among the five cases of ipsilateral tibial fracture in the series.

Angulation. Eight children needed wedging of the spica to correct posterior or varus angulation, five being recognised at the time of initial reduction and three on radiographs taken one week after reduction. There was no evidence of angular malalignment in any child at late review.

Rotation. At late review 13 children had an extra 10° to 15° of medial rotation of the leg with a corresponding
reduction in lateral rotation as compared with the normal side, though again none of the children or their parents were aware of this. This mild rotatory malunion was seen in nine of the 40 children with fractures at the junction of the upper and middle thirds of the femur and only four of the 140 children with fractures below this level. This difference was significant (chi-square, p < 0.0002).

Complications. Only nine children had complications due to the spica; most of these occurred during the early part of the study. Two spicas were windowed to relieve local pressure, three were changed because of malalignment of the fracture and two because of breakage. Spica treatment was abandoned in one case because of domestic difficulties and in one other because of shortening which at one week was thought at the time to be excessive, though we would now consider it acceptable.

DISCUSSION

The protocol of treatment we used has been shown to be simple and effective. Children without other injuries spent a total of six days or less in hospital, and this time is reduced to three days or less when the spica is removed in the outpatient clinic. Early spica treatment is also successful for children with associated mild head or abdominal injuries although they spend more time in hospital.

The policy of admitting all children to hospital for reduction of the fracture under general anaesthesia allows a short period of observation for other injuries and provides time for the parents to be instructed in the care of their child in a spica. The duration of admission for uncomplicated cases is only one to two days, but it would be possible to reduce the fracture and apply a hip spica in the accident and emergency department, as was advocated by Irani et al. (1976).

At late review, leg-length discrepancy was uncommon and insignificant, usually involving older children with an associated ipsilateral tibial fracture. This combination of injuries was difficult to treat in a hip spica because an intact tibia is required for reduction of the femoral fracture. Control of both fractures may be obtained by using a femoral or tibial Steinmann pin in the spica (Splain and Denno 1985). The rarity of leg-length discrepancy at late review supports previous reports that growth stimulation is directly proportional to the amount of shortening (Reynolds 1981; Shapiro 1981; Kohan and Cumming 1982). We found that radiographic shortening when the spica was removed varied from zero to 10% of femoral length. In a typical example, a nine-year-old girl with 36 mm of shortening (10% of femoral length) when her spica was removed had equal leg lengths at review four years later.

Slight medial rotatory malunion was seen in 13 children mostly after fracture at the junction of the upper and middle thirds. This was probably due to relative lateral rotation of the proximal fragment; it may be possible to avoid malunion of fractures at this level by an additional 10° lateral rotation of the foot in the spica.

Our results allow the definition of criteria for acceptable positions of the fracture during various stages of treatment. At all ages, and at all stages of treatment, anterior angulation of less than 20° and angulation of valgus less than 15° are acceptable. Angulation in excess of these amounts or in the opposite directions should be corrected by wedging the spica. Correct rotation is achieved by placing the foot in a slightly out-turned position, with an additional 10° lateral rotation for proximal fractures. Acceptable shortening is related both to the age of the child and the stage of treatment. At the one week review and at the time of fracture union the maximum allowable shortening was about 10% of femoral length at all ages. Greater overlap may have corrected spontaneously, but would hardly be acceptable to the parents at the time of spica removal.

It is important to ensure that the parents understand the natural history of recovery. They are often disturbed by the radiographic appearance of a transverse fracture with bayonet apposition and by obvious clinical shortening when the spica is removed. It is necessary to explain that the children are usually stiff and uncomfortable when the spica is removed and will not use the leg for several days, and that even when they start to stand and walk they will have a severe limp due to weakness and shortening. They are told that the child's gait will improve over a few months and the leg-length discrepancy will correct over a few years (Reynolds 1981; Shapiro 1981).

Our protocol for the early spica treatment of femoral fractures has substantially reduced the cost of treatment and has freed beds for use by other children. It is also in accordance with the general trend towards shorter hospital admissions for children.

We wish to acknowledge the assistance given by Mr P. F. Williams and Mr M. B. Menelaus who developed the protocol used in this study.

REFERENCES


