The efficacy of traction before an attempted closed reduction for patients with developmental dislocation of the hip remains controversial. We treated 55 children (62 dislocations of the hip) by preliminary, prolonged traction for a mean of eight weeks. All were followed up for at least two years in order to observe the development of any avascular changes within the femoral head. Of the 55 children, 27 (31 dislocations) were followed up until they were over six years of age. Fifty-seven of the 62 hips (92%) showed a successful closed reduction. Only one had radiological evidence of avascular necrosis of the femoral head. Of the 31 hips which were followed up to over six years of age, 15 (48%) showed residual subluxation. Our method of prolonged preliminary traction leads to a high rate of successful closed reduction, a low incidence of avascular necrosis and a reduced need for secondary operations.

The aim of treatment of developmental dislocation of the hip is to obtain and maintain a concentrically reduced hip as early as possible. For those children who have not yet stood, closed reduction can usually be achieved by a Pavlik harness. Closed reduction under general anaesthesia is reserved for those in whom a Pavlik harness is ineffective or when the diagnosis of developmental dislocation is made after walking has begun. The value of traction before a closed reduction remains uncertain. It has been advocated by some in order to facilitate closed reduction and to reduce the incidence of avascular necrosis of the femoral head but others disagree.

In this study, we have attempted closed reduction after preliminary traction for two months. Our aim was to estimate the chance of achieving successful closed reduction and to determine the incidence of avascular necrosis of the femoral head. We also identified occurrence of any residual subluxation which required a secondary reconstructive procedure and the radiological factors associated with this.

Patients and Methods

We treated 55 children (62 dislocations of the hip) with prolonged traction before an attempted closed reduction. There were 47 girls and eight boys with 48 unilateral and seven bilateral dislocations. Their mean age at the time of the start of traction was 11.5 months (6 to 23). Most had been treated beforehand by a Pavlik harness. Patients with subluxation of the hip or with neuromuscular disease were excluded from the study. All the patients were followed up for a minimum of two years in order to identify any avascular changes in the femoral head. The presence of avascular necrosis was assessed by the criteria of Salter, Kostiuk and Dallas. Of the 55 children, 27 (31 dislocations) were followed up until they were over six years of age.

We investigated the incidence of residual subluxation based on the age of the patients at reduction and a number of radiological measurements. These included the acetabular index, indicating acetabular development, and the distance ‘b’ used by Yamamuro and Chene (Fig. 1). This allowed measurement of the lateral displacement of the femoral head on the follow-up radiographs. The centre-edge angle was measured after reduction since it was difficult to determine the proximal femoral ossification centre accurately in patients under one year of age. When the spica cast was applied, arthograms were used to estimate a medialisation ratio (Fig. 2) in order to quantify any lateral displacement of the cartilaginous femoral head.

Treatment was similar in all the patients. We modified the method of reduction which was first described by Craig,
Risser and Kramer,12 subsequently modified by Mau et al13 and thereafter by Kramer, Schleberger and Steffen.14 Bilateral, longitudinal skin traction of 1.5kg was used for three weeks until the affected ossific nucleus lay adjacent to Hilgenreiner’s line, the plus-one station described by Gage and Winter.3 Next, 2 kg of skin traction was applied for one week with the hip in 90˚ of flexion and slight abduction and the knee in extension. The hips were then gradually flexed and abducted in overhead traction for one week until they achieved 120˚ of flexion and 60˚ of abduction. Finally, the position was adjusted to one of 100˚ of flexion and 50˚ of abduction with flexion of the knee. Spontaneous reduction, without manipulation but with the patient awake was observed by ultrasonography and maintained for a further three weeks in order to achieve stability of the hip with traction of only 0.5 kg. The mean duration of traction was eight weeks. If a stable and concentric reduction was seen on the arthograms subsequently performed under general anaesthesia, a spica cast was applied with the hips in 100˚ flexion and controlled abduction for four weeks. Thereafter, an abduction orthosis was worn for at least six months. If the hip could not be concentrically reduced and was thought to be unstable, the patient was prepared for a primary open reduction. Secondary procedures including the Pemberton osteotomy, innominate osteotomy and proximal femoral osteotomy were performed if residual subluxation was noted at the age of four or five years.

Statistical analysis. The data were analysed by the non-parametric Mann-Whitney test. The level of significance was set at p < 0.05.

Results

Of the 62 hips studied, 57 (92%) were successfully reduced by this method of traction. Open reduction had to be performed on five hips, one of which redislocated one month after a successful closed reduction. Only one hip showed radiological evidence of avascular necrosis of the femoral head. Reconstructive procedures on the acetabulum or femur were subsequently required in 11 of 31 hips which were followed up until the patients were more than six years of age. Our current criteria for reconstructive osteotomy, which differed from those which we used many years ago, are a centre-edge angle of less than 0˚ and an acetabular index of more than 30˚ at five years of age, taking into consideration the radiological features of normal hips in Japanese children.15 Only four hips with these findings did not undergo subsequent reconstructive procedures. Of the 31 hips which had a successful closed reduction and which were followed up to over six years of age, 15 (48%) showed residual subluxation (Fig. 3).

Several factors which are associated with residual subluxation were assessed, including the age at reduction and radiological measurements (Table I). There was no significant difference in the age at reduction and either the acetabular index or distance ‘b’ measured before traction between those children who demonstrated residual subluxation and those who did not, nor was any significant difference seen in the arthograms which were taken soon after closed reduction had been achieved. There were significant differences in the centre-edge angle and distance ‘b’ measured one year after reduction, although we did not find a significant difference in the acetabular index at this stage.

Discussion

There is considerable discussion in the literature about the use of traction, the weight which should be used, the most beneficial direction of pull and its duration. There is also controversy as to whether skin or skeletal traction should be
used and whether traction in the home or hospital is best. We used longitudinal skin traction followed by overhead traction before we attempted a closed reduction. The effect of preliminary traction on the rate of successful closed reduction is uncertain. We achieved and maintained reduction in 57 hips (92%) in our study. This is more than the 75% success achieved by Zionts and MacEwen\(^4\) who treated patients with pre-reduction traction for 5.6 weeks and the 43% reported by Kahle et al\(^6\) who attempted closed reduction without preliminary traction. Prolonged traction before reduction appears to facilitate closed reduction and reduces the need for an open procedure.

The most common and serious complication of the treatment of developmental dislocation of the hip is avascular necrosis of the femoral head. The incidence after closed reduction varies widely between studies. A very low incidence of avascular necrosis (0% to 5%) was noted after closed reduction, whether preliminary traction was attempted\(^1,4,15\) or not.\(^6,16\) Similarly, only one hip developed avascular necrosis after closed reduction in our series.
Although the patients were not reviewed until they had reached skeletal maturity.

Secondary procedures were performed on the femur or acetabulum if residual subluxation was noted after bracing had been discontinued. Many authors have reported that a significant proportion of children will eventually require secondary procedures after a closed reduction. Blockey advocated the routine use of osteotomy after a closed reduction. Zionts and MacEwen found that 66% of the hips which had been successfully reduced by closed reduction subsequently required a secondary procedure at a mean of five years later. Schoenecker et al. stated that 52% of the hips in which a closed reduction had been successful required a femoral or pelvic osteotomy because of a failure to remodel. In our study, 15 of 31 hips (48%) which had been treated by a successful closed reduction demonstrated residual subluxation, suggesting that more than half of the patients who receive prolonged traction can avoid a secondary procedure. The incidence of residual subluxation in our patients appears to be lower than that reported by other authors, which suggests that our method of traction can reduce the incidence of subsequent subluxation after a closed reduction.

There is a well-established correlation between late subluxation and the age at reduction, although Forlin et al. disagree. We could not establish such a link which may be because our patients were younger than those reported by other authors. Arthrography of the hip demonstrates the cartilaginous anatomy of the acetabulum and femoral head and the best position for immobilisation. There is some debate as to whether or not soft-tissue interposition between the femoral head and the acetabulum interferes with the future development of the hip. Several authors have shown that the width of the dye in the space between the femoral head and the medial border of the acetabulum correlates with the subsequent development of the hip, but others disagree. In our study, the medialisation ratio was not a significant prognostic factor in the development of the hip after a successful closed reduction, nor was the radiological assessment before traction, which agrees with the findings of Zionts and MacEwen. There was, however, a significant relationship between residual subluxation and both the centre-edge angle and distance ‘b’ one year after reduction. This did not apply to the acetabular index. It has been shown that acetabular development occurs primarily during the first year after a closed reduction and continues at a slow pace for a further three years. Strict reliance on the acetabular index for assessment of acetabular development has been shown to be problematical because of variability in the measurement.

Our aim with prolonged traction was to bring the femoral head distally to a plus-one station and to allow dislocated hips to be reduced at the bedside with the patients awake, not under general anaesthesia. A long period of hospitalisation costs more and demands much patience from both the children and their families. However, our method leads to a high rate of successful closed reduction, a low incidence of avascular necrosis and a reduced need for a secondary operation.

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### References


