One-stage bilateral open reduction through a medial approach in developmental dysplasia of the hip


From King Khalid University Hospital, Riyadh, Saudi Arabia

The outcome of one-stage bilateral open reduction through a medial approach for the treatment of developmental dysplasia of the hip in children under 18 months was studied in 23 children, 18 girls and five boys. Their mean age at operation was 10.1 months (6 to 17) and the mean follow-up was 5.4 years (3 to 8).

Acceptable clinical and radiological results were achieved in 44 (95.7%) and 43 (93.5%) of 46 hips, respectively. Excellent results were significantly evident in patients younger than 12 months, those who did not require acetabuloplasty, those whose ossific nucleus had appeared, and in those who did not develop avascular necrosis.

One-stage bilateral medial open reduction avoids the need for separate procedures on the hips and has the advantages of accelerated management and shorter immobilisation and rehabilitation than staged operations.

Most dislocations of the hip in children under 18 months of age with developmental dysplasia of the hip (DDH) can be successfully treated by harness, splintage or closed reduction and a spica cast. However, some hips which are irreducible or unstable require open reduction. The aim of any procedure is to achieve a comfortable reduction and a low rate of avascular necrosis (AVN).1,2 The choice of operative approach for open reduction is between the traditional anterior iliofemoral route and the recently revived medial approach. Each offers advantages and disadvantages. Supporters of the medial approach describe it as simple and safe, with minimal soft-tissue dissection and blood loss. The scar is cosmetically acceptable, and, both hips can be operated on at the same occasion.3-5

Ludloff first described the medial approach to the congenitally dislocated hip in 1913,6 and modifications of his technique were described by Ferguson in 19737 and by Weinstein and Ponseti in 1979.5,8,9 The various medial approaches are criticised for the associated risk of AVN due to accidental injury of the medial circumflex artery, but the relationship between this injury and AVN is uncertain.1,10,11 The lower age limit for a medial approach is six months, and initially, the upper age limit was two years. However, this was reduced to 18 months as it was felt that an anterior approach would be more suitable for older patients so as to deal with superior obstacles and allow the possibility of acetabuloplasty.3,8

The feasibility of one-stage bilateral open reduction through a medial approach in the treatment of DDH has been mentioned in most previous series,2,4,5,11,12 but no study thereof has so far been reported. We have reviewed our experience with this technique.

Patients and Methods

Between 1999 and 2004, 23 patients (18 girls, five boys) with bilateral DDH were treated by one-stage open reduction of both hips through a medial approach. Children with neuromuscular or teratological dislocation, previous AVN or who had undergone a two-stage bilateral open reduction were excluded. The medial approach was used in patients under 18 months of age who had failed treatment with a Pavlik harness (Fillauer LLC, Chattanooga, Tennessee) or a closed reduction. Preliminary traction was not used in any case.

All patients had bilateral arthrography under general anaesthesia prior to surgery to define the obstacles to reduction and to attempt closed reduction for patients who presented after the age of six months who had no previous treatment. Both hips were cleaned and draped. The details of the operation have been described previously,9 but some operative steps deserve mention. The adductor longus was divided routinely at its origin. Attempts to preserve the branch of the medial femoral
circumflex artery crossing the anteromedial capsule of the hip joint failed frequently (32 hips), and the artery was then coagulated following its accidental injury. The ligamentum teres was totally excised and the transverse acetabular ligament incised routinely. The acetabular limbus was not disturbed, regardless of its type.

The femoral head was then reduced gently into the true acetabulum and its position checked by image intensifier (Fig. 1). The capsule was left open and the adductor fascia, subcutaneous tissues and skin closed without drainage. The same procedure was repeated on the other side. Keeping both hips reduced, a bilateral spica cast was applied with the hips flexed to 90° and abducted to 40°. A radiograph in the operating theatre confirmed reduction. All patients were discharged on the first or second post-operative day. The cast was removed six to eight weeks later under general anaesthesia and the stability was tested. Once this was confirmed, a bilateral cylinder cast with an abduction bar, a broomstick cast, was applied for nine to 12 weeks, followed by an abduction splint at night. The children were allowed unrestricted activities after removal of the cast, and formal physiotherapy was not needed.

The children were followed up every three months for one year, every six months for two years, and then annually. At each follow-up a radiograph of the pelvis was taken, in the standing position for those walking, to assess acetabular development by measuring the acetabular index (AI), the concentricity of the reduction and for signs of AVN. Acetabular development was considered satisfactory when the AI was below 24°. Acetabuloplasty was indicated for children over 18 months of age if there was lateralisation of the femoral head with disruption of Shenton’s line on the standing anteroposterior view.

AVN of the femoral head was graded according to the classification of Kalamchi and MacEwen. At the most recent follow-up, all hips were evaluated clinically and radiologically. The appearance of the scar, the presence of pain and tenderness, the range of movement, any limb-length discrepancy and the Trendelenburg sign were evaluated. Clinical assessment was according to Berkeley et al excellent, a painless stable hip without a limp or positive Trendelenburg sign, with more than 15° of internal rotation and otherwise normal motion; good, a painless stable hip with a slight limp or decreased motion and a negative Trendelenburg sign; fair, a positive Trendelenburg sign, minimum pain and moderate stiffness; and poor, significant pain. Severin’s criteria were used to assess the radiological outcome. Acceptable results were those in Severin groups I and II and the unacceptable results were in groups III, IV, V or VI.

Statistical analysis of the data was by SPSS version 12 (SPSS Inc., Chicago, Illinois). For crude analysis of independent groups of data the chi-squared and Fisher’s exact test were used with p < 0.05 considered significant and p < 0.001 highly significant.

Results
Details of the patients are shown in Table I. Their mean age at diagnosis was 6.2 months (1 day to 14 months) and the mean age at operation was 10.1 months (6 to 17). A total of 16 patients (69.6%) were under 12 months of age at operation and seven (30.4%) were older. The mean age at final follow-up was 6.6 years (4 to 10). The mean duration of follow-up was 5.4 years (3 to 8). A Pavlik harness had been used in ten children (43.5%), closed reduction followed by hip spica in eight (34.8%), and five (21.7%) had no previous treatment. In this group, the trial of closed reduction that was performed immediately before open reduction had failed.

The ossific nucleus was present on the pre-operative radiograph in 29 hips (63%) and absent in 17 (37%). The operations were performed by a senior paediatric
orthopaedic surgeon in 17 patients (73.9%) and by a supervised specialist in six (26.1%). The mean blood loss was 34 ml (20 to 40) and blood transfusion was not needed. The mean operating time, including application of the cast, for all patients was 137 minutes (112 to 185). It was 130 minutes (112 to 160) for senior surgeons and 156 minutes (132 to 185) for supervised specialists. The mean period of post-operative immobilisation in a hip spica was 7.4 weeks (SD 0.7) and 10.5 weeks (SD 0.9) in a broomstick cast. Acetabuloplasty or a Salter osteotomy for residual acetabular dysplasia was performed in 15 hips (32.6%). The mean age at acetabuloplasty was 40 months (35 to 48), the frequency of which was significantly higher in those who had absent ossific nuclei at open reduction (p = 0.028) and highly significant in those aged 12 months or older at open reduction (p < 0.001).

Bilateral superficial wound infections in one patient were treated by wound care and antibiotics. This patient developed grade I AVN in the right hip. Another patient redislocated the left hip while in the broomstick cast and was treated by open reduction through the anterior approach (Fig. 2). Although her final assessment showed excellent clinical and radiological results bilaterally, we considered her left hip to be fair clinically, with a positive Trendelenburg test before the second open reduction, and Severin type VI radiologically. Six hips (13%) in five patients developed AVN. Five were grade I and one was grade IV. Active treatment for AVN was needed in two patients (Table I). Gender, age at open reduction, previous treatment, the need for additional surgery and the experience of the surgeon did not significantly affect the development of AVN (p = 0.208, 0.097, 0.61, 0.351 and 0.083, respectively), but an absent ossific nucleus at the time of open reduction had a significant association (p = 0.02).

At final follow-up the scar was almost invisible in all patients. The clinical and radiological assessments are shown in Table I. Absence of AVN was the only factor to have a significant relationship (p = 0.014) with an acceptable clinical outcome with an excellent and good result.

Table I. Patient data

<table>
<thead>
<tr>
<th>Case Number</th>
<th>Gender</th>
<th>Primary treatment</th>
<th>Age at operation (mths)</th>
<th>Complications</th>
<th>Additional operation</th>
<th>AVN*</th>
<th>Clinical assessment†</th>
<th>Radiological assessment‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>Closed reduction and hip spica</td>
<td>10</td>
<td></td>
<td></td>
<td>E, E</td>
<td>I, I</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>Pavlik harness</td>
<td>8</td>
<td></td>
<td>Valgus femoral osteotomy</td>
<td>Right (IV)</td>
<td>F, G</td>
<td>III, II</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>None</td>
<td>12</td>
<td></td>
<td></td>
<td>Left Pemberton</td>
<td>G, E</td>
<td>II, I</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>Closed reduction and hip spica</td>
<td>15</td>
<td></td>
<td></td>
<td>Bilateral Salter</td>
<td>G, G</td>
<td>II, II</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>None</td>
<td>13</td>
<td></td>
<td></td>
<td>Left Dega</td>
<td>E, E</td>
<td>I, II</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>Closed reduction and hip spica</td>
<td>11</td>
<td></td>
<td></td>
<td>Left (I)</td>
<td>E, G</td>
<td>I, II</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>Closed reduction and hip spica</td>
<td>16</td>
<td></td>
<td></td>
<td>Bilateral Pemberton</td>
<td>E, G</td>
<td>I, I</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>Pavlik harness</td>
<td>8</td>
<td>Left redislocation</td>
<td>Left anterior open reduction + left Pemberton</td>
<td>Bilateral (I)</td>
<td>E, F</td>
<td>I, VI</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>None</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>E, E</td>
<td>I, I</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>Pavlik harness</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>E, E</td>
<td>I, I</td>
</tr>
<tr>
<td>11</td>
<td>F</td>
<td>None</td>
<td>17</td>
<td></td>
<td></td>
<td>Bilateral Salter</td>
<td>G, G</td>
<td>III, II</td>
</tr>
<tr>
<td>12</td>
<td>F</td>
<td>Pavlik harness</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>E, E</td>
<td>I, I</td>
</tr>
<tr>
<td>13</td>
<td>F</td>
<td>Closed reduction and hip spica</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td>E, E</td>
<td>I, I</td>
</tr>
<tr>
<td>14</td>
<td>F</td>
<td>Pavlik harness</td>
<td>7</td>
<td>Infection</td>
<td></td>
<td>Right (I)</td>
<td>G, E</td>
<td>II, I</td>
</tr>
<tr>
<td>15</td>
<td>F</td>
<td>Pavlik harness</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>E, E</td>
<td>I, I</td>
</tr>
<tr>
<td>16</td>
<td>F</td>
<td>Closed reduction and hip spica</td>
<td>14</td>
<td></td>
<td></td>
<td>Bilateral Pemberton</td>
<td>G, E</td>
<td>II, II</td>
</tr>
<tr>
<td>17</td>
<td>F</td>
<td>Closed reduction and hip spica</td>
<td>9</td>
<td></td>
<td></td>
<td>Right Pemberton</td>
<td>E, E</td>
<td>II, I</td>
</tr>
<tr>
<td>18</td>
<td>M</td>
<td>Pavlik harness</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>E, G</td>
<td>I, I</td>
</tr>
<tr>
<td>19</td>
<td>F</td>
<td>None</td>
<td>11</td>
<td></td>
<td></td>
<td>Left Salter</td>
<td>E, G</td>
<td>II, II</td>
</tr>
<tr>
<td>20</td>
<td>F</td>
<td>Pavlik harness</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>E, E</td>
<td>I, I</td>
</tr>
<tr>
<td>21</td>
<td>M</td>
<td>Closed reduction and hip spica</td>
<td>14</td>
<td></td>
<td></td>
<td>Bilateral Pemberton</td>
<td>G, G</td>
<td>II, II</td>
</tr>
<tr>
<td>22</td>
<td>F</td>
<td>Pavlik harness</td>
<td>10</td>
<td></td>
<td></td>
<td>Right Pemberton</td>
<td>E, E</td>
<td>II, I</td>
</tr>
<tr>
<td>23</td>
<td>F</td>
<td>Pavlik harness</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>E, E</td>
<td>I, I</td>
</tr>
</tbody>
</table>

* AVN, avascular necrosis of the femoral head
† according to Berkeley et al;| E, excellent; F, fair; G, good
‡ according to Severin
§ Additional surgery needed for treating AVN
There was significant prevalence of excellent results in patients who were younger than 12 months, had no additional surgery, had an ossific nucleus, or did not develop AVN (p = 0.004, 0.043, 0.003 and < 0.001, respectively).

An acceptable radiological outcome (Severin groups I or II) was significantly associated with the presence of an ossific nucleus at open reduction and an absence of AVN (p = 0.045 and 0.041, respectively). An excellent radiological outcome (Severin group I), however, was significantly linked to patients younger than 12 months and to hips that did not develop AVN (p = 0.008 and 0.005, respectively). Also, there was a highly significant prevalence of Severin group I in hips for which acetabuloplasty was not performed and which had radiologically apparent ossific nuclei at open reduction (p < 0.001).

Discussion
The literature on open reduction through a medial approach shows great variation in results, mainly due to differences in treatment and in the criteria for evaluation.\textsuperscript{1,3,5,17} We preferred the approach described by Weinstein and Ponseti\textsuperscript{9} because it is more direct than Ferguson’s\textsuperscript{7} and less limited than Ludloff’s.\textsuperscript{6}

The operation is generally of short duration and the principal obstacles to a safe reduction are easily accessed and addressed with minimal dissection and blood loss. We believe that medial open reduction is technically easier than an anterior procedure for the experienced paediatric orthopedic surgeon, yet more difficult for the young trainee to learn. We agree with previous studies\textsuperscript{2,11} that medial open reduction restricts the field of view to one surgeon, and the assistant rarely sees clearly into the depths of the small wound. Our results showed a significant difference in the operating time between senior and junior surgeons. We recommend that only those who are skilled in paediatric hip surgery should perform bilateral medial open reduction.

Two major reported disadvantages of open reduction through the medial approach are the risk of AVN and the inability to perform a capsulorrhaphy, which may result in an inadequate reduction and an increased risk of residual subluxation or redislocation.\textsuperscript{2,3,5}

The reported incidence of AVN after open reduction through a medial approach ranges from 0% to 67%.\textsuperscript{1,11,18} An overall rate of 13% in the present study is acceptably low, and, if type I is excluded as relatively benign, the rate is only 2%. We recognise that a truly accurate assessment cannot be made until a patient has reached skeletal maturity. However, the same prevalence of type II AVN has also been reported after long-term follow-up of patients who had closed or open reduction through an anterior approach.\textsuperscript{2,3,5}

Our findings agree with those of others who state that age at operation does not appear to affect the incidence of AVN.\textsuperscript{5,8,11} We also agree with Ucar et al\textsuperscript{5} and Segal et al,\textsuperscript{19} who found that the presence of the ossific nucleus protects against AVN. However, we do not believe it is justified to wait until the ossific nucleus appears. In some reports there was a belief that accidental injury to the medial circumflex vessels is the most important contributing factor to the development of AVN.\textsuperscript{3,4} However, our findings support other reviews\textsuperscript{9,11} which conclude that injury to the medial circumflex vessels does not appear to cause AVN. Regardless of the cause, the incidence of AVN in our study almost equalled that after closed reduction or open reduction through the anterolateral approach. We therefore disagree with the hypothesis that open reduction through the medial approach is associated with a higher incidence of AVN.

The other criticism of the medial approach is that it does not allow the surgeon to perform a capsulorrhaphy.\textsuperscript{2,3} However, the prevalence of redislocation in this and earlier
acetabular dysplasia in 15 hips (32.6%). This figure is usually present in ambulant children.8,10 Deal with obstructions in the superior acetabulum, which require only a longer period of immobilisation to ensure a concentric reduction and to stimulate acetabular development (Fig. 3). This situation is different in older children with high dislocations because the medial approach cannot deal with obstructions in the superior acetabulum, which are usually present in ambulant children.8,10

We undertook additional pelvic surgery for residual acetabular dysplasia in 15 hips (32.6%). This figure is acceptable when compared with previous studies.4,5,13 Although pelvic osteotomy was indicated to protect a reduced hip from subluxation or redislocation, the need for acetabuloplasty is not related specifically to the medial approach because the reduced hip is prone to residual dysplasia after closed reduction or open reduction through the anterior approach. The need for acetabuloplasty in this study is highly significant in children older than 12 months. Therefore, as concurrent pelvic surgery cannot be achieved through a medial approach, we do not perform medial open reduction in children over 12 months of age with severe acetabular dysplasia (acetabular index > 40 and/or acetabular cartilaginous angle > 24°).20 We feel that as such children are destined to have residual acetabular dysplasia, a combined open reduction and pelvic osteotomy through the anterior approach is preferable. This could be carried out in patients approaching 18 months of age or delayed for a few months in those aged 12 to 16 months.

The combined excellent and good outcomes in previous series that advocated open reduction through the medial approach ranged between 73% and 98%.5,10,11 Conversely, Koizumi et al12 found acceptable results in only 45.7%, and suggested that open reduction through a medial approach is unsatisfactory in DDH. In our study, an acceptable clinical outcome was obtained in 95.7% of hips, of which 65.2% had excellent results. An acceptable radiological outcome was seen in 93.5% of the hips, of which 60.9% had excellent results. Our results are almost equal to those from previous studies5,8,9,11 supporting medial open reduction, although they were mainly unilateral cases.

Open reduction using the approach described by Weinstein and Ponseti9 is a safe and effective treatment for dislocations in infants between 6 and 12 months of age with DDH. It requires minimum soft-tissue dissection, the iliac apophysis and abductor muscles are not disturbed, blood loss is minimal and the scar is cosmetically acceptable. One-stage bilateral open reduction through a medial approach has all the advantages of operating on one hip together with a shorter time for treatment and cast immobilisation, thereby accelerating rehabilitation and reducing disruption to the family. We recommend that the bilateral operation be done by a surgeon experienced in paediatric hip surgery.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References