EARLY OPEN REDUCTION FOR CONGENITAL DISLOCATION OF THE HIP

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We have reviewed 82 children with congenital dislocation of the hip, after treatment by anterior open reduction followed by derotation femoral osteotomy.

The clinical and radiological results were significantly better in the group that had open reduction before the appearance of the capital femoral epiphysis; this group also had a lower incidence of avascular necrosis. We conclude that, when it is clearly indicated, the earlier an open reduction is carried out the better the results.

The goal of treatment in congenital dislocation of the hip (CDH) is to return the femoral head to within the acetabulum, and to maintain this position until the pathological changes have reversed. Early reduction implies that fewer adaptive changes have taken place, and reduces the time required for the femoral head, acetabulum and capsular structures to return to their normal configuration (Hensinger 1985).

It is generally agreed that closed reduction of the dislocated neonatal hip should be attempted first, but this will fail in a proportion of patients; some due to soft tissue interposition (Leveuf 1948; Somerville 1953; Renshaw 1981). Persisting with conservative therapy may then lead to a permanently defective joint. The earliest age at which an open reduction can safely be carried out is contentious (Zions and MacEwen 1986; Ross, Ford and Evans 1988). Chuinard (1972) stated that Wolf's law operates across a joint; if this is true then the earlier a concentric reduction is obtained, the better.

In our unit, most patients were initially seen by one of us (JFT), and treated in the Stracathro splint (MacKenzie 1972). Any subsequent clinical or radiological evidence of instability led to admission for arthrography and percutaneous adductor tenotomy under general anaesthesia. If a concentric reduction was achieved the patient was placed in a plaster spica, but radiographic evidence of soft tissue interposition was an indication for an open reduction, irrespective of the age of the patient or the state of ossification of the capital femoral epiphysis.

We have now reviewed these patients for the incidence and severity of avascular necrosis and residual subluxation, in relation to the state of ossification of the capital epiphysis, the chronological age of the patient and the use of pre-operative traction.

PATIENTS AND METHODS

We reviewed the medical records of all children treated by anterior open reduction for CDH at Alder Hey Children’s Hospital, from 1970 to 1985. Eighteen patients with inadequate records or follow-up of less than two years were excluded, leaving 82 patients, 17 with bilateral and 65 with unilateral dislocations, giving a total of 99 hips (Table I). There were 12 boys and 70 girls, but all 20 patients (28 hips) having operations before the appearance of the capital epiphysis were female.

Operation. Open reduction was through an anterior approach extended medially to permit division of the adductors and the intermediate capsule. After psoas tenotomy and reflection of the rectus femoris, the superior, anterior and inferior capsule was defined and opened through a T-incision. Any capsular constriction was divided and the limbus was excised to allow concentric reduction. The ligamentum teres was usually excised. The joint was then reduced in the best possible
position, usually with the leg in moderate abduction and internal rotation. Extreme positions were avoided and further release of adductors was undertaken, if needed, to allow reduction of the femoral head without tension. Postoperative immobilisation was in a plaster spica; six to eight weeks later a derotation osteotomy of the femur was carried out. The child was then treated in a spica until adequate acetabular cover could be demonstrated radiologically.

**Clinical evaluation.** Of the 82 patients, 66 were clinically examined at the time of the last follow-up by one of the authors (SD). Clinical details of the other 16 patients were obtained from the case notes. The clinical results were assessed using a modification of McKay’s criteria (Barrett, Staheli and Chew 1986) (Table II).

**Radiology.** Radiological evaluation was made according to Severin’s criteria (Table III), and the acetabular index was measured on all follow-up radiographs. The centre–edge angle (CE) of Wiberg was measured on radiographs of children over three years of age; below this age it was difficult to determine the exact centre of the femoral head. We used Kalamchi and MacEwen’s (1980) classification of avascular necrosis and its effect on the proximal femoral growth plate (Table IV).

**RESULTS**

**Open reduction before the appearance of capital epiphysis.** This group included 20 patients (28 hips), all below the age of one year. The average age at diagnosis was 16 weeks and at operation was 24 weeks.

At this stage, the average angle of anteverision of the femoral neck was 78.75°, estimated by observing the amount of internal rotation required for deep, concentric reduction. All the children had a derotation osteotomy at an average of seven weeks after open reduction.

At a mean follow-up of 67 months, 23 hips (82%) were clinically excellent (Figs 1 to 4) and five (18%) were good. There were no fair or poor results. Radiologically, 19 hips (68%) were excellent, four (14%) were good and five (18%) were fair (Table V), with no poor results and no instance of redislocation. However, one patient who had an inadequate initial varus-derotation osteotomy had subluxation of the hip. This settled after a repeat varus osteotomy.

Seven patients (11 hips) had pre-operative conservative treatment, using the Stracathro splint in three

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**Table I. Number of patients in each age group, and presence or absence of ossification of the capital epiphysis**

<table>
<thead>
<tr>
<th>Age in months</th>
<th>Number Patients</th>
<th>Number Hips</th>
<th>Ossified epiphysis Present</th>
<th>Ossified epiphysis Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 12</td>
<td>24</td>
<td>32</td>
<td>4</td>
<td>28</td>
</tr>
<tr>
<td>13 to 24</td>
<td>26</td>
<td>30</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>25 to 36</td>
<td>20</td>
<td>23</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 36</td>
<td>12</td>
<td>14</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>82</td>
<td>99</td>
<td>71</td>
<td>28</td>
</tr>
</tbody>
</table>

Figure 1 – Pre-operative radiograph showing bilateral CDH at four months. Both capital femoral epiphyses are unossified. Figures 2 and 3 – Arthrograms demonstrating the inverted limbus on both sides (arrows). Figure 4 – Five-and-a-half years after operation, both hips show excellent development.
patients (three hips), and a hip spica in four patients (eight hips). Group I avascular necrosis developed in one of the hips treated in the Strathclyde splint. Of the 11 patients (16 hips) under six months of age at the time of open reduction, only one hip showed evidence of avascular necrosis, but this was in group II of Kalamchi and MacEwen.

Pre-operative traction was employed in eight patients (12 hips); the results with and without traction are shown in Table VI. The clinical results were comparable in the two groups, but the radiological results appeared to be better in the group treated with traction, though, because of the small sample size, they are not statistically significant.

Only three of the 28 hips required secondary procedures (Table VII). Two of these were repeat varus-derotation osteotomies and one was an innominate osteotomy. The femoral osteotomies were for residual rotatory deformity in one hip and, as mentioned, for subluxation in the other. The pelvic osteotomy was for persisting acetabular dysplasia.
Four hips had evidence of avascular necrosis (Table VII); three in group I and one in group II (Figs 5 and 6). No hip showed total necrosis but one had almost complete fragmentation of the capital epiphysis. This, however, re-osssified completely (Figs 7 to 9). At latest review all the epiphyses had recovered almost completely except for slight coxa magna.

**Open reduction after the appearance of the capital epiphysis.** This group included 62 patients (71 hips). The average age at diagnosis was 21 months and at operation 26 months. All but three patients had a derotation osteotomy at an average of two months after open reduction; pre-operative traction was used in all but two patients.

At an average follow-up of 105 months, 47 hips (66%) were clinically excellent, nine (13%) were good, 11 (15%) were fair and four (6%) were poor. Radiologically there were 29 (41%) excellent, 23 (32%) good, 9 (13%) fair and 10 (14%) poor hips (Table V).

Avascular necrosis was observed in 19 (27%) hips (Table VII), being total in two (3%) and partial in 17 (24%). Of the 17, 10 (14%) were in group I, four (6%) were in group II and three (4%) were in group III.

Twenty-one hips (31%) required additional operations (Table VII). Four needed repeat open reduction for redislocation or inadequate reduction; all were done within four weeks of the initial procedure. Six hips had femoral derotation osteotomies and 11 had pelvic surgery which included seven Salter, one Pemberton and two Chiari operations.

**DISCUSSION**

**Results and age at operation.** Statistical analysis by the chi-squared test and Student's t-test shows a significant correlation between the age at operation and the final result. Children treated before the age of two are more likely to do better (p = 0.01), as is well-established in the world literature. The results of operations done before 12 months of age (prior to appearance of the capital femoral epiphysis) were significantly better (p = 0.01) than those done between the ages of 12 to 24 months (after the appearance of the capital femoral epiphysis). In 11 patients (16 hips) who had open reduction before the age of six months, only one hip developed avascular necrosis. It seems that better results follow an earlier open reduction, notwithstanding the age of the patient or the state of ossification of the capital epiphysis. However, we have not found open reduction necessary in patients under four months of age.

Additional surgery was required in only 11% of hips in patients under 12 months of age at the time of reduction, as against 30% for those of 24 to 36 months, and 71% for those over 36 months of age. The increasing rate of re-operation is possibly because of the secondary adaptive changes caused by prolonged persistent dislocation.

**Avascular necrosis and age at operation.** In our whole series total avascular necrosis was seen in 2% and partial in 20%. Kalamchi and MacEwen group II, III or IV changes were seen in only 10%, predominately in children over 24 months of age. The incidence of avascular necrosis correlates significantly with increasing age: in the pre-osssification group this was 14% (four hips), but three were in group I and therefore had an excellent prognosis. Significant necrosis occurred in only one hip (3%). Two of the four patients under the age of one year, but with an ossific nucleus, showed avascular changes but the sample is too small for statistical analysis.

After the age of 12 months, there was a steady increase in the incidence of avascular necrosis: of the two hips with total changes one was 19 months old at time of reduction and the other 40 months old. While grade I changes predominated in the 12- to 24-month group and almost full recovery could be expected, in the older age groups grade II and III changes predominated.

Previous studies of age factor related to avascular necrosis have given contradictory results. Kalamchi and
MacEwen (1980) found severe avascular changes where treatment started before six months of age and similar findings were reported by Gregosiewicz and Wóska (1988). However, Grill et al (1988), analysing the use of the Pavlik harness, concluded that treatment started within the first three months of life, produced only 50% of the rate of avascular necrosis seen when treatment begins between the third and sixth month. This is supported by the vascular studies of Ogden and Moss (1978) who demonstrated that partial head necrosis followed interruption of the medial circumflex artery prior to the age of five months, but total necrosis later in life. In addition, muscular contracture in chronically dislocated hips may put the vessels at an increased risk of being stretched and compressed, external to the joint itself (Hensinger 1979). Surgical release of the adductors and the iliopsoas would significantly reduce this risk.

A comparison of our incidence of avascular necrosis with that in other series is difficult, since the criteria for avascular necrosis vary: some studies have included only cases of total avascular necrosis.Ross et al (1988), reporting on 161 hips treated by open reduction, found a greater incidence of severe avascular necrosis when the open reduction was carried out before the ossification of the capital epiphysis. They used a similar operation to ours, routinely dividing the psoas tendon. However, our series started much later, with the benefit of reports emphasising the need to avoid extreme abduction and external rotation during immobilisation (Salter, Kostuik and Dallas 1969; Gage and Winter 1972). Differences in the position of immobilisation may explain our diminished incidence of avascular necrosis. Gibson and Benson (1982), reported a 5.4% incidence of avascular necrosis, in 147 hips treated by limbectomy and derotation osteotomy, between the ages of 12 months and three years. They, however, only used Salter's criteria for total avascular necrosis. Scaglietti and Calandriello (1962) reported 24% avascular necrosis after open reduction in children aged from under one year to five years, with 22% requiring secondary procedures, but make no mention of the criteria used for avascular necrosis.

**Avascular necrosis and conservative management.** Two recent series report the incidence of avascular necrosis after conservative treatment. Grill et al (1988), report an incidence of 2.38% in 3 611 hips of children less than 11 months old treated by the Pavlik harness. However, these included only total necrosis in Tönns grades I, II and III. In Tönns grade IV, the rate of avascular necrosis rose to 16%. Gregosiewicz and Wóska (1988) reported an incidence of 21% of avascular necrosis in 254 hips treated conservatively at various ages. They used the criteria of Kalamchi and MacEwen (1980).

It is evident that the iatrogenic complication of avascular necrosis in CDH occurs after all kinds of treatment. The goal is therefore to minimise it. Our study has made certain facts more clear. The age at early open reduction and the state of ossification of the capital epiphysis are not perhaps of great significance. What is
more important is that the hip is reduced and maintained in reduction without putting undue tension on the surrounding soft tissues or undue pressure on the bony surfaces. Where closed reduction fails, the sooner this is done by an open operation, the more likely is a good result. Close attention to operative detail and technique is essential. Other factors which may help to minimise the risk of avascular necrosis after open reduction are pre-operative traction, division of the psoas tendon and adductor tenotomy.

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REFERENCES


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