CONGENITAL DISLOCATION OF THE HIP
A Review and Assessment of Results of Treatment with Special Reference to Frame Reduction as Compared with Manipulative Reduction

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With the object of assessing the results of various methods of treatment of congenital dislocation of the hip used in this centre from 1920 to 1950, a clinical and radiographic review of all available cases was undertaken, the data being grouped according to the initial method of reduction. The results of treatment in this analysis have been assessed according to two criteria: 1) quality of the reduction; and 2) incidence of pathological changes in the head after reduction.

A method of traction and gradual abduction for the reduction of congenital dislocation of the hip was first used in this hospital in 1935 with the purpose of minimising the danger of damage to the blood supply of the femoral head during reposition. Details of this technique were published by Scott (1953). Traction was the method first used for the reduction of a congenital dislocation of the hip, when Pravaz (1837) attempted to bring the femoral head down gradually by prolonged traction and then to manoeuvre it into the acetabulum by a combination of extension, abduction and pressure on the trochanter. Later Putti (1929) introduced his divaricatore based on similar principles and Keith (1935) developed his traction frame improving on a board devised by McDonald. Forcible reduction by manipulation as described by Paci (1887) and by Lorenz (1895), who widely popularised it, and its modification by Denucé (1898) was the usual method of reduction in most hospitals, including ours, until the method of gradual reduction was developed. During the last few years a new surgical approach to the treatment of congenital dislocation of the hip was introduced in this hospital (Somerville 1953); the present review does not include these later cases.

MATERIAL

All patients with congenital dislocation of the hip in whom reduction was attempted at this hospital from 1920 to 1950 were reviewed. This allowed at least six years to elapse from the completion of treatment to the time that this analysis was begun.

Reduction of one or both hips was performed in 219 patients during that period. We were able to examine 179. The sex ratio was nine girls to two boys. The dislocation was unilateral in 127 patients and bilateral in fifty-two, so that 231 hips were available for analysis. Figure 1 shows the ages at which treatment was begun; although reduction was attempted up to the age of nine, only three patients were over the age of six at the time of starting treatment. Patients with bilateral dislocations came for treatment later than those with unilateral affection, probably because walking started later in the bilateral cases (Fig. 1).

ASSESSMENT OF RESULTS

Quality of reduction—It is probable that the wide variations in the results of treatment published by different authors have been due more to differences in methods of analysis than to real differences in clinical results. In the present investigation the results obtained with various methods of treatment were uniformly assessed.

Estimation of the functional result many years after treatment has ended is a good way of assessing the merits of any treatment. However, for two main reasons we have not used this method in our study of cases of congenital dislocation of the hip. Firstly, many years

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must elapse before one can with certainty assess the final result; a sufficiently long period of follow-up could not have been obtained in the more recent cases included in this study. Secondly, pain, the main symptom of abnormal function, is difficult to assess. A dysplastic joint may not give rise to symptoms and may function normally for a considerable number of

In the 179 patients available for review, the age at which treatment was started is shown in Fig. 1.

![Age at which treatment was started in the 179 patients available for review.](image)

The CE angle (Wiberg 1939). The angle between two lines passing through the centre of the head (C), one perpendicular to the line joining the centres of the heads, the other tangential to the edge of the acetabulum (E).

<table>
<thead>
<tr>
<th>Age</th>
<th>Doubtful</th>
<th>Pathological</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 TO 13 YEARS</td>
<td>15°-19°</td>
<td>UNDER 15°</td>
</tr>
<tr>
<td>14 YEARS AND OVER</td>
<td>20°-25°</td>
<td>UNDER 20°</td>
</tr>
</tbody>
</table>

For this reason early estimates of functional results of any method of treatment of congenital dislocation of the hip are misleading. An anatomical
classification of results, based on the shape of the femoral head and the relationship between it and the acetabulum, allows an objective assessment of the quality of reduction and of the subsequent development of the joint, and permits a forecast of the final result.

**Method of assessment of quality of reduction**—The hips have been classified according to the relationship between the head and the acetabulum as seen in the radiographs. The classification also takes into consideration the anatomical configuration of the femoral head and neck, which is often affected by pressure after reduction. These changes are studied in the next section.

For this anatomical assessment we have used Severin's (1941) six categories based on the anatomical configuration of the femoral head and neck and of the acetabulum, and their relationship to one another. The relationship between the head and the acetabulum has been expressed as the CE angle (Wiberg 1939). This angle is formed by two lines passing through the centre of the femoral head, one of which is perpendicular to the line uniting the centre of the two heads and the other tangential to the edge of the acetabulum (Fig. 2).

*Type I*—The hip is perfect in all respects, with rounded head and normal neck and acetabulum: *a*) the CE angle is more than 19 degrees between the ages of six and thirteen, and more than 25 degrees for ages from fourteen upwards (Fig. 3); *b*) the CE angle is from 15 to 19 degrees between the ages of six and thirteen, and from 20 to 25 degrees for ages from fourteen upwards (Fig. 4).

*Type II*—The head and/or neck of the femur reveals moderate deformity, the shape of the acetabulum is good and there is no subluxation: *a*) the CE angle is the same as in Type Ia (Fig. 5); *b*) the CE angle is the same as in Type Ib (Fig. 6).

*Type III*—There is dysplasia of the acetabulum but no subluxation of the joint. The CE angle is less than 15 degrees in ages from six to thirteen years, and less than 20 degrees in ages from fourteen upwards (Fig. 7).

*Type IV*—The femoral head is subluxated and articulates with a shallow acetabulum: *a*) positive CE angle, or equal to zero (Fig. 8); *b*) the CE angle is negative because the subluxation is greater (Fig. 9).

*Type V*—The femoral head articulates with a "secondary" acetabulum developed in the higher part or on the edge of the true acetabulum. In this type, as in Type IV, there is often considerable deformity of the head and neck of the femur (Fig. 10).

*Type VI*—There is a complete dislocation (Fig. 11).

**ANATOMICAL RESULTS**

**Manipulative treatment**—In eighty hips in fifty-seven patients reduction was attempted by manipulation. Of these, twenty-six hips (32.5 per cent) needed open reduction later and are considered in a special section. Five hips (6.3 per cent) had a shelf operation. One hip had a rotation osteotomy. Seven patients in this group did not attend the follow-up. Table I shows the anatomical results related to the age at initial reduction. A total of 26.8 per cent of the hips showed a perfect or good reduction, 32 per cent had a moderate result and 21 per cent showed failure of reduction.

**Frame reduction**—One hundred and twelve hips in ninety-two patients were treated by gradual reduction on a frame. Of these, fifteen hips (13.3 per cent) required open reduction later and are considered below. Ten hips (8 per cent) had a shelf operation. Twelve had a rotation osteotomy and one a combined acetabuloplasty and rotation osteotomy.

We have been able to assess the results in eighty-one hips. The anatomical results of these related to the age at initial reduction are shown in Table II. A total of nearly 60 per cent belong to groups I, II and III of Severin which we consider as perfect and good results. The slight or moderate residual subluxations accounted for 32 per cent and total failures 8 per cent. Analysis by age shows that the best results were obtained when treatment began before the age of two and a half years, and results were less satisfactory when the patient started treatment later.
Classification of results on anatomical basis. Figure 3—Type Ia. Figure 4—Type Ib. Figure 5—Type IIa. Figure 6—Type IIb. Figure 7—Type III. Figure 8—Type IVa. Figure 9—Type IVb. Figure 10—Type V. Figure 11—Type VI.
Open reduction—Open reduction was carried out in fifty-five hips; in twenty-six of these previous manipulation had failed; in fifteen attempted reduction on a frame had failed; in

### TABLE I
**ANATOMICAL RESULTS OF HIPS TREATED BY MANIPULATION RELATED TO THE AGE AT INITIAL REDUCTION**

<table>
<thead>
<tr>
<th>Age up to (years)</th>
<th>Number (hips)</th>
<th>Perfect</th>
<th>Good</th>
<th>Poor</th>
<th>Total failures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ia</td>
<td>Ib</td>
<td>La</td>
<td>Ib</td>
</tr>
<tr>
<td>2 years</td>
<td>10</td>
<td>2</td>
<td></td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>2½ years</td>
<td>12</td>
<td>2</td>
<td>2</td>
<td>33</td>
<td>4</td>
</tr>
<tr>
<td>3 years</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4 years</td>
<td>11</td>
<td>1</td>
<td></td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>5 years</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>9 years</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>5</td>
<td>2</td>
<td>14:9</td>
<td>5</td>
</tr>
</tbody>
</table>

22 hips: 46:8 per cent
15 hips: 32 per cent
10 hips: 21 per cent

### TABLE II
**ANATOMICAL RESULTS OF HIPS REDUCED ON FRAME RELATED TO THE AGE AT INITIAL REDUCTION**

<table>
<thead>
<tr>
<th>Age up to (years)</th>
<th>Number (hips)</th>
<th>Perfect</th>
<th>Good</th>
<th>Poor</th>
<th>Total failures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ia</td>
<td>Ib</td>
<td>La</td>
<td>Ib</td>
</tr>
<tr>
<td>1 year</td>
<td>3</td>
<td>1</td>
<td></td>
<td>33</td>
<td>1</td>
</tr>
<tr>
<td>2 years</td>
<td>20</td>
<td>7</td>
<td>2</td>
<td>45</td>
<td>1</td>
</tr>
<tr>
<td>2½ years</td>
<td>22</td>
<td>5</td>
<td>1</td>
<td>27</td>
<td>2</td>
</tr>
<tr>
<td>3 years</td>
<td>10</td>
<td>1</td>
<td></td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>4 years</td>
<td>6</td>
<td>1</td>
<td></td>
<td>17</td>
<td>2</td>
</tr>
<tr>
<td>5 years</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>6 years</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>7 years</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>81</td>
<td>14</td>
<td>4</td>
<td>22:2</td>
<td>7</td>
</tr>
</tbody>
</table>

48 hips: 59:3 per cent
26 hips: 32 per cent
7 hips: 8 per cent

twelve open reduction was used as a primary treatment; and in two previous attempts at reduction by operation had failed.

The results of open reduction could be assessed in forty-four hips. The relationship between the anatomical results of open reduction and previous treatment is shown in Table III.
The cases have been divided into two groups, one comprising patients operated on primarily or immediately after the failure of a previous reduction, and the other including patients who continued to have conservative treatment with plasters in spite of an unsatisfactory reduction. These were operated upon after a variable period of plaster immobilisation. At the time of operation they were on average nine months older than the patients of the first group. It will be seen that the results were more satisfactory when open reduction followed immediately the failure of the closed method of reduction, whereas open reduction rarely succeeded when the patient had been kept in plaster with the dislocation unreduced. Of eighteen such cases only one had a good anatomical result, while all the others had either some degree of residual subluxation or complete failure of reduction.

**TABLE III**

**RELATIONSHIP BETWEEN THE ANATOMICAL RESULTS OF OPEN REDUCTION AND PREVIOUS TREATMENT**

<table>
<thead>
<tr>
<th>Open reduction performed</th>
<th>Number (hips)</th>
<th>Perfect</th>
<th>Good</th>
<th>Poor</th>
<th>Total failures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Ia</td>
<td>Ib</td>
<td>Per cent</td>
<td>IIa</td>
</tr>
<tr>
<td>Primarily, or immediately after manipulation or traction in frame</td>
<td>26</td>
<td>6</td>
<td>1</td>
<td>27</td>
<td>4</td>
</tr>
<tr>
<td>After two to thirteen months in plaster, or weight bearing, after the initial treatment</td>
<td>18</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>44</strong></td>
<td><strong>6</strong></td>
<td><strong>1</strong></td>
<td><strong>16</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>

**INCIDENCE OF OSTEOCHONDritis OF THE FEMORAL HEAD AFTER REDUCTION**

During the early phases of treatment osteochondritis may occur in the femoral head with consequent changes in the anatomical and late functional results. Schede (1940) did not believe that the trauma of reduction was responsible for these changes and considered that the fragmentation observed was a sign of ossification; but others believe that the radiological changes are signs of femoral dysplasia (Gill 1948). The figures for the incidence of changes in the femoral head after similar methods of reduction vary from author to author; thus Crego and Schwartzmann (1948) claimed 0 per cent, Ortolani (1948) 2 per cent, Farrell and Howorth (1935) 10-2 per cent, Massie (1951) 45 per cent after closed reduction and 30 per cent after open reduction, Ponseti (1944) 46-2 per cent, Judet (1958) 51 per cent after closed reduction and 22 per cent after open reduction, and Bost, Hagey, Schottstaedt and Larsen (1948) 52 per cent. This wide disparity may be related not so much to the different methods of treatment used but to a variation in the interpretation of the findings and to the different methods of analysis employed. In fact, in some papers this discrepancy is not even considered and in others it is regarded as inevitable. Some authors have included in their figures only those cases presenting advanced changes resembling coxa plana; others include all changes occurring in the head after reduction, while some give no definition of the lesions. Massie (1951) found that, apart from the 30-45 per cent of hips which showed coxa plana, 40 per cent had some abnormal epiphysial changes without fragmentation, a lesion which he considered indicative of a vascular disturbance of the head. Therefore, 75 per cent (forty-seven out of sixty-two hips) showed some radiographic abnormality, and 72 per cent of those whose lesions were attributed to vascular disturbances had trouble with their hips in later life.
To summarise, it may be said that when cases have been studied in detail, as in the series of Ponseti and of Massie, it has been shown that a high proportion of patients show radiographic changes in the head which appear to have great significance for the condition of the joint in later life.

**Classification**—Changes in the radiographic appearance of the femoral head after reduction have been studied and the consequent permanent deformities classified in four groups.

![Fig. 12](image1.png)  ![Fig. 13](image2.png)

**FIG. 12**  **FIG. 13**

Classification of severity of osteochondritis. Figure 12—Type I. Figure 13—Type II. Figure 14—Type III. Figure 15—Type IV.

![Fig. 14](image3.png)  ![Fig. 15](image4.png)

**FIG. 14**  **FIG. 15**

Type I—Head and neck of normal appearance (Fig. 12). Type II—Some flattening of the head; neck moderately wider and shorter than normal (Fig. 13). Type III—Mushroom-shaped head spreading over a shorter and generally wider neck (Fig. 14). Type IV—The femoral head and neck grossly misshapen, the head nearly touching the trochanter, because of extreme shortening of the neck (Fig. 15).
Incidence related to method of reduction—Of the total number of hips initially treated by manipulation or by the frame method, we have analysed only those in which there is a series of radiographs covering the whole process of reduction and after-treatment. We have not considered the cases of primary operative reduction because of their small number. One hundred and forty-one hips were available: seventy-seven reduced by frame and sixty-four by manipulation. The final anatomical results of those hips which had exhibited early radiological changes after reduction have been assessed and classified.

It may be seen from Table IV and Figure 16 that the frame treatment gave an incidence of osteochondritis of 37.7 per cent, from very slight to severe, against 68.6 per cent in cases reduced by manipulation. The severity of the disturbance in the cases treated by frame was much less, only 2.6 per cent of the cases producing final gross deformity, as compared with 29.7 per cent of severe deformities in the cases of manipulation.
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The frame treatment proved to be of value in lessening the incidence of severe lesions in the head and neck, for there were only two cases in which this complication developed.

An observation in relation to the pathogenesis of these lesions is worth reporting: a boy aged ten months with subluxation of the left hip (not included in this analysis) was treated primarily in plaster in the position of full bilateral medial rotation and abduction without previous attempt at reduction. He showed five months later osteochondritic changes in both femoral heads. These changes started on the normal side and were followed afterwards by similar changes in the previously subluxated hip (Figs. 17 to 19). It is believed that the position of the leg in plaster had some bearing on the production of the lesion; the persistent over-stretching of the capsule when the leg was forcibly abducted with the adductors intact

TABLE IV
INCIDENCE AND SEVERITY OF PATHOLOGICAL CHANGES IN THE FEMORAL HEAD RELATED TO THE METHOD OF INITIAL REDUCTION

<table>
<thead>
<tr>
<th>Method of reduction</th>
<th>Hips</th>
<th>Per cent</th>
<th>Final anatomical results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td>Per cent</td>
<td>Number</td>
</tr>
<tr>
<td>Manipulation</td>
<td>64</td>
<td>68.6</td>
<td>—</td>
</tr>
<tr>
<td>Frame</td>
<td>77</td>
<td>37.7</td>
<td>4</td>
</tr>
</tbody>
</table>

(Nicholson, Kopell and Mattei 1954) may have been responsible for the lesion. Another possible cause is reflex vascular spasm of the capital vessels of the normal side. This has been shown by Barnes and Trueta (1942) to occur experimentally in the femoral and iliac arteries of the rabbit when the opposite leg is constricted by a tourniquet.

DISCUSSION

Gradual frame reduction of congenital dislocation of the hip has proved to have several substantial advantages over manipulative treatment, the most important of which is a diminished incidence and severity of osteochondritis; consequently a greater number of hips had a perfect final anatomical result. It has also proved to be a more effective method of reduction, failing less often than manipulative methods.

Dislocations in older patients, in whom radiography showed a long distance from the top of the ossific nucleus of the head to the Y-line, proved to be difficult if not totally impossible to reduce without operative removal of the obstacle to reduction.

It seems clear that efforts should be made to improve the quality of primary reduction. Arthography—used in the later cases of this series—is likely to be helpful in assessing the quality of reduction and in indicating those cases in which open reduction should be used.

SUMMARY AND CONCLUSIONS

1. The "frame" or traction method of reduction of congenital dislocation of the hip is, from the evidence collected in this hospital, both more effective and safer than the manipulative method of reduction. The traction method caused less frequent and less severe lesions of the femoral head than the manipulative method.
2. In cases in which closed reduction failed, open reduction was attempted; the quality of the results depended mainly on the time of operation, the best being in patients operated upon a few weeks after the initiation of the frame treatment.

3. Even with its improved results, still about 40 per cent of cases treated by the frame method showed insufficient reduction or structural changes of the femoral head.

4. Arthrography may help in indicating those cases in which open reduction is desirable.
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REFERENCES


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