CHIARI OSTEOTOMY FOR CONGENITAL DISLOCATION AND SUBLUXATION OF THE HIP

RESULTS AFTER 20 TO 34 YEARS FOLLOW-UP

REINHARD WINDHAGER, NIKOLAUS PONGRACZ, WOLFGANG SCHÖNECKER, RAINER KOTZ

From the Orthopaedic University Clinic of Vienna, Austria

We reviewed 236 of the 388 Chiari pelvic osteotomies performed between 1953 and 1967 at the Orthopaedic University Clinic of Vienna for the treatment of congenital dislocation and subluxation of the hip. Over 90% of the operations were performed by Chiari himself. Twenty-one hips had needed reoperation after an average of 15.4 years; the other 215 hips had been followed up for 20 to 34 years (mean 24.8).

The overall clinical results were excellent or good in 51.4%, fair in 29.8% and poor in 18.3%. The results were worse with increasing age at operation. The Trendelenburg sign improved only in patients aged seven or less at operation, and range of movement decreased in all cases. Subjectively poor results were seen in patients with pre-operative signs of osteoarthritis.

Radiological loss of correction during follow-up was seen only in cases with incomplete primary correction. The addition of an intertrochanteric varus osteotomy in 36 cases did not achieve either better centring or better development of the acetabular roof. Degenerative changes increased significantly during the long-term follow-up, but their progress seemed to have been slowed down by the osteotomy in the younger age groups. Indications and contra-indications for the operation are discussed.

Chiari published his first paper on pelvic osteotomy in 1953, and one on the encouraging short-term results in 1955. At first, he limited the indications to subluxated and dislocated hips, and claimed that his method provided stable coverage of the femoral head, and also improved the biomechanics by shortening the lever arm for weight and increasing that of the pelvotrochanteric muscles (Chiari 1968; Chapchal 1974).

The Chiari osteotomy is now used mainly where other pelvic osteotomies or acetabuloplasties are ruled out, for neglected congenital dislocation of the hip (CDH) with or without secondary osteoarthritis. In this context, the interposition of part of the hip capsule between the femoral head and the new acetabular roof helps to provide a substitute for damaged articular cartilage.

We have reviewed the long-term efficiency of this so-called 'salvage procedure' at a minimum follow-up of 20 years and analysed the clinical and radiological results.

PATIENTS AND METHODS

From 1953 to 1967, at the Orthopaedic University Clinic of Vienna, 388 Chiari pelvic osteotomies were performed in 357 patients, over 90% of them by Chiari himself. We were able to follow-up 213 of these patients (60%) with 242 operations. Ten patients were known to have died, 14 lived abroad, and we were unable to trace the remainder.

Five patients (six osteotomies) with underlying neuromuscular diseases were excluded. The operation was performed for CDH in all the remaining 236 hips in 208 patients. There were 186 women and 22 men, and the ratio of right side to left was 1 to 1.5. The mean age at operation was 14.1 years (2.6 to 51.3), with a majority of children and adolescents (Fig. 1).

Twenty-one hips had required reoperation at a mean
of 15.4 years (6 to 28) after the osteotomy: 19 had a total hip replacement and two were arthrodesed. The mean follow-up of the other 215 hips was 24.8 years (20 to 34.2). In 63 of the hips, an intertrochanteric femoral osteotomy had also been performed; 20 were done before the Chiari osteotomy, seven after it, and 36 at the same operation.

Operative technique. Chiari described this in 1953, and the basic elements, semi-circular osteotomy in the sagittal plane and ascending straight osteotomy in the frontal plane with a chisel, have not changed (Chiari 1953, 1965, 1977). For the reported series, Chiari used a spica in abduction for four weeks; we changed to internal fixation with two Kirschner wires in 1982.

Methods of assessment. We used the clinical and radiological guidelines recommended by the Commission for the Study of Hip Dysplasia (CSHD) of the German Society for Orthopaedics and Traumatology (Tönnis 1987a,b), preferring this to the less detailed analyses used in other studies (Colton 1972; De Waal Malefijt, Hoogland and Nielsen 1982; Graham et al 1986; Betz et al 1988).

Pre-operative case notes enabled us to record symptoms, walking distance, range of movement, and the results of the Trendelenburg test. We used the latter three features, each graded from 0 to 3, to give a new evaluation score for the result (Table I).

For radiographic evaluation we used anteroposterior films taken before and after osteotomy and at follow-up. False profile views (Lequesne and de Seze 1961) were available only at the latest reviews. Some old radiographs were missing, or were of such bad quality that not all characteristics were evaluated in each case. However, enough comparable observations remained to allow statistical analysis.

Where possible we recorded the centre-edge angle (CE) of Wiberg (1939) and the VCA angle of Lequesne and de Seze (1961) to indicate lateral and anterior coverage of the femoral head. The depth of the acetabulum was recorded from the ACM angle of Idelberger and Frank (1952) and the decentring of the femoral head by the distance MZ of Busse, Gasteiger and Tönnis (1972). For overall grading of dysplasia and dislocation we used the hip value of Busse et al (1972), which takes account of the CE and ACM angles and the decentring distance MZ. These numerical results were graded for dysplasia (Tönnis 1987a) and related to the mean hip values at different ages. Osteoarthritis before the operation and at follow-up was also assessed by the CSHD method (Tönnis 1987b).

We assessed overall results in three age groups:

Group I. Operation before the age of seven years (n = 75); mean age at follow-up 31.2 years (24.4 to 40.8).

Group II. Operation between seven and 14 years (n = 65); mean age at follow-up 36.5 years (29.6 to 43.7).

Group III. Operation after 14 years (n = 75); mean age at follow-up 47.1 years (35.2 to 66.3).

For statistical evaluation we used Student's t-test, the McNemar test and the chi-square test.

RESULTS

Clinical findings

Walking distance and pain. At follow-up, walking distance was unlimited in 60% of the cases and a further 28% could walk for more than one hour. At review, 13 hips caused unremitting pain and 80 were painful on exertion.

Before the osteotomy, 86 patients (40%) had reported pain on exertion. Of these, 46 were free of pain at long-term follow-up. The other 40 patients had had recurrence of pain on exertion after a pain-free interval averaging 17 years (4 to 30): 95% of them had been completely free from complaints for at least ten years.

The other 40 patients with pain on exertion at follow-up had been pain free before the osteotomy. Their new complaints had started after an average of 18.4 years (1 to 31). The incidence of pain on exertion was related to age: it was 26.7% in group I, 33.8% in group II, and 50.7% in group III (p < 0.008).
Range of movement. In comparison with the pre-operative findings, hip movement had deteriorated significantly in all planes. The mean losses were: flexion 15°, internal rotation 13°, and external rotation 15°.

Trendelenburg sign. The number of hips showing a positive Trendelenburg sign was much the same before osteotomy and at follow-up (Fig. 2). However, this also varied with age group: there was a tendency (p < 0.04) towards improvement in group I, the youngest.

Overall results. All but two of the 208 patients were working; no information was available on one and the other had retired. Most patients (51%) had an occupation which involved both sitting and standing, but 33% stood all the time.

The overall clinical assessment for the 215 hips not having reoperation, according to the points system shown in Table I, was excellent or good results in 53.8%, fair results in 31% and failure in 15.2%. These results deteriorated significantly with increasing age at operation: in age group I there were excellent and good results in 63.8%, in group II in 55.7%, and in group III in only 41.7% (p < 0.02).

Radiological findings. Before osteotomy, 90% of hips showed extremely severe dysplasia according to the grading system for hip value, and 7.5% had severe dysplasia: these grades occurred in only 26% of hips at long-term follow-up (Fig. 3). All the mean radiometric acetabular characteristics had been improved significantly by the operation (Table II) and there was only slight postoperative loss of correction at 20 years follow-up.

At latest follow-up, the mean VCA value of 43.5° (−18 to 87) corresponded to normal values, showing adequate anterior coverage of the femoral head.

Degenerative changes developed significantly during follow-up (Fig. 4): osteoarthritic changes were present in 90.8% of the hips which had shown no pre-operative signs of osteoarthritis (p < 0.0001), and in no hip was there any improvement. Only 12 hips showed no signs of osteoarthritis both before osteotomy and at follow-up. The grade of late osteoarthritis rose significantly with increasing age at operation: osteoarthritis grade II and III was seen in 31.7% of age group I, 45% of group II, and 79.1% of group III (p < 0.0001).

Correlation of findings. There was a significantly higher incidence of pain at follow-up where there had been pre-operative signs of osteoarthritis: 30.5% of those with pain at follow-up had had pre-operative degeneration, while this applied to only 9.9% of the patients who were free of pain at follow-up (p < 0.001). There were signs of osteoarthritis at follow-up in 97% of those with pain on exertion, and in 91% of those with no pain on exertion.

Analysis of the residual dysplasia at follow-up showed that those hips with severe or extremely severe dysplasia (grade III and IV) had started with more severe dysplasia. Although the amount of correction in this group had been larger (32.7 in comparison to 29.2 in the less severely involved hips), they had not been corrected to normal and had deteriorated during follow-up.

The addition of an intertrochanteric varus osteotomy in 36 hips made no significant difference either to the postoperative radiographic correction (Table III) or to the clinical course.

We found no significant radiographic difference between the 21 hips which had required reoperation and the remainder, but the patients had a higher average age at osteotomy (28.4 years, 3 to 51.3) and twice as many had pain pre-operatively. Six of these cases, however, had no pain for over ten years despite being over 29 years of age at operation. We classified these six hips as
It seems then, that the osteotomy should probably be delayed until the patient has some pain, but that the operation should then be performed as soon as possible. It is also important that there should be a minimum loss of range of movement, since some loss is to be expected in all planes after the osteotomy. We never use this osteotomy where hip flexion is less than 90° (Chiari 1974).

There are many different evaluations of the changes in the Trendelenburg sign in the literature. Chiari and Schwägerl (1976) and some other authors have reported distinct improvement or at least no deterioration in muscle power after the osteotomy (Hoffman et al 1974; Macnicol, Uprichard and Mitchell 1981; Kerschbaumer, Brückl and Endler 1985; Graham et al 1986; Reynolds 1986), but a contrasting view has been given by others (Calvert et al 1987; Zlatic et al 1988). Our own study reflects this contradiction. Our overall results show a nearly equal incidence of a positive Trendelenburg sign before and after osteotomy, but further analysis showed a significant improvement when the operation was performed before the age of seven years. We therefore confirm an improvement of the Trendelenburg sign after osteotomy in infants, and stress the need for continued postoperative follow-up and early intensive rehabilitation for older patients.

The successful radiographic correction after Chiari’s pelvic osteotomy has been shown to be better than that after other operations for CDH (Hoffman et al 1974; Jani 1974; Utterback and MacEwen 1974). Our review demonstrated adequate anterior cover for the femoral head, achieved by good operative technique and sufficient displacement of the fragments, with no need for supplementary bone grafting of the acetabular roof as described by Graham et al (1986) and Høgh and Macnicol (1987). At first, Chiari suggested a displacement of 1 to 2 cm, but later recommended enough medialisation of the distal fragment to ensure complete coverage of the femoral head (Chiari 1974b). The limited displacement, less than 55% of the length of the osteotomy, recommended by Colton (1972) is not enough, in our opinion, since early postoperative deterioration was seen only in patients with primarily inadequate correction (Fig. 5). Complete coverage of the femoral head seems to be the ideal aim for optimum medialisation of the distal fragment.

We feel that the value of combining pelvic osteotomy and an intertrochanteric varus osteotomy is sometimes overestimated. Some authors recommend this where complete coverage of the femoral head cannot be obtained by medialisation alone (Englhard and Morschler 1985; Kerschbaumer et al 1985), but in our own study, we found neither better centring of the femoral head nor an improvement in the further development of the acetabulum. This re-emphasises the importance of medialisation for femoral head coverage. The addition of an intertrochanteric femoral osteotomy may improve the good results. Four other hips had shown pain relief for more than ten years after osteotomy at between 19 and 29 years of age and were judged as fair. The remaining 11 hips were free of pain for less than ten years, and were regarded as failures. When the reoperated cases, assessed as above, were included in the overall results 51.4% were excellent or good, 29.8% were fair and 18.8% were poor (Table IV).

**Complications.** Four hips had required reoperation because of incomplete medialisation. Two patients developed a transient peroneal palsy, and one had transient meralgia paraesthesia. Three wounds healed by second intention and two had deep infection. Four hips required manipulation under anaesthesia. Only one hip showed para-articular ossification.

**DISCUSSION**

An important feature of the Chiari osteotomy is the rapid and continued relief of pain (Chiari 1974a,b; Hoffman, Simmons and Barrington 1974; Chiari, Endler and Hackel 1978; Graham et al 1986; Calvert et al 1987; Høgh and Macnicol 1987; Zlatic et al 1988). In our 20- to 34-year follow-up we found continued relief in 53.5% of those with pre-operative pain on exertion. In addition, pain relief had lasted an average of 17 years in the remaining cases. Subjectively poor results were equally frequent in patients with and without pre-operative pain.

**Table II.** Hip scores (mean and range) for dysplasia in different age groups

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Pre-operative</th>
<th>Postoperative</th>
<th>Long-term follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 7</td>
<td>55 (32 to 79)</td>
<td>22 (2 to 46)</td>
<td>23 (4 to 64)</td>
</tr>
<tr>
<td>7 to 14</td>
<td>53 (29 to 87)</td>
<td>19 (5 to 46)</td>
<td>20 (5 to 51)</td>
</tr>
<tr>
<td>Over 14</td>
<td>42 (23 to 82)</td>
<td>18 (4 to 59)</td>
<td>18 (6 to 64)</td>
</tr>
</tbody>
</table>

**Table III.** Hip scores (mean and range) for dysplasia in hips with and without additional varus femoral osteotomy

<table>
<thead>
<tr>
<th></th>
<th>Pre-operative</th>
<th>Postoperative</th>
<th>Long-term follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>With osteotomy</td>
<td>42 (23 to 87)</td>
<td>18 (7 to 42)</td>
<td>20 (7 to 61)</td>
</tr>
<tr>
<td>Without osteomy</td>
<td>49 (26 to 82)</td>
<td>19 (2 to 59)</td>
<td>20 (6 to 64)</td>
</tr>
</tbody>
</table>

**Table IV.** Results in all 218 hips which were fully reviewed, including reoperated cases (see text)

<table>
<thead>
<tr>
<th>Result</th>
<th>Number</th>
<th>Per cent</th>
</tr>
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<tbody>
<tr>
<td>Excellent</td>
<td>22</td>
<td>10.1</td>
</tr>
<tr>
<td>Good</td>
<td>90</td>
<td>41.3</td>
</tr>
<tr>
<td>Fair</td>
<td>65</td>
<td>29.8</td>
</tr>
<tr>
<td>Poor</td>
<td>41</td>
<td>18.8</td>
</tr>
</tbody>
</table>
Mean and range of hip value scores for dysplasia before and soon after operation, subdivided according to the long-term result. Those with good radiographic results had a full correction at operation.

Figure 6a – Left hip of an 11-year-old girl with painless progressive subluxation. Figure 6b – After a Chiari osteotomy, complete coverage of the subluxated femoral head was achieved. Figure 6c – At the age of 17 years there was satisfactory congruency between the deformed femoral head and the new acetabular roof.

Figure 6d – At the age of 31, 20 years after the osteotomy, the radiographic findings are nearly unchanged. Figure 6e – At 45 years of age, 34 years after osteotomy, the patient is free of pain except for moderate sensitivity to changes in the weather. Her walking distance is unlimited although there is moderate narrowing of the joint space. Figure 6f – A false profile view shows complete anterior coverage of the femoral head.
congruency of a deformed femoral head (Chiari et al 1978), but this is difficult to assess radiographically and statistically.

Most reviews of the Chiari osteotomy report an increase in osteoarthritic changes with increasing length of follow-up; only Zlatic et al (1988) with a mean follow-up of nine years observed an improvement in degenerative changes. After follow-up of 20 to 34 years we found a significant increase in degenerative changes, but had no comparative control group. However, Engelhardt (1988) reported a longitudinal study on the risk of osteoarthritis after the conservative management of CDH, using the same radiological criteria as our own study. He found that 84.5% of patients with severe dysplasia (hip value grade IV) had severe or extremely severe osteoarthritis after conservative treatment for an average of 47 years (25 to 68). These cases would have done better after osteotomy, since we observed these grades of osteoarthritis in what were all severely dysplastic hips in only 31% of age group I, 39.6% of group II and 76% of the oldest age group, III. Although the length of observation is very different, the trend appears to be for a lower rate of osteoarthritis after a Chiari osteotomy performed before the end of growth. In addition, our follow-up was at a mean age at which considerable secondary osteoarthritic changes are usually seen in patients with CDH (Engelhardt 1988). The better results as regards osteoarthritis in the younger age groups are most probably due to the better congruency in younger patients (Fig. 6).

Conclusions

1) If a Chiari osteotomy is indicated for CDH, it should be performed at an early age, when the patient first complains of pain.
2) A range of hip flexion of less than 90° is a contra-indication.
3) Intertrochanteric osteotomy is indicated only if an improvement of femoral head congruency can be expected.
4) The fragments should be displaced enough to provide complete femoral head cover, which is the most important factor for a good long-term result.

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REFERENCES


