CHIARI OSTEOTOMY FOR ACETABULAR DYSPLASIA
IN YOUNG SUBJECTS

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In 1955 Chiari described a pelvic displacement osteotomy for the improvement of cover of the femoral head in cases of acetabular dysplasia associated with congenital dislocation of the hip. This procedure produces a bony platform above the femoral head, with capsular interposition, by displacing medially the distal pelvic fragment after osteotomy of the pelvic isthmus (Fig. 1). The operation is now in current use at many centres in the world as part of the management of all stages of hip dysplasia (Kawamura 1959; Bertrand, Bénard and Chassagne 1965; Chapchal 1965; Nicod 1965; Klisic 1967; Salvati and Wilson 1971). Its adoption in this country has been limited. Since Chiari's original description in 1955, the work of Salter (1961, 1966) and his operation for acetabular reorientation in congenital hip dysplasia, together with improved techniques of acetabuloplasty along the lines indicated by Pemberton (1965), have probably superseded the Chiari procedure in the field of acetabular reconstruction in the young. There remains, however, a group of patients in their second or subsequent decades who develop symptoms related to early subluxation of the femoral head upwards and outwards (Severin 1950) (Fig. 2). It is in this group, where the degree of acetabular dysplasia contra-indicates a varus osteotomy and a bone-block type of buttress operation is the only alternative, that Chiari osteotomy seems to offer advantages.

MATERIAL

This paper presents a review of eighteen such patients upon whom nineteen Chiari osteotomies had been performed for the indications outlined, with follow-up for a minimum
period of two years. There were sixteen females (one case bilateral) and two males. Their ages ranged from eleven to twenty-seven years, and the operations had been performed between two and six years prior to review.

Clinical assessment—A clinical assessment was made of each patient using a point-scoring system which compared the gait, range of movement, Trendelenburg sign and level of pain before and after operation (Table I). With regard to movement, reduction in any one direction was sufficient to downgrade the score. The individual scores for each of the four parameters were then added, and the totals rated as excellent, good, fair or poor (Table II).

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<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
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</thead>
<tbody>
<tr>
<td>Gait</td>
<td>Normal</td>
<td>Improved</td>
<td>Unchanged</td>
<td>Worse</td>
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<tr>
<td>Range</td>
<td>90 per cent of previous range</td>
<td>75 to 90 per cent</td>
<td>50 to 75 per cent</td>
<td>Less than 50 per cent</td>
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<tr>
<td>Trendelenburg</td>
<td>Positive changed to negative</td>
<td>Unchanged negative</td>
<td>Unchanged positive</td>
<td>Negative changed to positive</td>
</tr>
<tr>
<td>Pain</td>
<td>None</td>
<td>Less</td>
<td>Unchanged</td>
<td>Worse</td>
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Radiological assessment—The following measurements were made on the post-operative radiographs (Fig. 3): 1) the osteotomy angle, which is the angle of the plane of the pelvic osteotomy above or below the horizontal; 2) the displacement or shift, expressed as a percentage of the thickness of the ilium at the level of osteotomy; 3) the roof angle. This is the angle,
TABLE II
THE RATING BY SCORES

<table>
<thead>
<tr>
<th>Score</th>
<th>Rating</th>
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<tr>
<td>16</td>
<td>Excellent</td>
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<tr>
<td>15</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Good</td>
</tr>
<tr>
<td>13</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Fair</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>8 or less</td>
<td>Poor</td>
</tr>
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FIG. 3
Diagram of a Chiari osteotomy showing the osteotomy angle and the roof angle.

FIG. 4
Early and late post-operative radiographs of a Chiari osteotomy to show filling in with bone in the step region. This must occur by ossification of the interposed capsular tissue.
FIG. 5
Diagram to show how two pelvic osteotomies can give vastly different degrees of improvement in femoral head cover, but the same CE angle.

FIG. 6
Diagram to show how the relationship of the new outer acetabular lip to the original lip is a function of the osteotomy angle, the osteotomy level and the degree of displacement.

FIG. 7
Diagram to show the postulated limits of CE angle and roof angle which will locate the new outer acetabular lip (within the shaded area) so as to give satisfactory cover of the femoral head.
above or below the horizontal, of a line joining the original outer acetabular lip to the new outer lip. Comparison of early and late post-operative radiographs shows that the osteotomy remolds by filling in of the “step” region (Fig. 4), and so the roof angle represents the slope of the increased acetabular overhang; and 4) the CE angle (Wiberg 1939). This alone cannot be used to express the quality of increased cover, because pelvic osteotomies at different levels and angles can give the same CE angle but widely varying degrees of acetabular improvement (Fig. 5).

The relationship of the new outer lip to the original acetabular lip is determined by the osteotomy level, the osteotomy angle and the degree of displacement (Fig. 6). This relationship determines the configuration of the improved acetabular roof and may be expressed as a combination of the CE angle and the roof angle. These observations led to the postulate that ideally the new outer lip should be so related to the original acetabular lip as to produce a CE angle between 20 and 40 degrees, together with a roof angle between 10 degrees below and 20 degrees above the horizontal (Fig. 7). Diagrammatically this would locate the new outer lip within the shaded area of Figure 7.

RESULTS

The overall clinical results are recorded in Table III. The postulate was tested by plotting the percentage shift of the osteotomy against the total clinical score (Fig. 8). Those cases which fulfilled the postulated radiographic criteria are recorded as round plots; the square plots represent those which failed to do so. With the exception of the plot marked X in a case complicated by avascular necrosis of the femoral head (Salvati and Wilson 1971), and the plot Y, where the acetabulum was damaged at operation, it can be seen that all those cases within the postulated limits had good or excellent results, whereas those outside had fair or poor results.

<table>
<thead>
<tr>
<th>Acceptable</th>
<th>Unacceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>2</td>
</tr>
<tr>
<td>Good</td>
<td>11</td>
</tr>
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</table>

This graph (Fig. 8) also demonstrates that those cases with more than 55 per cent displacement all had unacceptable results, whereas those with less than 55 per cent had good or excellent results. The only case of total displacement resulted in a painful stiff hip, presumably due to pressure necrosis of the interposed capsular tissue and consequent direct articulation of the femoral head with the bare surface of the proximal pelvic fragment (Fig. 9). The results therefore suggest that the postulate is valid, and that to produce a good clinical result the new outer lip must be so located as to give a CE angle between 20 and 40 degrees, together with a roof angle between 10 degrees below and 20 degrees above the horizontal (Fig. 7). At the same time more than 55 per cent displacement is to be avoided.

This result can be achieved by an osteotomy starting immediately above the capsular attachment and angled 10 degrees upwards and inwards, followed by medial displacement of the distal fragment by 50 per cent of the thickness of the ilium (Fig. 10).

OPERATIVE TECHNIQUE

Chiari (1955) described an operative approach to the ilium by splitting the fibres of gluteus medius vertically, retracting the gluteus minimus backwards and dividing the ilium...
Fig. 8
Graph plotting the degree of displacement of the osteotomy against the final clinical result expressed as an aggregate score.

Fig. 9
Radiograph showing total displacement of a Chiari pelvic osteotomy. This hip joint became painful and stiff.
under radiographic control with an image intensifier. In the cases presented in this study, the osteotomy was performed under direct vision on an orthopaedic table.

The outer surface of the ilium is exposed through a Smith-Petersen (1949) antero-lateral approach, the subperiosteal dissection being carried back to the greater sciatic notch. The anterior two-thirds of the iliac crest are then detached, bearing the attachments of the oblique and transverse muscles of the abdominal wall. This is followed by a subperiosteal exposure of the inner surface of the ilium as far back as the greater sciatic notch, where it communicates with the extra-pelvic operative field.
The level for the osteotomy is immediately above the attachment of the joint capsule to the ilium, between capsule and reflected head of rectus femoris. Frequently in these cases of adolescent dysplasia the capsular attachment and the reflected head are not separately identifiable, and it is therefore considered essential to site the osteotomy level accurately by making a small opening into the hip joint antero-superiorly. This admits a probe which can be used to palpate the outer acetabular lip and the capsular attachment. Capsular adhesion to the ilium (Waigand 1965) can suggest too high a level (Fig. 11), which is obviously undesirable; too low a level will seriously reduce the thickness of the interposed capsule or even remove it.

A guide wire is inserted at the proposed level and angle, and a check radiograph is taken. The osteotomy is then cut, angled 10 degrees upwards and inwards. Several osteotomes are used side by side and advanced together. In the interests of avoiding both sciatic nerve damage and splintering of the rim of the greater sciatic notch, the last posterior centimetre is cut with either a Gigli saw or an oscillating saw. Posterior slip of the distal fragment (Fig. 12), which can give an ugly prominence of the anterior superior iliac spine and a flexion deformity of the hip, may be avoided by slightly curving the osteotomy (Fig. 13).

If any instability is noted after displacement by abducting the leg and applying gentle inward pressure on the distal fragment, a Steinmann’s pin or a lag screw can be used to transfix the fragments obliquely (Wagner 1965) (Fig. 14). The position of the screw must be checked radiographically to avoid penetration of the hip joint.

A “one and a half” plaster spica is applied and retained for four to six weeks post-operatively according to age.

DISCUSSION

At the time of Chiari’s original description of his technique, the only procedures available for reconstruction of the dysplastic acetabular roof were the classical types of acetabuloplasty by levering down a flap of acetabular roof (Ghomrley 1931), or the bone block type of shelf operation which Colonna (1932) termed the “osteoplastic buttress”. Each of these techniques had its shortcomings. In the case of acetabuloplasty, kinking of the acetabular roof at the base of the depressed osteochondral flap could cause joint incongruity (Fig. 15). Furthermore,
in the presence of coxa magna or coxa plana, the reduction in acetabular volume caused by depression of the flap was unacceptable. The osteoplastic buttress procedures were notorious for the problems of siting and fixing the bone block, together with uncertainty of incorporation from either absorption or non-union (Fig. 16).

![Figure 15](image1)

**FIG. 15**
Figure 15—A radiograph taken six months after an acetabuloplasty, showing kinking of the acetabular roof.

![Figure 16](image2)

**FIG. 16**
Figure 16—A radiograph of an ununited osteoplastic buttress.

![Diagram A](image3)
![Diagram B](image4)
![Diagram C](image5)

**FIG. 17**
Diagrams A and B show how the ratio of the medial arm to the lateral arm of the abductor lever system is reduced by Chiari osteotomy, thereby decreasing the joint load. Diagram C shows that this effect is further enhanced by the correction of any coxa valga by varus osteotomy. (After Burch, H. B. (1965), by kind permission of Georg Thieme, Stuttgart.)

The Chiari procedure was designed to overcome these disadvantages by avoiding direct interference with the acetabular roof, and by rapid and certain union of the pelvic fragments. By displacing the fulcrum of the hip joint medially and so shortening the medial arm of the hip abductor lever system (Fig. 17A, 17B), the hip mechanics are improved and the load on the femoral head is reduced (Strange 1965). Further advantage is gained because the operation results in a more vertical line of action of the abductors, which effectively lengthens the lateral arm of the same lever system (Chiari 1965) (Fig. 18). Prelusive correction of any coxa valga by high femoral varus osteotomy enhances this latter effect (Burch 1965, Kondo 1969) (Fig. 17C).
The results presented demonstrate that over-displacement of the pelvic osteotomy is undesirable, and that total displacement is a disaster. At the level of the osteotomy the ilium is approximately triangular in horizontal section (Abbot 1944) and it can be seen from Figure 19 that progressive shift of one triangular surface upon another results in very marked reduction of the contact area. Over-displacement therefore results in instability and high loading at the contact area, with the danger of slip and total displacement.

The approach described here affords a full view of the osteotomy procedure on both surfaces of the ilium, so permitting the necessary accuracy of pelvic division. It protects the...
sciatic nerve and avoids damage to the internal iliac vessels, which Chiari (1955) states to be a danger.

Other approaches, such as the lateral approach of Chiari (1955), the lateral trans-trochanteric approach recommended by Kawamura (1959), the posterior approach (Bertrand et al. 1965) and the inferior approach (Klisić 1967) do not give a wide operative field with its facility of technical precision.

Of the sixteen female patients in this study, four subsequently became pregnant. All were delivered normally including the bilateral case who had on one side internal fixation with an excessively long lag screw, the end of which was just palpable per vaginam (Fig. 20).

![Radiograph showing excessive length of a lag screw used for fixation of a pelvic osteotomy.](image)

**SUMMARY**

1. The results of Chiari pelvic osteotomy have been examined two to six years after operation in a group of eighteen patients with persisting acetabular dysplasia in the second and third decades.
2. The analysis suggests that for a good clinical result it is essential to create a relationship of the new outer acetabular lip to the original lip so that the CE angle is between 20 and 40 degrees and the roof angle is between 10 degrees below and 20 degrees above the horizontal.
3. This may be achieved by a pelvic osteotomy immediately above the joint capsule, angled 10 degrees upwards and inwards and displaced by 50 per cent of the pelvic thickness.
4. Details of the operative technique using a Smith-Petersen approach are presented.

My thanks are due to Sir Herbert Seddon, Mr David Trevor, Mr C. W. Manning and Professor R. G. Burwell for permission to publish details of their cases. I am equally grateful to Mr B. A. Roper whose interest in this procedure led to the present investigation. I also wish to express my thanks to the Departments of Medical Photography and Medical Records of the Royal National Orthopaedic Hospital for assistance with the preparation of illustrations and typescript.

**REFERENCES**


