THE CHIARI PELVIC OSTEOTOMY

A REVIEW OF THE LONG-TERM RESULTS

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We report the clinical and radiographic results of the Chiari pelvic osteotomy in 49 hips (45 patients) at an average of 14 years after operation. Of these hips, over half had minimal or no pain, had good or excellent results as assessed by the Harris hip score, and could walk at least three miles; three-quarters, however, had a positive Trendelenburg sign.

A younger age at operation and a painless hip with no radiographic evidence of degeneration before operation were associated with a higher hip score at review. The percentage of hips without degenerative changes fell from 68% before operation to 15% at final review. There were no major complications and it was found that a Chiari osteotomy need not interfere with normal childbirth.

Chiari developed his medial displacement osteotomy for the dysplastic hip with subluxation in 1950 and reported his first results in 1955. Because subluxation reduces the area of contact between the femoral head and acetabulum, the stresses across the joint increase, leading to premature degenerative change (Pauwels 1951). The Chiari osteotomy provides increased bony cover of the femoral head and alters the forces around the hip by displacing the whole joint medially. The operation is meant to improve the function and longevity of the joint.

Ultimately the success of an operation depends on its clinical results. There have been a number of reports of short-term results in the English literature (Colton 1972; Hoffman, Simmons and Barrington 1974; Salvati and Wilson 1974; de Waal Malefijt, Hoogland and Nielsen 1982; Reynolds 1986) but, because the operation has been used primarily for adolescents and young adults, the longer-term results are also important. The purpose of this paper is to report the outcome of the Chiari pelvic osteotomy at a minimum of 10 years after operation.

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Fig. 1

Age distribution of 45 patients at the time of operation.

PATIENTS AND METHODS

Between 1965 and 1974 72 patients were treated by a Chiari pelvic osteotomy at the Royal National Orthopaedic Hospital. Sixteen patients could not be traced and eight with underlying neurological disease were excluded; two patients who subsequently had total hip replacements and one who had arthrodesis of the hip were also excluded from further analysis except to record them as failures.

This study, therefore, presents the results of Chiari's operation in 49 hips (34 left, 15 right) in 45 patients. There were seven men and 38 women with an average age at operation of 19.8 years (range 3 to 41 years) (Fig. 1). The average age at review was 33.9 years (range 18 to 54 years). The average period of follow-up was 14 years (range 10 to 19 years).

The primary diagnosis was congenital dislocation of the hip in 42 hips and acetabular dysplasia in seven. Twenty-one hips had had no previous surgery; the remaining 28 had had one or more operations (Tables I and II).

Table I. Number of operations before a Chiari osteotomy

Number of operations	Number of hips (%)
0	21 (43)
1	5 (10)
2	10 (21)
3	8 (16)
4	5 (10)
Total	49 (100)

The operative technique has been previously described (Colton 1972) and differs slightly from Chiari's original method. One of the senior authors (HBK) uses a straight rather than a curved osteotomy in order to allow the distal fragment to be displaced posteriorly as well as medially (Kemp 1979), and a Steinmann pin is used for fixation so that the patient may be mobilised on crutches 10 days after operation. The operations were carried out by a number of different surgeons. Postoperatively all patients were treated in a hip spica.

Table II. Types of operation before a Chiari osteotomy

Operation	Number
Open reduction	13
Femoral osteotomy	23
Shelf	12
Soft-tissue surgery	3
Pelvic osteotomy	1
Plate removal	13
Other	4
Total	69

All patients were seen for clinical review by one of two authors (ACA or PTC) and the notes and radiographs were analysed. Pain was assessed on a six-point grading for the Harris and Iowa hip scores (Larson 1963; Harris 1969) and also on a linear analogue scale (Huskisson 1974). A questionnaire which contained all the information required for the Harris and Iowa hip scores was completed. A full clinical examination was made and a standing anteroposterior radiograph of the

pelvis was taken; an obstetric history was taken if appropriate.

The centre-edge (CE) angle (Wiberg 1939) and Sharp's angle (Sharp 1961) were measured, and the percentage of subluxation of the femoral head calculated from radiographs taken before operation, at one year, five years and 10 years after operation, and at final review (Fig. 2). The grades of osteoarthritis as judged from radiographs are shown in Table III. On the postoperative radiograph the angle of the osteotomy, the percentage of displacement and the height of the osteotomy were measured (Fig. 3). All data was entered on a computer for statistical analysis.

Table III. Grades of osteoarthritis

Grade	Radiographic appearance
0	Normal
1	Marginal osteophytes
2	Minimal loss of joint space
3	Obvious joint space narrowing and sclerosis
4	Subchondral bone collapse with or without cysts
5	Same as above and subluxation
6	Joint totally disorganised

RESULTS

Pain. Pre-operatively, 11 hips were painless. Of the 38 hips which were painful before operation, 25 were completely painfree one year after operation; in 20 of these 25 hips, some pain returned at an average of 7.5 years after operation.

At final review 28 of the 49 hips (57%) had little or no pain. Eight hips (16%) had mild pain with no effect on activity. The remaining 13 hips (27%) had more severe pain. It was noted that no patient had more than mild discomfort in any other joints of the lower limbs or in the lumbar spine.

On a 100 mm linear analogue scale (where zero indicated no pain), the average subjective assessment of pain was 28 mm (range 0 to 90 mm).

Functional assessment. Pre-operatively 42 patients had a limp and 26 a positive Trendelenburg sign. At review 14 patients (31%) had a limp which was barely noticeable on walking but more obvious on running, while 25 (56%) had a more severe limp. Only six patients (13%) had a normal gait. Thirty-seven hips (76%) had a positive Trendelenburg sign.

Thirteen patients (29%) had no limitation of their ability to walk any distance; 12 (27%) could walk up to three miles and 10 (22%) up to one mile. Another 10 patients (22%) were severely restricted, and five of these

Fig. 2

The measured radiographic indices: α = Sharp's angle; β = CE angle; A , the horizontal line joining the "tear drops"; B , length divided by the femoral head diameter to give the percentage of subluxation.

Fig. 3

Measurements made on the immediate postoperative radiographs: A , height of osteotomy; θ , angle of osteotomy; C/B , percentage of the displacement of the osteotomy.

were confined to indoor activities. Three patients made regular use of a stick. The majority were able to manage the activities of daily living with ease, although 15 patients (33%) had difficulty with shoes and socks. Fifteen patients (33%) participated in regular sports.

Range of movement. Before operation abduction was the only movement which was restricted as compared with the normal hip ($p=0.004$). At review, however, there was no significant difference in the range of movement between the operated and the unoperated hip. The mean flexion in the operated hips was 112° .

Hip scores. The mean Harris hip score was 76 (range 33 to 96). The mean Iowa hip score was 78 (range 33 to 94) (Table IV).

Childbirth. Of the 38 women, 25 had had children: 16 women had 32 children by vaginal delivery and nine women had 15 children by caesarean section.

Complications and failures. The postoperative complications are shown in Table V. There were no sciatic nerve palsies and no non-unions. At review 25 patients had some numbness in the distribution of the lateral cutaneous nerve of the thigh.

There were three patients excluded from the study whose Chiari operation had been converted to either a total hip arthroplasty or an arthrodesis; this give an overall revision rate of three out of 52 hips (6%).

Radiographic assessment. The details of the radiographic measurements are shown in Table VI. The pre-operative

Table IV. Comparison of grade with Harris and Iowa hip scores (49 hips)

Grade (score)	Harris	Iowa
	Hips (%)	Hips (%)
Excellent (91-100)	11 (22)	9 (18)
Good (81-90)	16 (33)	23 (47)
Fair (71-80)	5 (10)	11 (22)
Poor (<70)	17 (35)	6 (12)

Figure 4 shows the relationship between age at operation and the final Harris hip score; it was found that the younger the age at operation, the better the final hip score.

Other joints. Seven patients (16%) complained of mild back pain and seven had restricted movements of the lumbar spine. Ligamentous laxity of the ipsilateral knee was seen in seven patients (16%).

Fig. 4

Hip score at review in relation to age at operation.

Table V. Complications

Superficial infection	3
Chronic infection	1
Plaster sores	2
Dislocation of hip	1
Stiffness (needing MUA)	1
Screw protruding into pelvis	1
Thigh numbness*	25

* Many were not aware of this until asked MUA, manipulation under anaesthesia

Table VI. Mean values of radiological indices

	Pre-op.	Postop.	1 year	5 years	10 years	Last review
CE angle	-1.6°	25.5°	25.5°	23.4°	19.7°	27.8°
Sharp angle	50.2°	43.6°	42.4°	42.1°	40.1°	40.6°
Subluxation (%)	39.5	4.5	8.0	7.9	10.0	6.0
OA score (mean)	0.7	-	1.1	1.3	1.7	2.7
Congruent joints (% of total)	38.3	-	38.6	46.2	63.0	50.0

CE angle was abnormal in all cases. The mean postoperative figure was 25.5° but was not corrected to normal (>25°) in all cases (range -10° to 49°); the initial correction, however, was maintained throughout the period of follow-up.

The Chiari osteotomy improved the Sharp angle (normally 28° to 42°), the immediate postoperative mean being 43.6° (range from 33° to 52°). Subluxation was improved from a mean of 39.5% before operation to 4.5% after operation.

Fig. 5

Percentage of hips without osteoarthritis in relation to the length of follow-up.

The percentage of hips with a grade zero score for osteoarthritis fell from 68% before operation to 15% at final review (Fig. 5), and the mean score for osteoarthritis rose progressively throughout the period of follow-up (Table VI).

The mean osteotomy angle (see Fig. 2) was 87° but the range was wide, varying from 62° to 102°, that is, from 28° below the horizontal to 12° above. The percentage shift also was variable, with a mean of 43% (range 13% to 99%). The osteotomy height (see Fig. 3) varied from 0 mm to 23 mm (mean 9 mm).

Correlations. There were three significant positive correlations:

1. A younger age at operation was associated with a higher final hip score: this applied to both the Harris and Iowa scores ($p=0.002$).
2. A hip that was painless at the time of operation had a significantly higher Harris hip score at review ($p=0.02$); for the Iowa score this trend did not quite reach statistical significance ($p=0.08$).
3. The absence of degenerative changes on the pre-operative radiograph was associated with a higher Harris score ($p=0.003$).

There was no correlation between the final hip score and the pre-operative CE angle; nor was there any correlation between this score and the percentage of subluxation, the osteotomy shift, osteotomy angle or osteotomy height.

DISCUSSION

The natural history of the dysplastic acetabulum with a subluxed femoral head is to develop premature osteoarthritis (Wiberg 1939). Pauwels (1951, 1980) has demonstrated that lateral displacement of the femoral head produces an increased load on the joint. By displacing the hip joint medially, the Chiari osteotomy provides additional superior bony cover for the femoral head and reduces the forces across the joint; by contrast, the shelf operation provides only the superior bony cover. Ultimately the choice between the two procedures must depend on the long-term clinical results, and our findings compare well with those of the shelf operation (Love, Stevens and Williams 1980; White and Sherman 1980). Approximately half of our patients were free of pain with good function and had a Harris hip score greater than 80.

This operation certainly does not prevent the onset of osteoarthritis in these dysplastic hips, but the question remains as to whether the inevitable degenerative changes are delayed. Conclusions cannot be drawn without a comparable series of untreated hips studied over the same period of time. The inference from Wiberg (1939) is that the dysplastic subluxed hip deteriorates rapidly, and it is reasonable to suggest that the results in this series show a slower progress towards osteoarthritis.

The reported incidence of a positive Trendelenburg sign after Chiari osteotomy varies. A number of reports (Hoffman et al. 1974; Chiari and Schwagerl 1976; Macnicol, Uprichard and Mitchell 1981) note a fall in the incidence of a positive Trendelenburg sign. Salvati and Wilson (1974) and Reynolds (1986) say that the operation does not cause a limp whereas Mitchell (1974) holds the opposite view. Schulze and Krämer (1975) report a positive Trendelenburg sign in 83% of their patients after Chiari's osteotomy. In our series 76% were positive, and half the patients had a lurching gait which was of concern to them.

Some of the radiological indices measured in the immediate postoperative period and at one year were maintained for the duration of the follow-up. In many cases with pre-operative joint-space narrowing, there was considerable improvement in the postoperative months.

It has been said that correct technique is essential for a good clinical result (Mitchell 1974). In this series there was no correlation between the parameters measured on the radiographs, which would indicate correct positioning and angulation of the osteotomy, and the final result. We do not wish to suggest that technique is of no importance, but there may be a greater capacity for remodelling than has been previously appreciated and this may compensate for some technical inadequacies.

One of the previously quoted objections to the Chiari operation has been the potential for obstetric complications, particularly in those patients who have had bilateral surgery (Hoffman et al. 1974). Of the 25 women in our series who had delivered children, only nine had had caesarean sections, and the majority of these were elective because it was thought that complications might arise. Perhaps the obstetric complications of the procedure have been overstated.

In this series there was a low incidence of complications with no major nerve injuries such as those reported elsewhere (Chiari 1974; Benson and Evans 1976). Half our patients, however, had numbness in the distribution of the lateral cutaneous nerve of the thigh; this did not seem to worry them and many had not been aware of it until asked directly and tested by us.

The results tended to be worse in those patients who had radiographic evidence of osteoarthritis before operation. This raises the question as to whether the operation is suitable for those patients with existing osteoarthritic changes. An advantage of the operation, irrespective of the longer-term clinical result, is that a better acetabulum is created should joint replacement become necessary.

In conclusion, the Chiari operation does appear to have stood the test of time as an option for the subluxed

hip with a dysplastic acetabulum in a patient who is too old for acetabular redirection. Our evidence suggests that the best results are obtained in the younger patient before degenerative changes are apparent.

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