

Dynamics of hip joint remodeling after Chiari osteotomy

10 patients with neuromuscular disease followed for 8 years

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We analyzed the development of 10 hips in 10 consecutive patients with neuromuscular disease (9 with spasticity, 1 with Charcot-Marie-Tooth disease) who had undergone Chiari osteotomy for painful hip subluxation or dislocation. The patients were 11 (5–19) years old at surgery and follow-up time was 8 (6–11) years.

The Chiari osteotomy particularly improved and maintained femoral head coverage. These parameters did not show the postoperative deterioration noted in some other studies. The osteotomy did not

improve femoral head lateral displacement. Throughout the postoperative period, the configuration of the proximal femur and the height of the joint cartilage were unchanged and undisturbed, indicating that osteotomy did not place excessive or uneven pressure on the femoral head.

The ambulatory status of the patients was dependent on the severity of the underlying disease, and was not improved by osteotomy. However, pain associated with subluxation or dislocation was reduced in 9 of the patients.

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Submitted 96-09-01. Accepted 96-12-02

Chiari osteotomy has been used to treat hip subluxation and dislocation resulting from *neuromuscular disorders* (Otte 1969, Chiari 1974, Purath 1979, Bohler 1983, Root 1987, Thompson et al. 1987, Osterkamp et al. 1988, Gamble et al. 1990, Pope et al. 1994, Dietz and Knutson 1995, Niethard et al. 1995a, Root et al. 1995), *DDH* (Chiari 1974, Salvati and Wilson 1974, De Waal Malefijt et al. 1982, Moll 1982, Bohler 1983, Fernandez et al. 1984, Bohler et al. 1985, Hogh and MacNicol 1987, Matsuno et al. 1992, Rigo et al. 1994, Niethard et al. 1995a), *Legg-Perthes' disease* (Chiari 1974, Lack et al. 1987, Thompson et al. 1987, Robinson et al. 1988, Mike and Bellyei 1989) and *posttraumatic dysplasia* (Trousdale and Ganz 1994). Osteotomy potentially improves femoral head coverage. However, a disturbance of lateral acetabular development after the Chiari osteotomy has been reported, with decreasing coverage during the postoperative years (Otte 1969, Purath 1979, Niethard 1995, Niethard et al. 1995a,b).

We analyzed the long-term results of Chiari osteotomy in 10 consecutive patients (9 with spasticity, 1 with Charcot-Marie-Tooth disease), in whom particular emphasis was placed on the site of entry and on the cephalad inclination of the osteotomy.

Patients and methods

10 consecutive patients with neuromuscular disease (9 with spasticity, 1 with Charcot-Marie-Tooth disease) treated with Chiari osteotomy were analyzed (Table 1). At the time of surgery, they were 11 (5–19) years old and the follow-up time was 8 (6–11) years.

Before surgery, 8 patients had progressive painful hip subluxation, 1 had a recurrent painful dislocation after an attempted closed reduction 5 years previously (complicated by aseptic necrosis), and 1 had a recent painful dislocation. 5 patients had increasing difficulty with ambulation, 4 were losing sitting balance, and 1 was bedridden.

The osteotomy was performed according to Chiari (1974), with emphasis on placing the entry point of the osteotomy at the exact proximal edge of the acetabular cartilage and with 10°–15° cephalad angulation. Postoperatively, the patients were immobilized in a hip spica cast for 6 weeks, and the threaded Steinmann pins were removed at 8 weeks. Ambulation with a walker or crutches began after 3 months surgery.

Radiographic examinations preoperatively, postoperatively, and at latest follow-up were compared. The femoral head coverage was measured according to Heyman and Herndon (1950), and the CE-angle of Wiberg (1939) (Figure 1). The degree of subluxation

Table 1. 10 consecutive patients with neuromuscular disease treated with Chiari osteotomy

Case	Diagnosis	Hip status	Pain status	Ambulatory status ^a	Age at osteotomy	Years of follow-up	Age at last follow-up
1	Spastic quadripareisis	Progressive subluxation	Progressive	A	13	11	25
2	Spastic quadripareisis	Progressive subluxation	Progressive	A	11	6.6	18
3	Spastic quadriplegia	Progressive subluxation	Progressive	B	10	6.8	16
4	Prematurity, mild paresis	Recurrent dislocation ^b	Progressive	A	7.2	11	18
5	Severe spastic quadriplegia	Recent dislocation	Painful dislocation	C	5.8	6.3	12
6	Spastic quadriplegia	Progressive subluxation	Progressive	B	13	10	23
7	Charcot-Marie-Tooth disease	Progressive subluxation	Progressive	A	13	9.8	23
8	Spastic quadriplegia	Progressive subluxation	Progressive	B	11	6.0	16
9	Spastic quadriplegia	Progressive subluxation	Progressive	B	15	11	25
10	Athetoid and spastic quadripl.	Progressive subluxation	Progressive	A	19	11	30
Average					11	8	20

^a A increasing difficulty with ambulation, B decreased sitting balance, and C bed ridden.

^b Previously had closed reduction of right hip with subsequent aseptic necrosis and persistent dysplasia

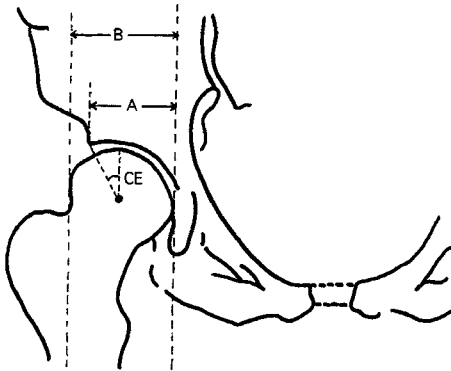


Figure 1. Measures of femoral head coverage. Percent coverage = $A/B \times 100$ (Heyman and Herndon 1950). CE angle of Wiberg (Wiberg 1939).

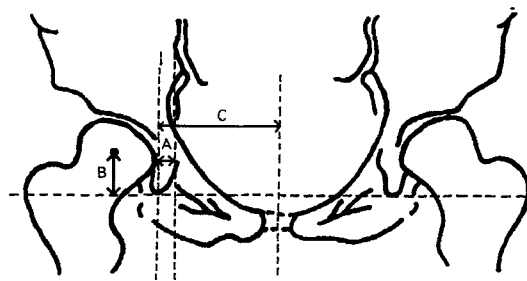


Figure 2. Measures of subluxation: lateral and cephalad displacement of the femoral head (A, B, C distances). (From Matsuno et al. 1992. Used with permission of J Bone Joint Surg).

was measured according to Matsuno et al. (1992) (Figure 2), and the ability of the subluxated hip to reduce with abduction and internal rotation was noted. The acetabular development was measured with the Sharp angle (Sharp 1961), with the distance between the teardrop and Perkins' line (acetabular depth) and with the amount of lateral acetabular margin over-

hang (Figure 3). Development of the proximal femur was analyzed by measurement of the neck-shaft angle, the articulothrochanteric distance, the femoral head and neck height and width, the joint space, and the sphericity using Moses' template. Finally, the pelvic inlet diameter was recorded.

In the clinical evaluation, the hip ROM, ambulatory level and ambulatory aids were recorded and the Harris hip rating system was used (Harris 1969).

Results

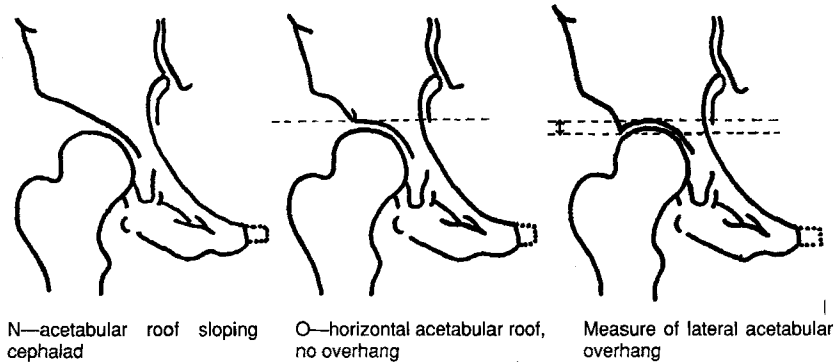
2 patients each had a femoral fracture 3 and 6 months postoperatively. 1 was treated in traction, the other with a pillow splint. There were no other complications. At latest follow-up, the ambulatory status was the same as preoperatively. 6 patients were pain-free at follow-up, 4 had occasional pain with walking or sitting.

The femoral head coverage was increased by the osteotomy ($p = 0.001$) (Table 2). The coverage did not change significantly during the postoperative period, and did not differ from that of the unoperated hip. The CE-angle of Wiberg was also increased ($p = 0.0001$) and remained stable.

The degree of subluxation (Matsuno measurements, Figure 2) was not significantly affected by the osteotomy. 7 of the hips could not be reduced preoperatively, but could be reduced at latest follow-up.

The Sharp angle was improved ($p = 0.01$). The distance from the teardrop to Perkins' line (acetabular depth) increased postoperatively ($p = 0.0001$) and continued to improve during the follow-up period (but this was not statistically significant). The acetabular overhang was increased ($p = 0.01$) and remained increased during the follow-up period.

Figure 3. Lateral acetabular overhang.



The configuration of the proximal femur was not influenced by the osteotomy, and in none of the hips was there a loss of joint space. The pelvic inlet diameter was decreased by an average of 1.3 cm after the osteotomy, but during the follow-up period the average diameter increased by 2.6 (0.5–5) cm.

Discussion

The spastic dislocated hip is a difficult problem because of the high incidence of intractable pain. Early treatment with soft tissue procedures (Reimers 1980, Wheeler and Weinstein 1984, Root 1987, Moreau et al. 1990, Nelson et al. 1990, Murri 1995, Werner and Haynes 1995) and proximal femoral osteotomies (Eilert and MacEwen 1977, Hoffer et al. 1985, Root 1987, Kling et al. 1992, Baggt et al. 1993) is preferred for developing subluxation in these hips, but painful

subluxation and progressive dysplasia may require pelvic osteotomy.

Niethard et al. (Niethard 1995, Niethard et al. 1995a,b) cited Otte's (1969) and Purath's (1979) observations of disturbed lateral acetabular margin development following Chiari osteotomy. These authors noted that the younger the patients were at the time of surgery, the greater the severity of this disturbance. We saw no such disturbances. Our findings concur with those of Bohler et al. (1985) that lateral acetabular bone growth and blood supply are not disturbed by Chiari osteotomy and that the operative technique is decisive in obtaining a good result. If the Chiari osteotomy is initiated in exactly the most cephalad area of the acetabular margin, and inclined 10–15° cephalad, the acetabular growth plate, including the lateral margin ossification centers, will be left intact, allowing undisturbed interstitial and appositional growth of the lateral acetabular growth plate and secondary os-

Table 2. Head coverage in 10 consecutive patients treated with Chiari osteotomy

Case	Femoral head coverage (%)			Wiberg center-edge angle			Sharp angle			Medial teardrop to Perkins' line (mm)			LAMO ^a (mm)		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
1	65	127	106	16°	58°	53°	45°	27°	38°	49	77	68	N	5	4
2	57	130	100	0°	48°	50°	58°	40°	33°	37	61	66	N	N	5
3	68	132	106	8°	65°	65°	51°	31°	25°	46	63	72	O	5	22
4	-15	156	147	-53°	40°	42°	55°	49°	47°	33	38	54	N	2	4
5	-12	66	91	-110°	7°	49°	51°	52°	34°	34	47	60	N	N	3
6	65	100	70	10°	43°	25°	58°	49°	50°	41	55	54	N	4	N
7	45	89	109	-7°	45°	50°	50°	40°	38°	52	71	82	N	4	6
8	53	134	95	-1°	53°	48°	46°	34°	30°	43	58	65	N	4	4
9	51	90	80	-7°	43°	30°	43°	33°	38°	50	77	79	N	3	3
10	64	98	100	10°	41°	59°	55°	44°	43°	52	67	77	O	3	7
Average	31	112	100	-13°	44°	47°	51°	40°	38°	44	61	68			

^a Lateral acetabular margin overhang (mm): O = flat lateral acetabular margin, N = lateral acetabular margin sloping cephalad. A Immediately preoperative, B Immediately postoperative, C At last follow-up

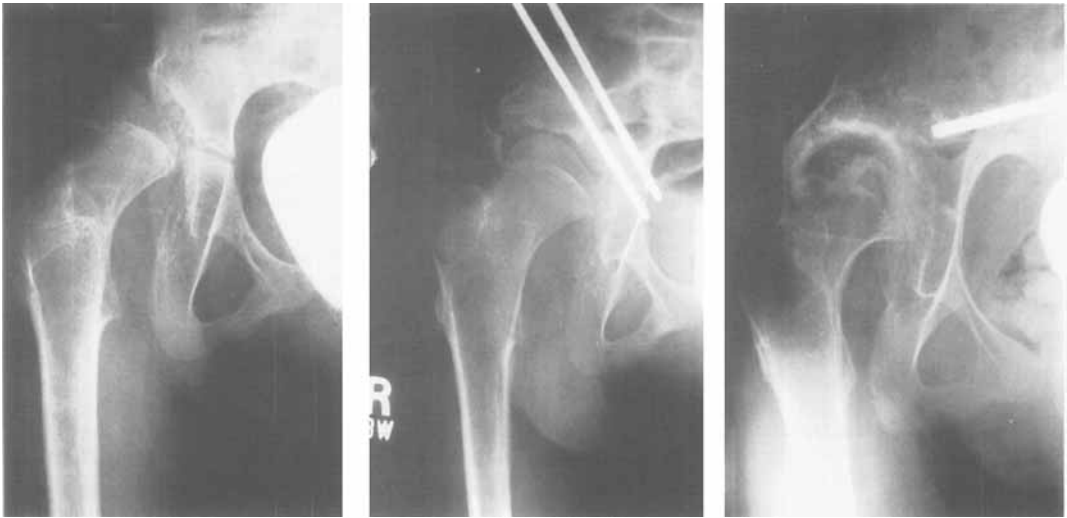


Figure 4. A. 10-year old patient immediately before surgery. B. Immediately after surgery with improved femoral head coverage. C. 4 years after surgery, lateral acetabular overhang has increased by a further 17 mm.

sification centers. The fact that we also saw good acetabular development in patients operated after 8 years of age may reflect the delay in maturation of secondary lateral acetabular ossification centers, consistent with the generalized delay in growth plate maturation, typical of spastic patients (Figure 4).

The proximal femur was unchanged and undisturbed. This indicates that Chiari osteotomy did not place excessive or uneven pressure on the femoral head. Pelvic inlet diameter is initially decreased, then increases over time with patient growth. Femoral head lateral and proximal displacement relative to the teardrop (subluxation measurements by Matsuno, Figure 2) are unchanged by the osteotomy, indicating that the Chiari operation is a salvage procedure and cannot create a normal hip. Ambulation was not improved by surgery, but depended instead on the severity of the underlying neuromuscular disease.

In conclusion, we found that Chiari osteotomy arrested the deteriorating course of progressive hip subluxation in these neuromuscular patients, and postoperatively the improvements obtained at surgery were maintained. The severity of pain was decreased in nine of ten patients.

Acknowledgements

We thank Triana Nagel and Charlotte Preuschoff, who typed the manuscript. George Starks helped prepare the data for computer analysis.

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