Acetabular development after open reduction for developmental dislocation of the hip

15-year follow-up of 22 hips without additional surgery

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We reviewed serial radiographs of 22 hips in 20 patients with developmental dislocation of the hip (DDH), who were treated by open reduction and followed without additional surgery until puberty, to identify predictive measures of subsequent acetabular development. The average age at surgery and at final follow-up was 14 (5–26) months and 15 (13–20) years, respectively. Hips with a CE angle above 20° and femoral head coverage above 75% at the final follow-up were classified as "satisfactory outcome". At the final follow-up, 14 hips were classified as satisfactory and 8 hips as unsatisfactory. In the former group, acetabular improvement continued throughout growth, whereas in the unsatisfactory group, the acetabulum did not improve after 3–5 years of age. Unsatisfactory condition at the final follow-up was noted in all hips that had a CE angle less than 0° and head coverage less than 50%, when the patients were 3–5 years old and less than 5° and 60%, respectively, at the age of 6–8 years. These findings should be useful in assessing the need for and the timing of acetabuloplasty after open reduction for DDH.

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It is important to predict acetabular development after reduction for developmental dislocation of the hip (DDH) to clarify the need for and the timing of acetabuloplasty to prevent later arthrosis and to avoid unnecessary additional surgery. There are only a few reports about the prediction of acetabular development after open reduction (Race and Herring 1983, Brougham et al. 1988, Cherny and Wilbur 1989, Chen et al. 1994). In this study, we attempted to identify radiographic parameters predictive of acetabular development in patients with DDH, who were treated with open reduction and followed without additional surgery until puberty.

Patients and methods

We reviewed the radiographs of 22 hips in 20 children (17 girls) with DDH, treated by open reduction and followed until puberty without secondary surgery. The average age at surgery and at the final follow-up was 15 (5–26) months and 15 (13–20) years, respectively. The indication for open reduction was unsuccessful closed treatment, including Pavlik harness, overhead traction and manual reduction. The operation was performed through the anterior approach. The joint capsule was exposed using Smith-Peterson's approach (Akagi et al. 1994). The psoas tendon was detached from the lesser trochanter and transferred to the anterolateral surface of the capsule after reduction of the femoral head. The hypertrophied ligamentum teres and fibrofatty tissues were removed completely and the transverse acetabular ligament was excised. The inner part of the hypertrophied limbus preventing reduction, was excised, but preserved to the extent possible. The hip spica was applied after operation in slight flexion, abduction and internal rotation for 4 weeks.

As parameters of acetabular development, we used the center-edge angle (CE angle, Wiberg 1953) and the acetabular head index (AHI) (Heyman and Herndon 1950), which express the femoral head coverage. In patients with immature ossification, the midpoint of the proximal physis was designated as the center of the femoral head (Suzuki and Yamamuro 1990). In patients with a well-ossified epiphysis, the Mose template was used. The radiographic assessment was based on Severin's (1941) classification. The final outcome was classified as satisfactory for hips with CE angle above 20° and AHI above 75% at final follow-up, whereas an unsatisfactory result was a CE angle less than 20° and/or AHI less than 75%. We also

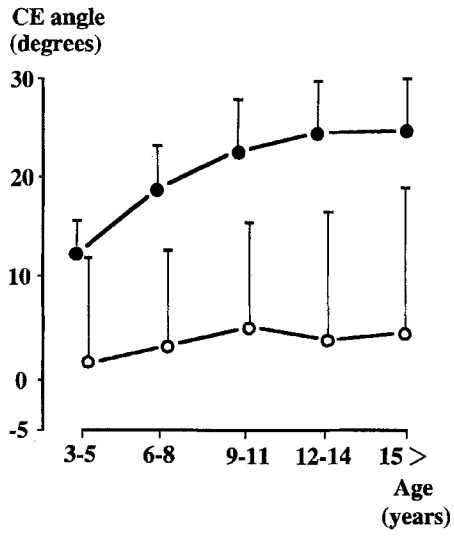


Figure 1. Serial change in average CE angle in hips with satisfactory (●) or unsatisfactory (○) outcome.

investigated the effects of avascular necrosis and of age at operation on the final outcome. The severity of avascular necrosis (AVN) was classified into 4 grades according to Kalamchi and MacEwen (1980). Data analyses were conducted, using the Mann-Whitney test, with a p-value < 0.05 as significant.

Results

At the final follow-up, the outcome was satisfactory in 14 hips and unsatisfactory in 8 hips. Comparison of the serial changes in CE angle revealed that the average CE angle continued to improve throughout the growth period in the satisfactory group, whereas in the unsatisfactory group it did not improve after 3–5 years of age (Figure 1). At the final follow-up, unsatisfactory radiographic results were found in all hips with a CE angle less than 0° at 3–5 years of age and less than 5° at 6–8 years of age (Table).

The change in AHI showed a pattern similar to that in the CE angle. The average AHI in the hips with satisfactory outcome at the final follow-up continued to improve throughout the growth period, whereas in those with an unsatisfactory outcome it stopped changing after 9–11 years of age. All hips with an AHI of less than 50% at 3–5 years of age and less than 60% at 6–8 years of age were unsatisfactory at the final follow-up (Table).

7 hips showed avascular necrosis, classified as Kalamchi groups 1, 2, and 3 in 1, 3 and 3 hips, respectively. 3 of the 7 hips with necrosis and 5 of the 15 hips without necrosis showed an unsatisfactory outcome at the final follow-up.

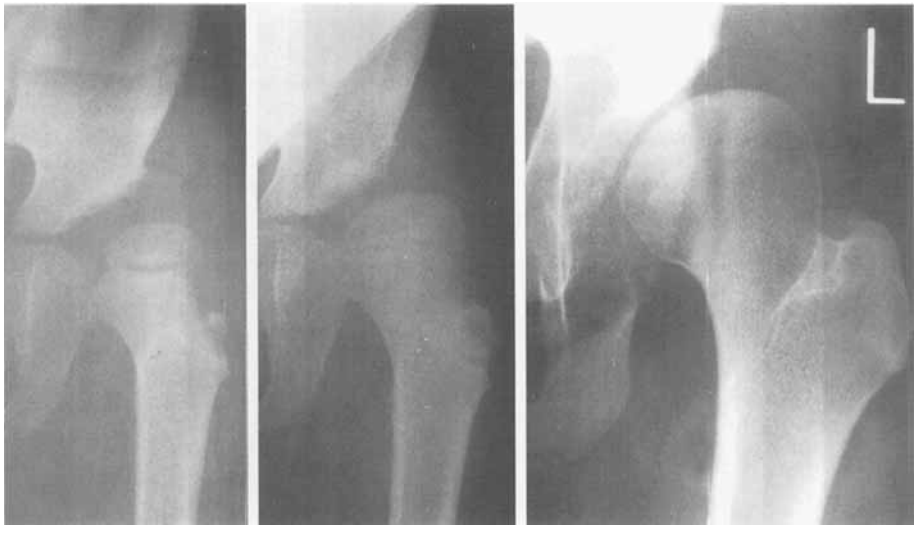
Of 10 hips surgically treated when the patients were older than 1 year of age, only 1 hip showed an

CE angle and AHI at different ages and final results in 20 patients

Case	Sex	Site	Age at op.	CE angle (degrees)					AHI (%)					Severin	AVN (Kalamchi)
				A	B	C	D	E	A	B	C	D	E		
1	F	R	7	5	20	20	21	–	61	73	77	76	–	I	–
2	F	L	17	15	22	30	27	25	74	84	89	76	76	I	1
3	F	L	6	16	19	22	27	30	90	88	82	78	78	II	–
4	M	R	7	–	20	23	25	–	–	73	81	76	–	II	–
5	F	R	10	12	10	18	30	25	71	69	76	71	75	II	–
6	F	L	10	10	10	–	20	–	61	67	–	75	–	II	–
7	F	R	12	10	17	25	30	30	64	68	74	70	80	II	3
8	F	L	15	12	17	20	23	–	60	74	83	80	–	II	–
9	F	R	19	15	23	30	30	25	75	80	84	82	82	II	–
		L	19	13	16	16	18	22	70	74	70	76	79	II	–
10	M	L	23	7	28	–	25	–	80	82	–	81	–	II	2
11	F	L	24	12	–	20	20	22	65	–	73	71	75	II	–
12	F	L	25	15	15	24	20	23	72	70	70	80	83	II	2
13	F	L	26	12	23	20	20	–	79	83	71	75	–	II	–
14	F	R	6	7	8	15	17	19	61	63	69	68	69	III	–
		L	10	5	10	10	10	12	52	64	65	65	64	III	–
15	F	L	9	5	14	14	18	18	61	69	68	76	76	III	3
16	F	R	10	15	4	5	5	–	69	57	58	52	–	III	3
17	F	R	11	–10	–5	–4	3	3	40	40	50	59	58	III	–
18	M	L	20	10	12	8	8	10	71	65	62	60	61	III	2
19	F	L	5	–2	–6	–	–16	–16	40	46	–	40	40	IV	–
20	F	L	9	–18	–15	–15	–14	–14	40	53	52	56	56	IV	–

A 3–5 years, B 6–8 years, C 9–11 years, D 12–14 years, E > 15 years

Figure 2. Case 19, treated at the age of 5 months.



A. At the age of 3 years, poor concentric position is apparent.

B. The acetabular development was insufficient at the age of 7 years.

C. The outcome at the age of 15 years was unsatisfactory.

unsatisfactory outcome, whereas this outcome was found in 7 of 12 hips surgically treated in patients less than 1 year of age. Several hips in patients less than 1 year of age showed a poor concentric position soon after open reduction, which resulted in an unsatisfactory outcome at final follow-up.

Discussion

It is clear that the main factor affecting the acetabular development after open reduction is whether concentric reduction is obtained and maintained (Akagi et al. 1994). In hips showing poor concentric reduction soon after operation, we could predict an unsatisfactory final outcome (Figure 2). We found that in hips showing a CE angle less than 0° and AHI less than 50% at 3–5 years of age, subsequent satisfactory acetabular development did not occur, indicating that these parameters are useful in predicting the acetabular development after open reduction and in considering whether to perform secondary procedures. However, it is difficult to predict the outcome when the CE angle is 0–20° and the AHI 50–75% at 3–5 years of age. The final outcome is uncertain in such hips and careful follow-up is necessary.

The presence of growth disturbance in the proximal part of the femur, related to vascular insufficiency, seemed to have no influence on acetabular development, as also reported by others (Harris et al. 1975, Brougham et al. 1988). This conclusion, however, might have been affected by the absence of patients with severe vascular insufficiency in our series and by the fact that the number of patients was small.

The age at operation seemed to influence the final outcome. Hips reduced after 1 year of age tended to have a better radiographic outcome. Many authors have reported that better and more rapid acetabular development can be expected in hips reduced by closed reduction at an earlier age (Lindstrom et al. 1979, Chen et al. 1994). However, a more concentric position is more likely to be obtained by open than by closed reduction, when the patient is older than 1 year.

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