

Long-term results of rotational acetabular osteotomy in young patients with advanced osteoarthritis of the hip

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Abstract Between 1974 and 1987, we performed 38 rotational acetabular osteotomies to treat advanced coxarthrosis caused by acetabular dysplasia in 38 patients who were aged 40 years old or less at the time of surgery. Of these patients, 28 were followed-up for more than 10 years after surgery. The pre-operative severity of coxarthrosis was graded as stage III in 21 hips and as stage IV in 7 hips, according to our modification of the classification of coxarthrosis advocated by the Japanese Orthopaedic Association. At the time of follow-up, 27 patients retained their own hip joints on the operated side 10 to 18 years (average, 13 years) after surgery, and the remaining patient had had a secondary total hip replacement 7 years after the surgery. Of the 27 patients who retained their own hip joints on the operated side, 20 had little or no pain and none suffered from severe pain in the operated hip; the severity of coxarthrosis was graded as stage II in 4 hips, as stage III in 9 hips, and as stage IV in 14 hips. We conclude that rotational acetabular osteotomy can be a useful procedure in young patients who have advanced coxarthrosis secondary to acetabular dysplasia.

Key words Osteoarthritis · Hip · Rotational acetabular osteotomy · Acetabular dysplasia · Coxarthrosis

Introduction

Untreated acetabular dysplasia leads to early degeneration of the hip joint. In some patients with untreated acetabular dysplasia, radiographs show findings of advanced coxarthrosis before age 40, and a series of operations are, presumably, necessary. Among possible procedures selected as the primary operation for these patients, periacetabular osteotomies have the theoretical advantage of preservation of bone stock and acetabular cover of the femoral head. They are

expected to relieve pain and delay the need for total hip replacement (THR). However, little has been reported on the long-term results of these osteotomies.^{7,26} In the present study, we evaluated the results of rotational acetabular osteotomy (RAO),¹⁶ one type of periacetabular osteotomy, in 28 patients who had had advanced coxarthrosis before surgery. These patients were aged 40 years or less at the time of surgery and were followed-up for more than 10 years.

Patients and methods

Between 1974 and 1987, we performed RAO on 267 hips in 240 patients with dysplastic hips. Of these procedures, 46 were performed for advanced coxarthrosis in 44 patients aged 40 years or less at the time of surgery who were without concomitant femoral osteotomies. Three patients were excluded from the study group because they had systemic diseases which seriously influenced locomotion. Another 3 patients were also excluded because of previous operations. An effort was made to contact the remaining 38 patients. It was found that 4 patients were unavailable for follow-up, and a further 6 patients did not come to our hospital. We studied the hospital records of the 4 patients unavailable for follow-up and found that none of them had undergone a THR 1 to 9 years after surgery. We sent questionnaires to the 6 patients who did not come to our hospital and received answers from all of them 11 to 20 years after surgery. All the patients could walk without limitations, and all had minimal or no pain in the operated hip, while no patient had undergone a secondary THR until the time of our inquiry.

The remaining 28 patients attended for clinical and radiological assessment, a recall rate of 74%. In patients with bilateral procedures, only the first procedure was included in the data.^{13,18} Thus, 28 hips in 28 patients are included in this study.

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There were 26 women and two men; 22 patients had had a history of developmental dysplasia of the hip in infancy. The average age at operation was 33 years (range, 19 to 40 years). Seven patients were operated when they were aged less than 30 years; 8 when aged between 31 and 35 years; and 13 when aged between 36 and 40 years. We had performed the following concomitant minor procedures with RAO in 10 patients: excision of osteophytes of the femoral head or the acetabular floor, or both, in 8; incision of the joint capsule in 1; and autogenous bone grafting to the acetabular cyst in 1.

The severity of osteoarthritis of the dysplastic hip was radiographically staged from I to IV, as defined by the following classification, that is, a modification of the classification for coxarthrosis advocated by the Japanese Orthopaedic Association (JOA).^{14,21} Stage I, no findings of osteoarthritis, with the center-edge angle²⁵ less than 20°; stage II, slight narrowing of the joint space, sclerosis or small cysts, or both, in the acetabulum or femoral head; stage III, the subchondral bones of the acetabulum and the femoral head in contact in a localized area, and osteophytes or cysts, or both, in the acetabulum or femoral head; and stage IV, obliteration of the joint space, and large osteophytes in the acetabulum or femoral head. According to this classification, 21 hips were graded as stage III, and 7 hips as stage IV.

The indications for RAO were: (1) significant hip pain, (2) a dysplastic hip, (3) antero-posterior radiographs showing improved congruity in abduction, and (4) the patient's willingness to use crutches for more than 6 months after surgery. Details of the surgical procedures have been published elsewhere.¹⁴⁻¹⁶ Active range-of-motion exercises for the hip were introduced in the third week after surgery. Kirschner wires that were used to transfix the osteotomized acetabulum to the bone graft and the pelvis were removed at the sixth or seventh week postoperatively. Partial weight-bearing on two crutches was then allowed. The crutches were discarded 6 months after surgery and a cane was then used.

Assessment

The center-edge angle²⁵ and the acetabular roof obliquity¹¹ of all the 28 hips were measured, using the antero-posterior radiographs taken before and 3 months after surgery. We clinically assessed the patients who retained their own hip joints at the time of follow-up, using the system of Merle d'Aubigné and Postel,¹² which has a full score of 18 points; from zero to six points each, for pain, mobility, and ability to walk, respectively. The severity of coxarthrosis was also

assessed, using the radiographs taken at the time of follow-up.

In addition, we evaluated the results regarding patients as units of observation.^{13,18} For this purpose, we classified the conditions of both hips in a patient into six classes, as follows. Class I, both hips were classified as stage I or II osteoarthritis; class II, one hip was classified as stage I or II, the other, as stage III or IV; class III, one hip was classified as stage I or II, the other was replaced with an artificial joint; class IV, both hips were classified as stage III or stage IV; class V, one hip was classified as stage III or IV, the other was replaced with an artificial joint; and class VI, both hips were replaced with artificial joints. To simplify the classification, a normal hip was dealt with as stage I osteoarthritis, and a hip in the state of arthrodesis was regarded as stage IV osteoarthritis. According to this classification, 18 patients were classified as class II, and 10 patients as class IV before surgery.

Spearman's rank correlation coefficient was used to determine the correlation between the flexion ranges of the operated hip joint before surgery and at the time of follow-up. A *P* value less than 0.05 was regarded as significant.

Results

As a direct result of RAO, the center-edge angle was improved from -5° to 36° on average; the acetabular roof obliquity, from 34° to 5° on average. At the time of follow-up, 27 patients retained their own hip joints on the operated side; the remaining 1 patient had had a secondary THR. The details of all 28 patients are summarized in Table 1.

Regarding the conditions of both hips in the patients, 20 patients were classified as being in the same class before surgery and at the time of follow-up (Table 2). Four patients had had a unilateral THR during the follow-up period; no patient, however, had bilateral THR.

At the time of follow-up, the average age of the 27 patients who retained their own hip joints on the operated side was 47 years (range, 31 to 58 years). They had an average follow-up of 13 years (range, 10 to 18 years). Twenty patients had little or no pain, and 24 could walk for a comparatively long time with or without a cane. Five patients, however, had a flexion range under 40°; these patients were among the 20 patients who had had a flexion range of 90° or less before surgery. The flexion range at the time of follow-up was significantly related to the flexion range before surgery (*P* = 0.02). With regard to the severity of coxarthrosis at the time of follow-up, 4 hips were graded as stage II, 9 hips, as stage III, and 14 hips, as stage

Table 1. Clinical details and long-term results of 28 patients with coxarthrosis treated by rotational acetabular osteotomy

Case no.	Sex	Side	Age at surgery (years)	Age at follow-up (years)	Duration of follow-up (years)	Severity of osteoarthritis ⁸		CE Angle ^c (°) AC Angle ^d (°)				Hip score ^e					
						Before surgery ^b	At follow-up ^b	Preop	Postop	Preop	Postop	Before surgery		At follow-up			
												Pain	Mobility	Pain	Mobility	Walking	Walking
1	F	L	37	49	11	III/N	IV/N	-10	30	35	10	3	6	5	5	5	5
2	M	L	38	53	14	III/N	III/N	5	25	25	10	4	6	6	6	6	6
3	F	L	33	45	11	III/I	IV/II	0	40	30	0	4	4	3	3	3	4
4	F	R	39	55	16	III/I	IV/II	5	40	30	0	5	5	3	3	5	5
5	F	R	37	51	13	III/I	IV/III	10	35	30	5	1	4	2	2	5	5
6	F	L	40	52	11	III/I	IV/I	-15	20	25	10	4	4	5	5	5	5
7	F	R	36	49	13	III/I	IV/II	0	40	50	25	3	3	2	2	5	5
8	F	L	31	42	11	III/I	III/II	-15	25	45	10	4	6	5	5	5	5
9	F	L	21	34	12	III/I	III/I	0	35	45	5	4	5	5	5	5	5
10	F	L	25	39	14	III/I	III/II	-40	45	55	15	2	5	5	5	4	4
11	F	R	40	53	12	III/I	III/I	-15	40	30	5	3	6	4	4	4	4
12	F	R	34	47	13	III/I	II/I	-5	40	30	-20	4	5	6	5	5	5
13	F	L	38	51	13	III/I	III/II	10	45	30	5	4	6	5	5	5	5
14	F	R	30	37	7 ^f	III/I	THR/IV	5	40	25	5	3	5	5	THR	THR	THR
15	F	L	36	48	11	III/II	III/THR	-15	10	35	15	4	5	5	4	5	5
16	F	L	27	42	14	III/III	IV/IV	-10	45	40	20	3	4	4	2	2	4
17	F	L	26	42	16	III/III	IV/IV	-25	10	45	25	3	5	5	2	2	4
18	F	L	30	41	11	III/III	III/THR	10	40	30	15	4	6	5	4	4	4
19	M	L	36	48	10	III/III	III/IV	-30	20	50	5	4	5	5	4	4	4
20	F	R	34	48	13	III/IV	II/IV	0	35	30	-5	3	6	3	6	4	4
21	F	L	40	53	13	III/IV	IV/IV	0	40	35	-5	4	5	5	4	4	3
22	F	L	19	31	12	IV/N	IV/N	15	50	30	0	3	4	5	5	5	5
23	F	L	32	44	10	IV/I	IV/I	5	45	35	5	4	5	5	5	5	5
24	F	R	39	58	18	IV/I	II/IV	-5	55	30	-15	3	6	4	6	5	6
25	F	R	37	50	12	IV/III	IV/THR	-5	35	30	5	3	5	4	2	3	3
26	F	R	32	44	11	IV/III	IV/IV	-5	40	35	-10	4	5	5	5	5	5
27	F	R	35	52	17	IV/III	IV/IV	-15	45	25	-5	4	5	3	3	4	4
28	F	R	35	48	13	IV/V	III/V	0	35	25	0	2	5	5	3	3	3

F, Female; M, male; L, left; R, right; preop, preoperative; postop, postoperative; THR, total hip replacement

^a According to our modification of the classification for coxarthrosis advocated by the Japanese Orthopaedic Association^{14,21}

^b Operated hip/Contralateral hip

N, normal hip; I, stage I osteoarthritis; II, stage II osteoarthritis; III, stage III osteoarthritis; IV, stage IV osteoarthritis; V, arthrodesis

^c Center-edge angle²⁵

^d Acetabular roof obliquity¹¹

^e According to the scoring system proposed by Merle d'Aubigné and Postel¹²

^f Interval between rotational acetabular osteotomy and secondary total hip replacement

Table 2. Conditions of both hips in 28 patients before surgery and at follow-up

Class before surgery	Class at follow-up					
	I	II	III	IV	V	VI
II	2	13	0	1	2	0
IV	0	1	0	7	2	0
Total	2	14	0	8	4	0

Class I, both stage I or II osteoarthritis;^{14,21} class II, stage I or II / stage III or IV; class III, stage I or II / artificial joint; class IV, both stage III or IV; class V, stage III or IV / artificial joint; class VI, both artificial joints. A normal hip was dealt with as stage I osteoarthritis, and a hip in the state of arthrodesis, as stage IV

IV. Regression of the severity of coxarthrosis was observed in 5 hips. Figure 1 shows radiological findings of chronological change in the operated joint in an illustrative patient.

Complications had developed in 2 of the 28 patients. There was snapping of the rectus femoris tendon (case 23) and chondrolysis (case 25). Four patients had had additional operations; an additional intertrochanteric valgus osteotomy had been performed in 3 patients (cases 3, 7, and 15) to improve congruity of the joint, and release of the rectus femoris tendon had been performed in the other patient (case 23). In addition, 6 patients had given birth to healthy babies after RAO; Caesarean section was performed in 4 patients for gynecological reasons.

In the patient who had had a secondary THR (case 14), the affected hip had markedly lost mobility in the 7 years after RAO and the indication for THR was substantial arthrodesis. However, the surgical procedure of the THR was uneventful.

Discussion

Our study found that RAO was effective for the relief of pain and delayed the need for THR in patients with coxarthrosis. More than 10 years after surgery, 20 of the 28 patients in our study had little or no pain, no patient suffered from severe pain, while only 1 patient had undergone secondary THR. Although comparable non-operated series are not available, in Danielsson's³ study of the natural evolution of coxarthrosis over a 10-year period, one-third of the patients were pain-free and one-quarter of the patients had severe pain at the time of follow-up. It is probable that the outcome is significantly better in our study than in Danielsson's series.

Our results also show that RAO is efficacious regarding patients as units of observation. More than 10 years after surgery, the condition of both hips was the

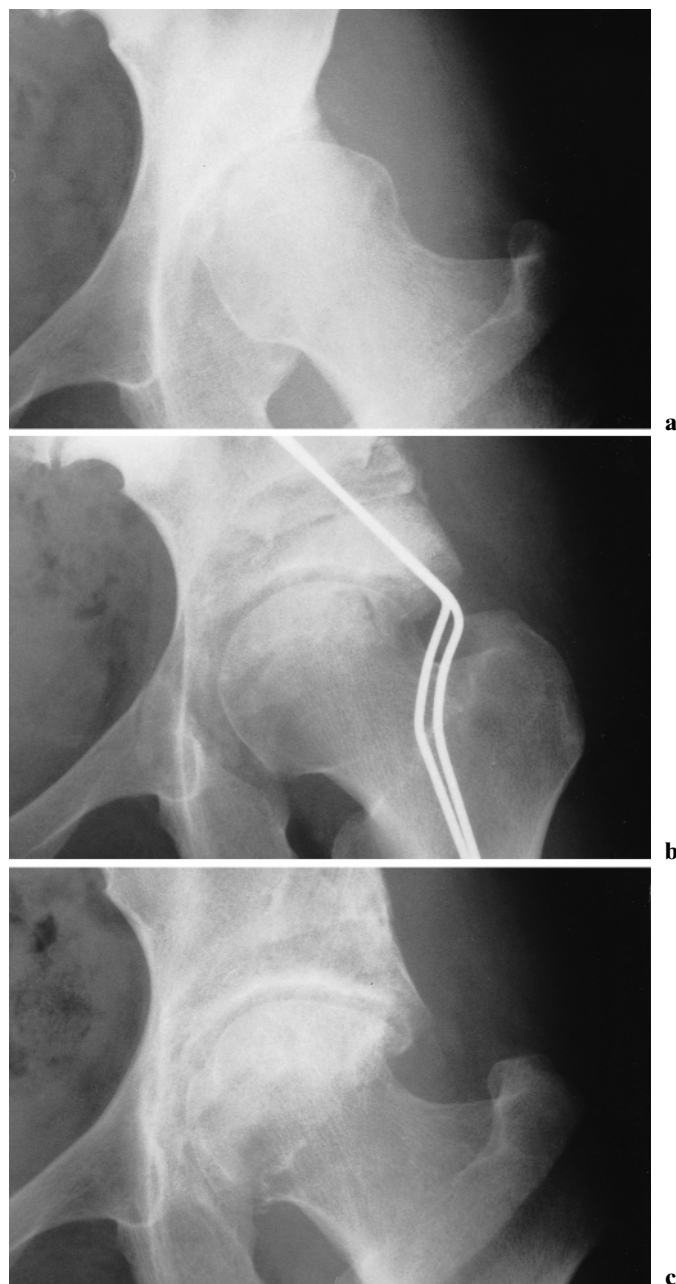


Fig. 1a-c. Case 13. **a** Preoperative radiograph of the left hip in a 38-year-old woman shows findings of stage III coxarthrosis, according to our modification of the classification for coxarthrosis advocated by the Japanese Orthopaedic Association.^{14,21} **b** One month after rotational acetabular osteotomy, the transferred acetabulum covers the femoral head and is fixed to the pelvis with two wires. **c** After 13 years, the patient could walk without limitation; the radiograph shows findings of stage II coxarthrosis

same or better in 23 of 28 patients, compared with their preoperative status. These results suggest that RAO does not accelerate deterioration of the contralateral hip. In addition, the preoperative condition of the

contralateral hip does not significantly affect the outcome of RAO from this point of view.

In the present study, we treated young patients with advanced coxarthrosis. These patients had severely dysplastic acetabula, and both hips were involved in most patients. These conditions precluded them from being good candidates for other established procedures, such as THR, proximal femoral osteotomy, and arthrodesis. The long-term results of THR in young patients are still controversial,^{2,8,20,22} and the systemic distribution of wear debris^{1,9} can be hazardous for patients of reproductive age. Although proximal femoral osteotomies are reported to be valuable as the primary operation for young adults who have coxarthrosis,⁴ they are not indicated as an isolated procedure for patients with severe acetabular dysplasia.¹⁰ Moreover, arthrodesis is not appropriate for patients with bilateral hip involvement because it may accelerate deterioration of the contralateral hip. Thus, acetabular osteotomies should be considered seriously in the treatment of these patients.

Although we have shown in the present study that RAO was effective in the treatment of patients with coxarthrosis, two studies have claimed that other pelvic osteotomies are ineffective. First, Trousdale et al.²⁴ reported the results of the Bernese periacetabular osteotomy. They graded the preoperative severity of the osteoarthritis according to the Tönnis classification.²³ Of nine patients with grade-3 osteoarthritis, five had a THR within 8 years of osteotomy. Second, Reynolds¹⁹ reported the results of 44 consecutive Chiari innominate osteotomies. He grouped the hips into four categories according to the degree of dysplasia and degeneration present before operation. In his classification, category 4 includes hips in a state of advanced osteoarthritis, with moderate or marked loss of range of motion. Of the 12 hips in category 4, 8 had a THR and 1 had spontaneous ankylosis within 5 postoperative years. There is a distinct difference between the findings in our study and in these studies. One possible reason for this difference is the duration of protected weight-bearing. We instructed all patients to use crutches for more than 6 months after surgery. On the other hand, Trousdale et al.²⁴ allowed patients to walk with a cane if there was radiographic evidence of bone union. Reynolds¹⁹ also allowed patients full weight-bearing as soon as their strength and comfort permitted.

As we¹⁴ and others⁶ have previously reported, the outcome of RAO was worse for dysplastic hips with osteoarthritis than for hips with mild, if any, osteoarthritis. When RAO is performed, the femoral head is covered with fibrocartilage or eburnated bone in the former group of hips, and with articular cartilage in the latter group. Accordingly, this makes a difference in

the outcome, especially in the mobility of the joint. Even in hips with osteoarthritis, however, RAO improves the acetabular coverage of the femoral head and increases the weight-bearing surface. Thus, RAO decreases the unit load on the articular surface¹⁷ and it may induce articular cartilage regeneration.⁵ We believe that these effects promote remodeling of the arthrotic joint under conditions of protected weight-bearing.

Despite the widespread use of the classification for coxarthrosis advocated by the JOA, some surgeons have questioned the validity of this classification for the evaluation of results of surgical procedures. They claim that this classification is mainly based on the width of the joint space, and that other findings of coxarthrosis do not always change proportionately after surgery. However, we believe that the use of the JOA classification is reasonable. First, RAO is a procedure designed to prevent the early deterioration of the articular cartilage. Even in patients with advanced coxarthrosis, a change in the width of the joint space is an issue of concern. In addition, other popular classifications, such as the Tönnis²³ classification, are also not designed to evaluate the postoperative conditions.

Although Ninomiya and Tagawa¹⁶ described RAO as having a minor degree of technical complexity, it is a technically demanding procedure. Moreover, the prolonged use of crutches is an integral part of this procedure when it is employed for hips with arthrotic change. We believe, however, that RAO offers a good chance of delaying the need for THR in young patients who have coxarthrosis.

In conclusion, RAO can be a useful procedure in young patients who have advanced coxarthrosis secondary to acetabular dysplasia.

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