Two-incision technique for rotational acetabular osteotomy

Good outcome in 35 hips

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ABSTRACT We have developed a 2-incision technique for rotational acetabular osteotomy. This includes both an extraperitoneal and an anterolateral exposure of the pelvic bones allowing an unconstrained approach without dissection of the muscle insertion. 2 plates are used to stabilize the osteotomy and full range motion of the hip is permitted within 2 days of surgery, while weight bearing is restricted for 6 weeks after the operation. We reviewed the complications and technical results in 27 patients (28 hips) after a minimum follow-up of mean 3 (1–5) years. No major surgical complications occurred, but dysfunction of the lateral femoral cutaneous nerve occurred frequently (14 patients). The radiographical correction of the femoral head covering was similar to those in previous reports of rotational osteotomy. The range of hip motion was not affected by the operation. A significant increase in the mean Merle D'Aubigné and Harris Hip scores was observed in a subgroup of 20 patients with a minimum follow-up of 2 years. In conclusion, the method we have used is safe and the early results are satisfactory.

Up to one half of patients with untreated hip dysplasia are known to suffer from arthrosis at the age of 50 years (Cooperman et al. 1983, Harris 1986, Murphy et al. 1990). Although the short-term outcome of total hip arthroplasty has been promising even in young patients with arthrosis (Halley and Charnley 1975), the long-term outcome has been not entirely satisfactory (Chandler et al. 1981, Dorr et al. 1990, Collis 1991). The rate of revision arthroplasty among young and active people exceeds that in the general population (Callaghan et al. 1998, Garcia-Cimbrelo et al. 2000).

The Bernese rotational acetabular osteotomy (RAO) was developed in 1983 (Ganz et al. 1988) to retard the development of arthrosis in young patients with hip dysplasia, and several reports on satisfactory results have since then been published (Trousdale et al. 1995, Nakamura et al. 1998, Crockarell et al. 1999, MacDonald et al. 1999, Matta et al. 1999, Siebenrock et al. 1999, Trumble et al. 1999, Yasunaga et al. 2001). The RAO, performed via the two commonest approaches—i.e., the ilioinguinal and Smith-Petersen—requires a broad dissection of the pelvic bones and detachment of muscle insertions (Leunig et al. 2001). Consequently, full motion and exercises to increase muscle strength should be started no sooner than several weeks after the operation. This has encouraged us to develop a 2-incision technique which permits a less invasive approach to the pelvic bones, allowing immediate free motion and early unrestricted weight bearing of the extremity. Here we describe this new technique and the short-term results.

Patients and methods

33 patients with hip dysplasia (35 hips), characterized by a center-edge (CE) angle of Wiberg (1939) less than 25 degrees, were operated on in our department from 1994 to 1999. All operations were done by the senior author (EH), using a new dual approach. The osteotomy was performed with Ganz et al.'s method (1988).

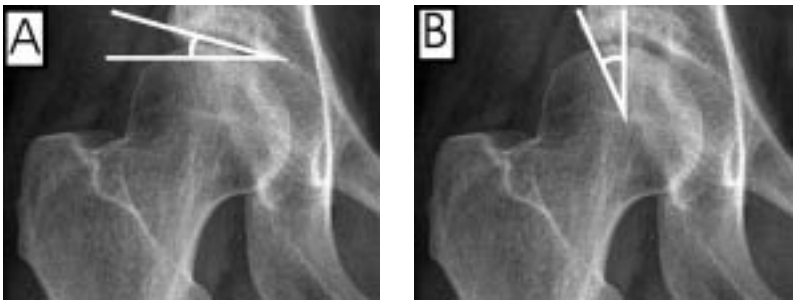

Figure 1. Radiographic measurements.
A. Acetabular index measured as the angle between the roof and a horizontal line.
B. Center-edge angle of Wiberg measured as the angle between a vertical line and the line from the center of the femoral head to the lateral edge of the acetabular roof.

7 were male and 26 female. Their average age at the time of the operation was 40 (19–54) years, the female patients being, on average, older than the males (42 and 33 years, respectively). The right hip was operated on in 20 and the left one in 15 patients. 8 patients had had congenital hip dislocation as a child. 1 of these had had an intertrochanteric osteotomy of the femur, 2 an osteotomy of the acetabulum, and 1 several osteotomies of the femur. 1 patient (no. 9 in Table 1) has spastic diplegia, which largely interfered with evaluation of hip motion.

Pre- and postoperative assessment

Pain, performance and range of motion (ROM) were assessed preoperatively and at the most recent follow-up, using Harris (1969) and Merle d'Aubigné and Postel's scores (1954). The function of major muscle groups of the extremity (extensors and flexors of the knee and ankle) and tactile sense of the thigh and calf were assessed at the latest follow-up. Anterioposterior and lateral radiographs were obtained preoperatively, postoperatively and at follow-up. The radiographic analysis included the acetabular index (Massie and Howorth 1950) and CE angle of Wiberg (Figure 1). The Tönnis classification (1987) was used to evaluate the severity of arthrosis preoperatively and at the most recent follow-up. All radiographic and postoperative clinical scorings were done blind to previous information by the first author (JP). Blood loss and the duration of surgery were obtained from the medical records.

Surgery

The indications for the operation included hip pain for a minimum of 6 months (mean 4 (0.5–19) years), and dysplasia without severe arthrosis (Tönnis grade 2 or less). We used a 2-incision technique, previously described for pelvic and acetabular fractures (Hirvensalo et al. 1993). A 10-cm incision was made laterally on the anterior superior spine and on the anterior part of the iliac wing. The lateral cutaneous femoral nerve was exposed and protected with a retractor. The inguinal ligament was partly detached from its lateral origin. The muscle insertions or tendons were not compromised. The incision through the anterior part of the ilium over the dome was done through this incision (Figure 2). A second 10-cm long low midline incision was made from the symphysis cranially. An extraperitoneal approach via the inner aspect of the pelvic bones was used and the exposure was extended laterally on the superior pubic ramus beneath the neurovascular structures. The pubic branches of the inferior epigastric vessels were ligated, if they interfered with exposure. The quadrolateral surface was cleaned of the origin of the obturatorius internus muscle so that the lower edge of the ischial bone could be visualized. A Hohmann retractor, placed in the ischial foramen, protected the obturator nerve and vessels and provided a sufficient view of the periacetabular area. The incisions on the posterior and inner parts of the ilium, as well as towards the ischial bone and the superior ramus of the pubic bone, could be completed via this approach under direct view by using chisels (Figure 2). The desired rotation was done through the lateral portal with a broad chisel and facilitated by raising the superior ramus of the pubic bone with a rasp. Fixation of the osteotomy was done temporarily with one 2-mm K-wire, and

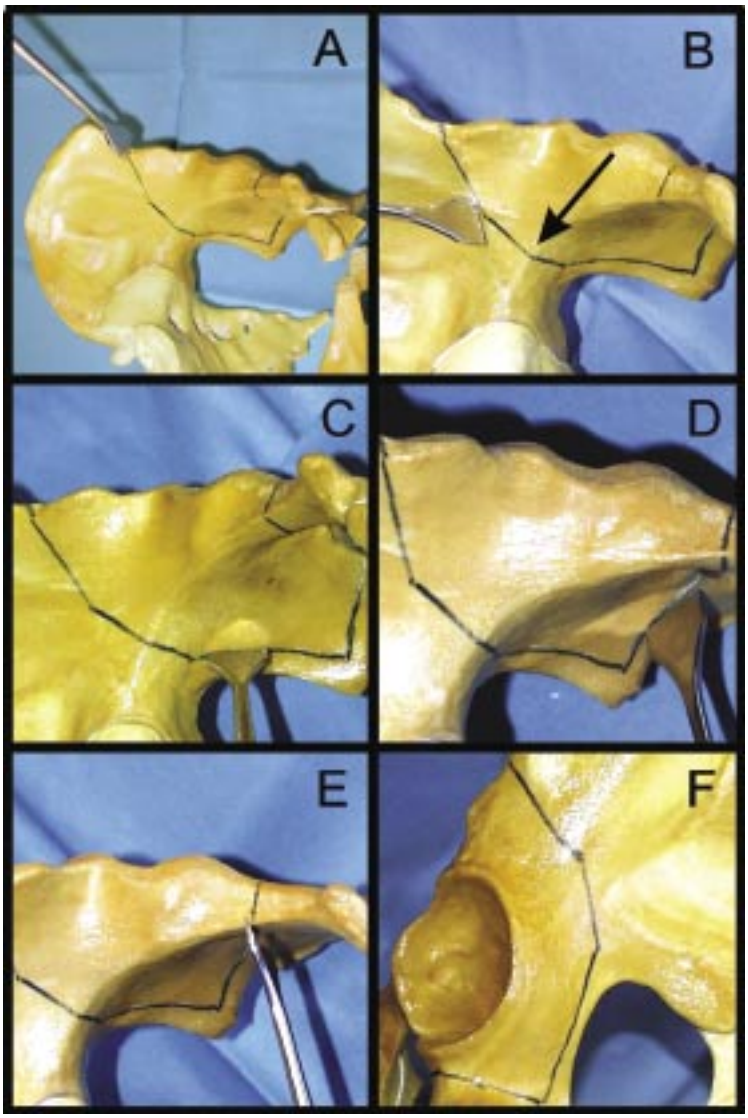

Figure 2. Schematic diagram showing the osteotomy steps with a plastic model. The first cuts (A and B) are made down to the level of the pelvic brim (arrow) via the lateral approach at the anterior part of the iliac wing. The subsequent cuts in the iliac and ischial bones (C-D) are made extraperitoneally under the iliopsoas and neurovascular bundle via the low midline approach. The quadrilateral surface is cleaned and the landmarks of the posterior edge of the ischial bone and the ischial spine are recognized by placing a blunt retractor behind the posterior column. The osteotomy of the superior ramus of the pubic bone via the same midline approach completes the periacetabular osteotomy (E). The osteotomy line is marked on the posterior column (F).

the correction was checked with fluoroscopy. The final fixation was initially done with screws (16 hips) and is currently done with 2 reconstruction plates (19 hips), one placed on the dome area and the other on the superior ramus (Figure 3).

Full range of motion of the extremity was permitted on the first postoperative day, and controlled ambulation was carried out whenever the patient felt it possible, on the first or second postoperative day. Weight-bearing was limited for a minimum of 6 weeks, and full weight bearing was thereafter allowed individually, according to the clinical status and union of osteotomy.

Statistics

Differences in means for factors are presented with 95% confidence intervals (CI). Intervals excluding 0 are considered as statistically significant. The Wilcoxon matched pairs test was used to analyze the results in 20 patients with a follow-up of at least 2 years. P-values < 0.05 were considered to be statistically significant.

Results

The duration of surgery averaged 145 (100–215) minutes, and the mean blood loss was 1.7 (0.6–5) L. The positive effect of the learning curve was demonstrated—i.e., a time-dependent reduction in duration of surgery and peroperative blood-loss, with an average time of 115 min and blood loss of 1 L for the last 5 operations (June 1999–December 1999). Patients were discharged from the hospital after an average of 7 (4–12) days. The first postoperative follow-up occurred at 6 weeks, and patients were followed until complete healing

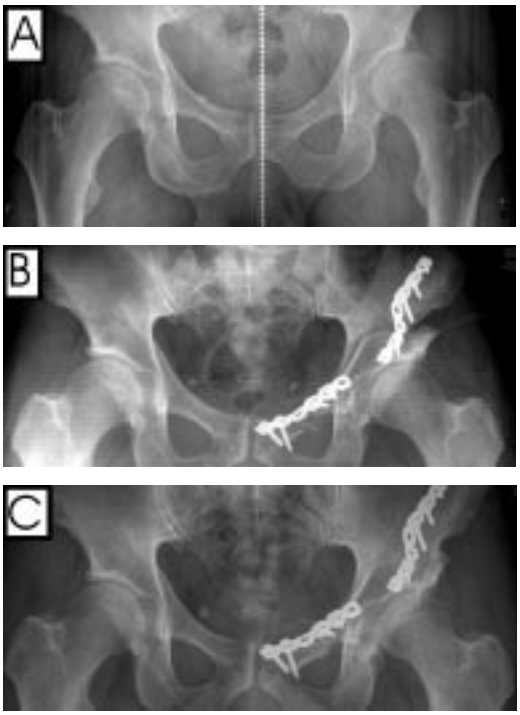

Figure 3. Radiographs taken preoperatively, postoperatively and at latest follow-up of a 43-year-old male patient with dysplasia of the left acetabulum, who had ha pain in his hip for several years (patient no. 5 in Table 1).
A. Preoperatively.
B. The osteotomy was performed using a dual incision method and fixed with two reconstruction plates. The postoperative femoral head covering has increased significantly on the anteroposterior radiograph.
C. The osteotomy has healed uneventfully. The range of motion of the hip is about the same as before surgery and at the latest follow-up at 2 years. Arthrosis has not progressed and he has no pain in his hip.

was observed. Subsequent follow-ups were done at various intervals.

Surgical complications

There was 1 intraarticular osteotomy (the chisel penetrated into the acetabular roof), but no iatrogenic fractures of the acetabulum. One patient had a temporary postoperative palsy of the femoral nerve, which resolved within a few days. Dysfunction of the lateral femoral cutaneous nerve, either hyper- or hyposensation or both, was observed in 14 patients. No major bleeding or deep vein thrombosis occurred. 1 patient had a delayed union of the pubis, but this healed uneventfully. 2 had a hardware failure (broken screws), which caused a minor displacement towards the original position of the osteotomized component. Subsequently, we abandoned screw fixation and have used plate-fixations alone since January 1998. 2 patients have had their screws removed because of pain.

Clinical assessment

27 of the 33 patients attended the final follow-up examination (Table 1), with an average follow-up of 33 (12–61) months. 5 patients could not be reached and 1 could not attend the latest follow-up due to an unrelated disease. Union of the osteotomy and a painless hip, which permitted full weight bearing, was noted in 5 cases at the first postoperative follow-up (6 weeks), in 4 cases at 9 weeks, and in 14 cases at 12 weeks. Reliable data were not available in 5 cases. The median time to union was thus 10 (6–12) weeks. Patients with a preoperative arthrosis of grade 2 had a significantly longer median time (11 (7–12) weeks) until full weight bearing was achieved, than those with no or grade 1 arthrosis (8 (6–12) weeks). Age, preoperative Merle d'Aubigné score, the duration of preoperative pain, duration of surgery, or the correction of CE angle showed no correlation with the duration of rehabilitation. 7 of 27 patients had a slight reduction in strength of the quadriceps muscle, and 14 had some atrophy of the thigh. 2 patients have had total arthroplasty of the operated hip 1.5 years after the osteotomy due to progressing arthrosis and increasing pain.

The average range of motion of the operated hip at the latest follow-up did not differ significantly from that seen preoperatively (Table 2). Factors associated negatively with the range of motion included a postoperative acetabular index of more than 10 degrees ($p = 0.02$, versus those with less than 10 degrees), and preoperative arthrosis of grade 2 ($p = 0.01$, versus those with no or grade 1). The postoperative CE angle showed no statistically significant correlation with the range of motion ($p = 0.35$).

The mean Merle D'Aubigné score increased from a preoperative value of 14 (7–17) to 15 (11–18) at the latest examination (difference of means: 1.7, 95% CI: 0.0–3.4, $p < 0.001$) (Table 3) in patients with a follow-up of at least 2 years. The main factor contributing to the increase in total score was the improvement in the pain score,

Table 1. Characteristics of 27 patients with acetabular dysplasia preoperatively and at latest follow-up

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	X	Y	Z
1	49	F	140	140	45	45	30	30	40	40	45	45	6	34	19	15	0	0	3	5	15	17	40	79
2	50	F	[a]	100	[a]	45	[a]	30	[a]	40	[a]	20	[a]	34	[a]	16	[a]	0	[a]	4	[a]	11	[a]	39
3	51	F	[a]	140	[a]	45	[a]	30	[a]	40	[a]	45	19	34	18	7	2	1	[a]	3	[a]	12	[a]	44
4	43	F	140	140	45	45	30	30	40	40	45	45	12	38	8	0	1	1	4	5	16	17	54	96
5	43	M	140	120	45	45	30	30	20	30	20	20	0	31	32	15	0	1	4	5	15	16	66	96
6	31	F	120	140	45	45	30	30	40	40	45	45	–20	47	19	18	2	1	3	6	10	16	68	93
7	42	F	100	90	20	40	20	30	15	0	15	10	[a]	22	[a]	22	2	3	3	4	7	11	24	73
8	32	F	130	140	45	45	30	30	40	40	45	45	14	25	16	12	1	1	5	6	17	18	[a]	[a]
9	19	M	90	80	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	9	18	16	5	0	1	5	6	[a]	[a]	[a]	[a]
10	42	M	100	90	20	45	25	30	20	10	30	15	5	13	32	24	2	2	3	5	12	12	80	60
11	54	F	130	140	45	45	30	30	15	40	45	25	15	58	20	13	2	1	4	6	15	17	49	96
12	46	F	135	120	40	45	30	30	25	30	25	30	17	48	11	6	1	1	5	6	16	17	58	94
13	21	F	140	110	45	45	30	30	40	40	45	45	21	49	15	–10	0	0	4	6	16	18	61	100
14	46	F	120	120	20	20	30	30	30	30	30	30	16	30	17	21	1	1	4	5	14	15	[a]	83
14b	45	F	120	120	20	20	30	30	30	40	30	45	[a]	35	[a]	23	1	2	4	6	14	16	59	[a]
15	40	F	120	110	40	40	20	30	20	20	30	45	13	59	25	10	1	2	5	6	15	16	60	98
16	49	F	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]	17	24	23	14	[a]	[a]	[a]	[a]	[a]	[a]	[a]	[a]
17	33	F	120	110	20	30	20	20	20	20	20	30	15	48	12	13	2	2	3	5	10	14	47	93
18	42	M	100	90	20	20	20	10	0	10	0	10	0	35	11	11	2	2	4	5	11	11	69	66
19	32	F	100	110	20	30	20	30	10	40	10	30	20	24	32	18	2	2	4	5	9	15	57	83
20	46	F	[a]	130	[a]	40	[a]	30	[a]	30	[a]	45	14	30	22	10	2	2	[a]	3	[a]	11	[a]	27
21	37	F	135	130	45	45	30	20	40	40	45	45	20	32	14	8	1	0	4	5	16	16	[a]	[a]
22	49	F	110	110	20	45	20	30	20	30	5	40	18	29	23	6	2	2	3	6	11	17	36	86
23	44	M	90	130	40	45	30	30	40	40	30	35	7	36	30	8	1	1	4	6	11	17	53	86
24	37	F	120	90	40	30	40	30	25	25	20	10	10	50	16	14	2	2	3	4	13	13	64	77
25	22	M	135	120	40	45	30	30	25	20	25	45	8	32	35	18	2	1	4	5	15	16	58	83
26	46	F	140	90	45	40	30	30	40	40	45	20	15	35	24	10	2	3	4	5	16	15	45	49
27	32	F	140	140	45	45	30	30	40	40	45	45	8	34	13	2	1	1	5	5	17	17	73	100

[a] Data missing or not reliably accessible or interpretable.
Patient no. 9: Spastic diplegiea. Range of motion of hi hip, except flexion, could not be evaluated reliably.
Patient no. 16: Bilateral hip arthroplasty at the latest follow-up.

A Case no.
B Age
C Gender
D Preoperative flexion
E Flexion at latest follow-up
F Preoperative abduction
G Abduction at latest follow-up
H Preoperative adduction
I Adduction at latest follow-up
J Preoperative internal rotation
K Internal rotation at latest follow-up
L Preoperative external rotation
M External rotation at latest follow-up
N Preoperative CE angle of Wiberg
O CE angle of Wiberg at latest follow-up
P Preoperative acetabular index
Q Acetabular index at latest follow-up
R Preoperative arthrosis (Tönnis grade)
S Arthrosis at latest follow-up (Tönnis grade)
T Pain score (Merle D'Aubigné) preoperatively
U Pain score (Merle D'Aubigné) at latest follow-up
V Preoperative Merle D'Aubigné score
X Merle D'Aubigné score at latest follow-up
Y Preoperative Harris Hip score
Z Harris Hip score at latest follow-up

which increased from a preoperative mean of 3.9 (3.0–5.0) to 5.1 (3.0–6.0) ($p < 0.001$). The mean Harris hip score increased from 52 (24–80) to 78 (27–100) ($p < 0.001$).

Radiographic assessment

(Table 3). Heterotopic ossification or osteonecrosis of the osteotomized component was not seen in any of the patients during follow-up.

Discussion

The long-term results of 63 patients who had had a Bernese rotational acetabular osteotomy because of acetabular dysplasia (Ganz et al. 1988) have been reported recently (Siebenrock et al. 1999, Siebenrock et al. 2001). The average duration of surgery, when using a Smith-Petersen approach, was 3.5 hours, with a mean blood loss of 2 L. Most

Table 2. Range of motion and radiographic measurements of the operated hip preoperatively and at latest follow-up of 27 patients. Difference in means is presented with 95% confidence interval. Confidence interval, excluding the value of 0, is considered to be statistically significant

	Preoperative			At latest follow-up			Difference	
	mean	SD	range	mean	SD	range	mean	95% CI
Flexion	123	16	90–140	118	20	80–140	5	-5–15
Abduction	32	14	0–45	40	8	20–45	–8	-14– -2
Adduction	26	8	0–30	28	5	10–30	–2	-6–1
Internal rotation	23	13	0–40	32	12	0–40	–9	-16– -2
External rotation	28	15	0–45	33	13	10–45	–5	-13–3
CE angle of Wiberg	11	9	-20–21	35	11	13–59	24	18–30
Acetabular index	20	8	8–35	12	7	-10–24	8	4–12

Table 3. Merle D'Aubigné and Harris Hip scores preoperatively and at latest follow-up in a subgroup of 20 patients with a minimum follow-up of 2 years

	Merle D'Aubigné score	Harris Hip score
Preoperative		
Mean	13.5	52
SD	2.8	15
Range	7–17	24–80
At latest follow-up		
Mean	15.2	78
SD	2.4	21
Range	11–18	27–100
Difference in means with 95% confidence interval	1.7 (0.0 –3.4)	26 (14–38)
Wilcoxon test	$p < 0.001$	$p < 0.001$

of the other studies of RAO performed via the same approach have had similar durations of surgery and blood loss. Moreover, the other commonest approach, the ilioinguinal, seems to be even more time consuming (Hussell et al. 1999 a). In our series, the mean total duration of surbery was 2.5 hours, indicating that the dual approach technique may shorten the operation, possibly because of better visualization of the periacetabular area, so that the osteotomy can be performed under direct visual control, unlike the partly blind procedure when using the Smith-Petersen approach. Our technique also reduces the need for fluoroscopy, which may prolong surgery.

Our dual approach method does not compromise the pelvic muscle insertions, which facilitates early full range exercise of the hip. A reduction to 8 weeks of weight bearing and hip musculature exercises, which is recommended when using the Smith-Petersen approach due to detachment of the muscle insertion, may diminish postoperative hip motion (Siebenrock et al. 1999). In our patients, full range motion exercises were started early, and no difference was found between the average pre- and follow-up range of motion of the operated hip. Healing of the osteotomy was not compromised by this early mobilization or by the short 6-week period of reduction in weight bearing.

The rate of serious complications in RAO with the Smith-Petersen approach is low (Hussell et al. 1999b). However, a high incidence (22–30%) of lateral femoral cutaneous nerve dysfunction has been reported in association with both the Smith-Petersen and ilioinguinal approaches. 50 complications have recently been reported in a series of 70 operations using the Smith-Petersen approach (Davey and Santore 1999), with over half of them classified as trivial, such as dysfunction of the lateral femoral cutaneous nerve. The high rate of this minor complication in our series corroborates their findings, but it seems difficult to avoid, regardless of care during the operation or the approach used. However, as a recent report suggests, the incidence of even trivial complications can be reduced to 10% (Yasunaga et al. 2001).

The surgical approach we describe has not been reported in connection with osteotomies, but it has been used for pelvic and acetabular fractures. This 2-incision technique permits a less traumatic access to the pelvic bones. The exposure is adequate, allowing the bone to be cut under direct

visual control and reducing to a minimum the need for fluoroscopy. The avoidance of muscle detachments and rigid fixation with plates permits immediate free motion of the hip and has shortened the period without weight-bearing to as little 6 weeks. Apart from the relatively high incidence of lateral femoral cutaneous nerve dysfunction and blood loss, the complication rate associated with this method seems to be low.

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