Polygonal triple (Kotz) osteotomy in the treatment of acetabular dysplasia

17 patients (19 hips) with 4–9 years of follow-up

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ABSTRACT We reviewed 19 hips in 17 patients between 17 and 33 years of age, who underwent a Kotz polygonal triple osteotomy. Their average follow-up was 7 (4.5–9) years. Although 13 patients had less pain after surgery, 3 continued to limp. The average corrections were 36° for the center-edge angle, 31° for the vertical center-edge angle and 19° for Sharp's angle. 3 patients developed transient palsy of the sciatic nerve, and 3 asymptomatic nonunion of the ischium or pubic bone. The degree of arthrosis decreased in 10 hips.

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Acetabular dysplasia of the hip in adolescent and young adults is a main cause of secondary arthrosis of the hip (Wedge and Wasylenko 1979, Cooperman 1983, Bombelli 1984). Total hip arthroplasty may be a good solution for old patients. Several methods for reorientation of the acetabulum have been proposed to reduce the symptoms and prevent or delay arthrosis in adolescents and young adults (Steel 1973, Ganz et al. 1988, Tönnis 1993). None of these uses an angle cut at the roof of the acetabulum, as in polygonal triple osteotomy, which was first described by Kotz et al. (1992). Since 1992, we have used this to treat acetabular dysplasia in young patients. In the present study, we have evaluated the surgical technique and short-term clinical and radiographic results.

Patients and methods

Between January 1992 and August 1996, we performed 19 polygonal triple osteotomies in 17 female patients with acetabular dysplasia. Their mean age at operation was 24 (17–33) years and the mean follow-up was 7 (4.5–9) years. The etiology of the dysplasia was congenital dislocation of the hip in 18 hips and the sequela of poliomyelitis in 1. 11 patients had been treated in infancy for dislocation (7 with a cast, 4 with open reduction). 2 others had undergone previous operations—e.g., femoral varus osteotomy and varization-derotation osteotomy.

The indications for surgery were: hip pain and limping for more than 6 months, acetabular dysplasia (center edge (CE), vertical center edge (VCE) and Sharp's angles 25°, 30° and > 40°, respectively), nearly normal congruence between the femoral head and acetabulum, and almost full range of motion. The CE angle is between the perpendicular line to the center of the femoral head and the line from the lateral edge of the acetabulum to the center of the head. The VCE angle is between the perpendicular line to the center of the femoral head and the line from the anterior edge of the acetabulum to the center of the head on standing lateral view of the hip. On AP view, Sharp's angle is between the horizontal line to the tear drop figure and the line from the lateral edge of the acetabulum to the tear drop figure.

For clinical evaluation, we used the Harris Hip Score (HHS). HHS evaluation includes pain (44 points), function (47 points), deformity (4 points), and range of hip motion (5 points). 90–100 points denote excellent results, 80–89 good, 70–79 fair, and < 70 poor.

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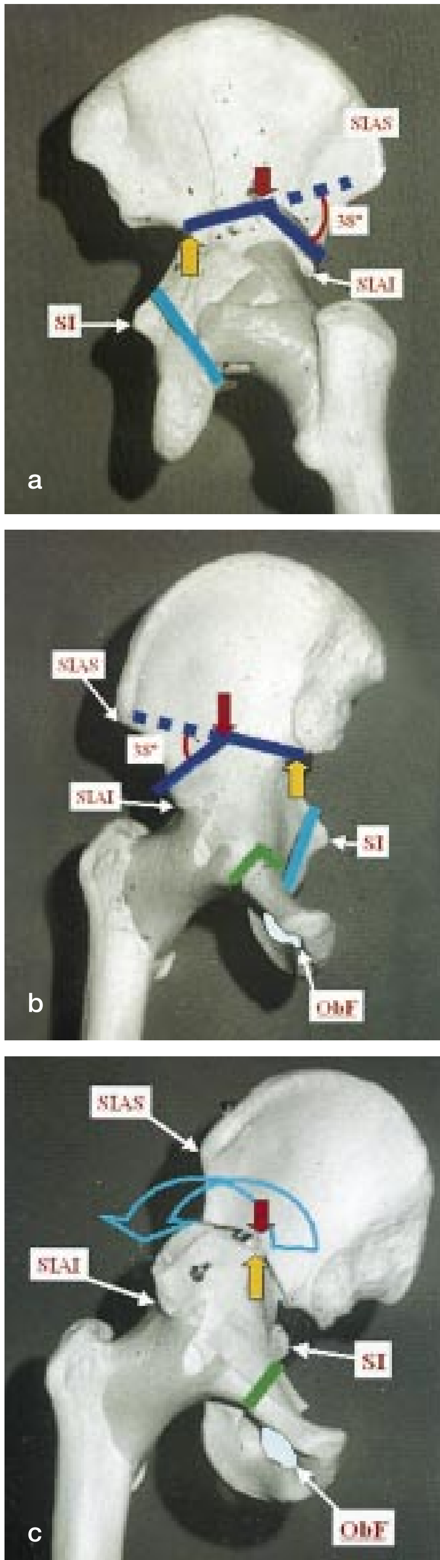

We evaluated patients for arthrosis with Pauwels' (1976) classification—i.e., grade 1–sclerotic bone (sourcil) in the superolateral area of the acetabulum, grade 2–an increase in the sourcil and decrease in the joint space in the superolateral area of the acetabulum, grade 3–a cyst in the superolateral part, an osteophyte in the medial part of the femoral head and a decrease in all of the joint space, grade 4–a cyst in both the acetabulum and the femoral head.

Surgical technique (Figure 1)

The surgical technique was described by Kotz et al. (1992). The patient lies in the lateral decubitus position which helps the surgeon when he has to turn and work by moving the table forwards and backwards. We used an ilioinguinal approach to perform the pubic and iliac osteotomies and an ischial incision for the ischial osteotomy. The pubic osteotomy (green line) is done parallel to the midline and medial to the site of insertion of the pectineus muscle. The ischial incision (turquoise line) starts from the infra-cotyloid groove (just below the inferomedial hip joint) and passes over the sacrotuberal and sacrospinal ligaments (just above the spina ischiadica), connecting the obturator foramen and sciatic notch. The iliac osteotomy is done by stripping the gluteal muscles until the sciatic notch is exposed. After preparing the iliac bone, the incision is made immediately above the anteroinferior iliac spine (SIAI), creating a 38° angle with the middle portion of the ilium (red arrow); the chisel is then directed towards the sciatic notch (yellow arrow), where it ends. The

Figure 1. Schematic model of Kotz osteotomy.
a. posterior oblique view of the right hip
b. anterior oblique view of the hip
c. anterior view of the hip after 3 osteotomies
Blue lines: Anterior and posterior parts of the iliac osteotomy
Turquoise line: Ischial osteotomy (infra-cotyloid groove)
Green line: pubic osteotomy
SIAS: Spina iliaca anterior superior
SIAI: Spina iliaca anterior inferior
SI: Spina ischiadica
Obf: Obturator foramen
Turquoise arrow: direction of rotation of acetabulum after 3 osteotomies
Red arrow: the middle point (38°) of iliac osteotomy
Yellow arrow: the end point of posterior part of iliac osteotomy.

Clinical and radiographic data in 17 female patients (19 hips) with acetabular dysplasia

A	B	C	D	E		F		G		H		I		J		K	
1	23	1	62	1	2	1	2	65	98	5	35	8	48	55	35	1	0
2	28	1	74	1	2	2	2	75	90	0	40	0	35	55	33	1	1
3	28	2	56	1	1	1	1	70	74	–40	6	5	20	50	47	3	0
4	23	1	58	1	2	2	2	90	90	0	30	10	35	55	34	1	1
5	17	3	84	1	1	2	2	80	85	–3	30	–5	32	60	35	2	1
6 left	18	3, 4	107	1	1	1	1	60	70	–30	12	–22	20	60	50	2	1
right	18	3, 4	111	1	2	1	1	70	72	–35	5	–25	15	72	45	4	4
7	19	3	91	1	2	1	2	80	95	0	40	5	42	54	30	2	1
8 right	33	2	112	1	2	2	1	70	80	5	25	0	30	55	35	4	4
left	33	1	102	1	2	2	1	80	82	–15	10	–5	20	60	43	2	4
9	17	1	79	1	2	1	2	80	91	–5	27	15	35	55	35	0	0
10	24	3	83	1	2	1	2	75	88	–5	35	–15	40	50	35	2	0
11	25	3	94	1	2	1	2	80	92	6	46	10	30	58	30	1	0
12	27	1	67	1	2	2	2	85	95	0	40	19	48	53	35	1	0
13	24	2	78	1	1	1	2	80	88	2	40	20	50	53	38	1	1
14	27	1	86	1	2	1	2	80	95	2	35	18	40	60	35	1	0
15	29	1	64	1	2	1	2	75	88	0	40	20	41	57	38	0	0
16	30	3	106	1	2	2	2	65	85	0	35	20	45	60	35	3	1
17	28	2	101	1	2	1	2	70	90	4	35	12	43	50	35	0	0

A Case
B Age
C Previous treatment
  1 no treatment
  2 open reduction
  3 cast
  4 proximal femoral osteotomy
D Follow-up (months)
E Pain, pre- and postop
  1 yes
  2 no
F Trendelenburg, pre- and postop
  1 positive
  2 negative
G Harris hip score, pre- and postop
H CE angle, pre- and postop
I VCE angle, pre- and postop
J Sharp,s angle, pre- and postop
K Hip arthrosis, pre- and postop
  0–4 Pauwels' grading

acetabular fragment is rotated anterolaterally with a Steinman pin or chisel. When the rotation is completed, the yellow arrow region moves anteriorly and locks in the middle of the ilium (red arrow). Fixation is done with a Sherman plate or 2–3 spongious or long cortical screws placed crosswise.

External supports, such as a cast, splint or brace, are not needed postoperatively. 2 days after the operation, patients were encouraged to walk with crutches. At 6 weeks, partial weight bearing with crutches and at 12 weeks, walking without crutches, was allowed.

On the follow-up examination, we evaluated pain, Trendelenburg's sign, limping, HHS, and daily activities. The radiographic assessment consisted of plain anteroposterior and false profile (standing lateral view) radiographs for measuring the CE, VCE, and Sharp's angles and the degree of arthrosis.

Results (Table)

13 patients had no pain at the follow-up. Of these, 11 had had a limp before surgery. The limp persisted in 2 (cases 6 and 8) because of gluteal muscle weakness. Trendelenburg sign was positive in 5 hips postoperatively. As compared with before operation, we found a loss of active flexion by an average of 13° (5°–20°), but movement in all other planes was unchanged, except in 1 patient with a 30° limitation of internal rotation. As regards daily activities, the patients who were working reported that they had continued with the same activities, as well as jogging and swimming. The 2 patients who were housewives also stated that they had no difficulty in doing their housework. Overall, HHS improved by a mean of 11 (0–33) points with excellent results in 9 patients, good in 6, and fair in 2.

The lateral and anterior covers of the femoral head improved in all patients. The average CE

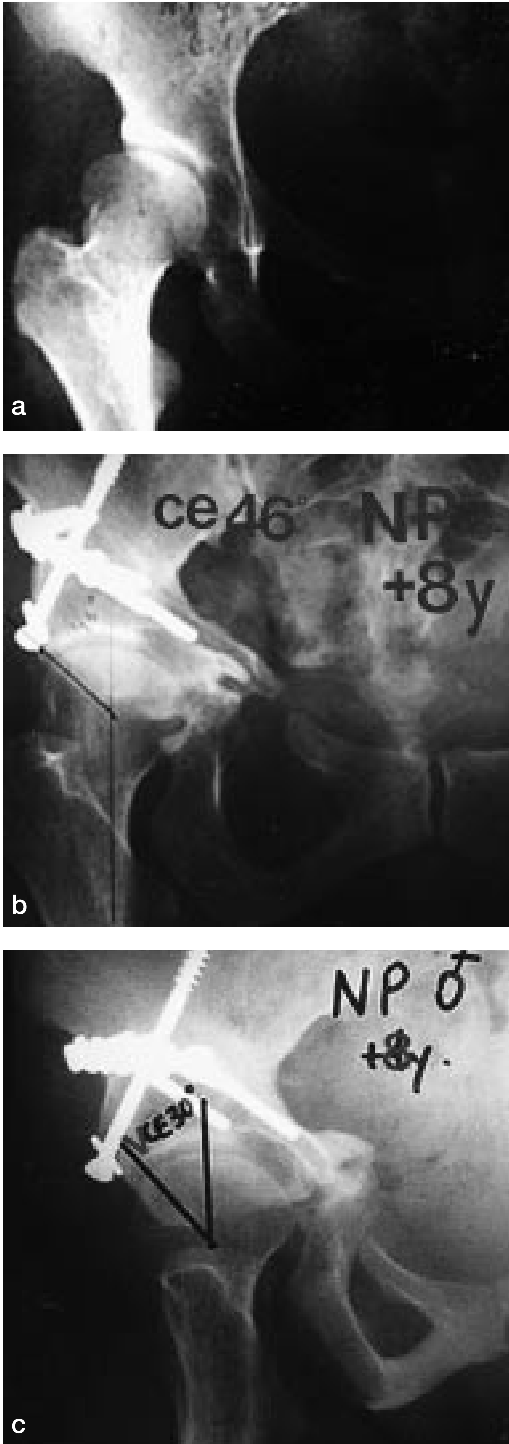

Figure 2. A 25-year-old woman (case 11).
a. before operation, the CE angle was 6° in the right hip. b and c. 8 years after the osteotomy, the CE angle was 46° and VCE angle 30°.

and VCE angles at follow-up were 30° and 35°. The mean Sharp's angle decreased by 37° at the follow-up (Figure 2). Shenton's line was interrupted in 11 patients preoperatively and in 5 of these postoperatively. Before operation, 3 hips had no arthrosis, 7 grade I, 5 grade II, 2 grade III, and 2 grade IV arthrosis. At the follow-up, 9 of the hips had no arthrosis. 7 grade I and 3 grade IV arthrosis (Figure 3).

We used a Sherman plate or screws for fixation in all cases. Removal of screws was needed in only one patient (case 8). This was done with a percutaneous technique using an image intensifier.

3 patients developed transient palsy of the sciatic nerve. Asymptomatic nonunion of the pubic bone occurred in 1 patient and of the ischial bone in 2. No patient was clinically diagnosed as having deep venous thrombosis and infection.

Discussion

Many patients with acetabular dysplasia develops arthrosis (Wedge and Wasylenko 1979), presumably because the reduction in weight bearing surface increases the load on the joint and shearing forces affecting the cartilage (Murphy et al. 1990).

Steel's (1973) triple pelvic osteotomy and Ganz et al.'s (1988) periacetabular osteotomy are commonly used to treat acetabular dysplasia. In Steel's technique, correction is limited because the osteotomy of the ischial bone is far from the acetabulum. Ganz et al.'s osteotomy may give good correction, but it is difficult to perform; and the osteotomy line is close to the acetabulum, which increases the risk of injury to the joint (Wenger et al. 1998, Davey and Santore 1999).

In Kotz et al.'s (1992) osteotomy, the polygonal design of the osteotomy can improve acetabular geometry predictably without removing wedges and medialize the hip. Polygonal triple osteotomy provides satisfactory correction thanks to close proximity of the osteotomies to the acetabulum, like the Ganz osteotomy. The osteotomy is also technically easier than the Ganz osteotomy, since it can be done under direct vision using a template.

Kotz's original series included 12 patients having a mean age of 25 (15–44) years and mean follow-up of 29 months. All of them had obtained

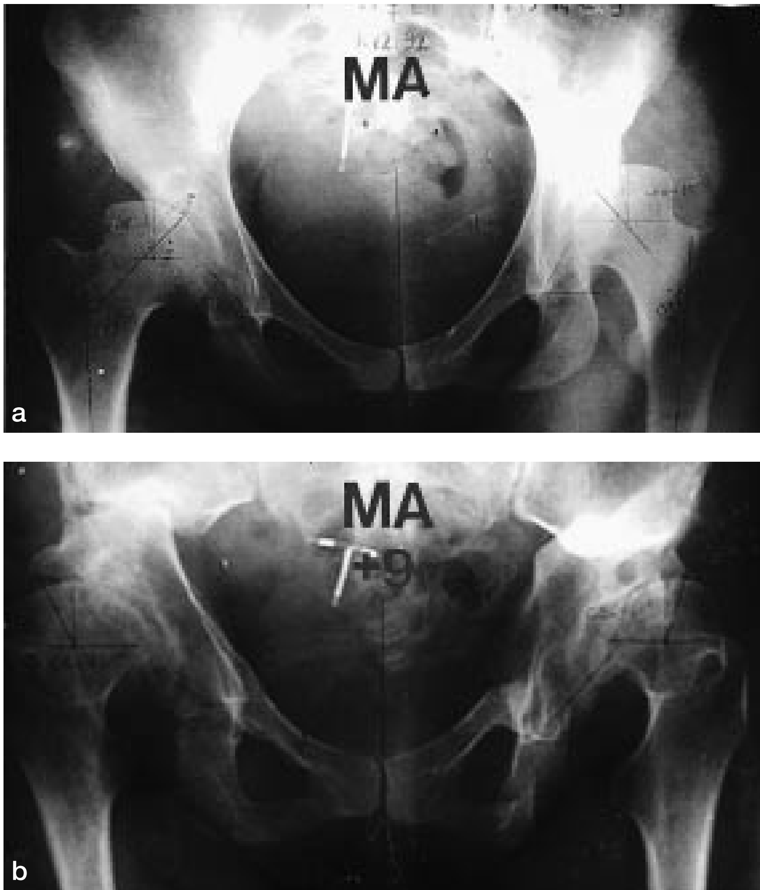

Figure 3. A 33-year-old woman.
a. bilateral dysplasia before osteotomy.
b. grade 4 arthrosis increased in the left hip and remained unchanged in the right one despite adequate coverage obtained 9 years after surgery.

complete relief of their preoperative pain at follow-up. Flexion and the range of internal rotation had decreased by an average of 22°, but the VCE angle increased by 42° and the CE angle by 32°. In our study, which has a longer follow-up, the results differed to some extent. We found that the pain disappeared in 13 patients. The average flexion range decreased by 13°, but the CE angle increased by 36°, the VCE angle by 31°, and Sharp' s angle decreased by 19°, on average, postoperatively. Moreover, the Harris Hip Score improved by 11 points. Thus, the correction obtained with polygonal triple osteotomy is generally satisfactory. However, we believe that this osteotomy should not be done when the CE angle is less than –10°. In our series, 3 patients (3, 6, 8) with CE < –10° preoperatively had below normal values for CE at the follow-up.

Limping due to persistent Trendelenburg insufficiency is the main disadvantage of Kotz osteotomy. Particularly during iliac osteotomy, we believe that excessive detachment of the gluteal muscle for better exposure and possible injury to the superior gluteal nerve are the major causes of limping. Trochanteric osteotomy can be used to avoid this complication, as recommended by Szepesi et al. (1993). In our series, only 2 patients had persistent limping. This might be avoided by detaching the gluteal muscle subperiostally.

A few authors have reported a reduction in the severity of arthrosis after periacetabular and triple osteotomy (Tönnis 1993, Millis et al. 1995, Trousdale et al. 1995, Wenger et al. 1998). Harris and Enneking (1995) showed that subchondral remodeling of bone could be achieved by a well performed osteotomy. Hipp et al. (1999) measured contact pressure on 70 dysplastic and 12 normal acetabula and found that the surface contact was 26% less and contact pressure 23% more in dysplastic hips. However, by reorientation of the acetabular fragment in the sagittal and frontal planes, using simulation with a computerized tomographic method, the magnitude of this pressure was reduced by 50%. In our series, arthrosis regressed in 10 hips, so we believe that polygonal triple osteotomy may prevent the progression of arthrosis.

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