Cengiz Sen · Mehmet Asik · I. Remzi Tozun
Nadir Sener · Murat Cinar

Kotz and Ganz osteotomies in the treatment of adult acetabular dysplasia

Accepted: 4 November 2002 / Published online: 19 December 2002
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Abstract In hips with acetabular dysplasia, we performed Kotz osteotomy (group 1) in 22 hips (20 patients; mean age 24.3 years) and Ganz osteotomy (group 2) in 23 hips (22 patients; mean age 23.1 years). Group 1 was followed 83.3 (56–112) months and group 2 40.9 (24–66) months. In group 1, Harris hip score improved from average 74.9 to 86.9, mean center edge (CE) angle from -4.5° to 30.3° , and mean vertical center edge (VCE) angle from 5.3° to 36.2° . In group 2, Harris hip score improved from average 76.6 to 91.1, mean CE angle from -5.9° to 32.0° , and mean VCE angle from 5.0° to 41.3° . Using Pauwels criteria, regression was observed in 12 hips in group 1 and one progressed. In group 2, 15 hips showed regression and three progressed. In patients treated with Ganz osteotomy, the complication rate was higher and the complications more serious than in patients treated with Kotz osteotomy. Most complications were, however, seen among the first ten patients treated with Ganz osteotomy. Although we detected no significant difference between the two groups in terms of clinical and radiological findings, we believe the outcome to be slightly better after a properly performed Ganz osteotomy.

Résumé Sur des hanches avec dysplasie acetabulaire nous avons exécuté une ostéotomie de Kotz (groupe I) dans 22 cas (20 malades avec un âge moyen 24,3 ans) ou une ostéotomie de Ganz (groupe II) dans 23 cas (22 malades avec un âge moyen de 23,1 années. Le groupe I a été suivi 83,3 (56–112) mois et le groupe II 40,9 (24–66)

mois. Dans le groupe I le score moyen de Harris a été amélioré de 74,9 à 86,9, l'angle CE moyen de $4,5^\circ$ à $30,3^\circ$ et l'angle VCE moyen de $5,3^\circ$ à $36,2^\circ$. Dans le groupe II le score moyen de Harris a été amélioré de 76,6 à 91, l'angle CE moyen de $-5,9^\circ$ à 32° et l'angle VCE moyen de 5° à $41,3^\circ$. Avec les critères de Pauwels, une régression a été observée pour 12 hanches et une progression pour une dans le Groupe I. Dans le Groupe II, 15 hanches ont montré une régression et 3 hanches ont progressé. Chez les malades traités par une ostéotomie de Ganz, le taux de complications était plus élevé et les complications plus sérieuses que chez les malades traités par l'ostéotomie de Kotz. Cependant la plupart des complications sont survenues parmi les premiers 10 malades traités par l'ostéotomie de Ganz. Bien que nous n'ayons pas détecté de différence significative entre les deux groupes quant aux aspects cliniques et radiologiques, nous croyons que le résultat est légèrement meilleur après une ostéotomie de Ganz correctement exécutée.

Introduction

Although total hip arthroplasty is an alternative treatment modality in acetabular dysplasia, this approach has limitations in younger patients. Therefore, biological reconstructive methods have attracted much attention in the last 10 years and various reconstructive acetabular osteotomies for adult acetabular dysplasia have been defined. The results and our experiences in the learning curve in polygonal triple osteotomy described by Kotz [8] and periacetabular osteotomy described by Ganz [4] are evaluated here.

Patients and methods

We first treated 22 dysplastic hips in 20 patients with a mean age of 24.3 years (group 1) with Kotz osteotomy. We then changed to Ganz osteotomy and treated 23 dysplastic hips in 22 patients with a

C. Sen (✉)
Medical School, Department of Orthopaedics and Traumatology,
University of Gaziosmanpasa, 60100 Tokat, Turkey
e-mail: senc64@yahoo.com
Tel.: +90-0356-2133831, Fax: +90-0356-2133830

M. Asik · I.R. Tozun · M. Cinar
Department of Orthopaedics and Traumatology,
Medical Faculty of Istanbul, University of Istanbul,
Istanbul, Turkey

N. Sener
SSK Goztepe Training Hospital, Istanbul, Turkey

Fig. 1a–b Preoperative and postoperative AP view (74 months) of a patient managed with Kotz osteotomy

mean age of 23.1 years (group 2). In all patients except one, acetabular dysplasia was due to developmental hip dysplasia. Prerequisites for operation were a history of hip pain and limping for more than 6 months, radiographic presence of acetabular dysplasia as determined by a center edge angle (CE) below 20° and a vertical center edge angle (VCE) below 30°, nearly normal congruency between the femoral head and acetabulum, and almost full range of hip motion.

Normal congruency was found in 18 cases in group 1 and in 20 cases in group 2. A full range of motion was found in 16 cases in group 1 and in 19 cases in group 2.

For the Kotz osteotomy, the patient was placed in lateral decubitus position. We used both ilioinguinal and ischial incisions. Abductor detachment was inevitable for exposure. We used a Sherman plate or two to three spongy screws for the internal fixation [8] (Fig. 1a and b).

For the Ganz osteotomy, the patient was placed in a supine position. In the majority of operations, we used only one incision – the ilioinguinal – to perform the osteotomies. As the iliac wing was exposed medially, no abductor detachment was necessary. In the last nine patients, we also performed an osteotomy of the anterior superior iliac spine to reflect the sartorius and the inguinal ligament medially. Internal fixation was done using two to three spongy or long cortical screws [4] (Fig. 2a and b).

External support was not used. Partial weight bearing was allowed at 6 weeks and complete weight bearing at 12 weeks.

Results

Group 1 patients were followed for an average of 83.3 (56–112) months and group 2 for 40.9 (24–66) months. They were evaluated for pain, Trendelenburg limp, and by Harris hip score. Radiologically, CE and VCE angles were assessed. In addition, the hips were graded using Pauwels classification [16].

Clinical results

In group 1, five patients postoperatively complained of pain developing after more than 1 hour of walking. In group 2, two patients suffered postoperative pain, which worsened while walking on inclined surfaces or climbing stairs.

Postoperatively, five patients in group 1 continued limping; in four this was due to gluteal muscle weakness. In group 2, three patients had persistent limping due to 3.5, 3, and 2 cm shortening respectively, and one patient limped due to gluteal muscle weakness. In group 1, Harris hip score increased 12 points on average and, in group 2, by 14.5 points. Further details are given in Tables 1 and 2.

Radiological results

Postoperative mean CE angle improved from -4.5° to 30.3° in group 1, and from -5.9° to 32.0° in group 2. Mean VCE angle improved from 5.3° to 36.2° in group 1, and from 5.0° to 41.3° in group 2. Using Pauwels classification, an improvement was seen in 12 hips in group 1, whereas nine hips remained unchanged and one deteriorated. In group 2, 15 hips regressed, five remained unchanged, and three progressed.

Complications

Superficial infection was seen in three patients in each group. They were treated with appropriate systemic anti-

Fig. 2a–b Preoperative and postoperative AP view (34 months) of a patient treated with Ganz osteotomy

biotics and local dressings. Peroneal paralysis was seen in three patients in group 1, but they recovered. In two cases, pseudoarthrosis developed at the pubic osteotomy. The osteotomy was intraarticular in two patients in group 2 and was caused by technical difficulties. It was observed that these patients could perform their daily activities with moderate pain in spite of a grade IV osteoarthrosis. In addition, extreme lateralization was seen in one case, heterotopic ossifications in two, hematoma and lateral femoral cutaneous nerve neuropraxia in three, and fracture of the posterior column in one.

Discussion

Development of osteoarthrosis is inevitable in acetabular dysplasia [1, 12, 16, 17, 18, 20, 22]. The most important reason is excessive weight bearing on osteocytes and chondrocytes beyond their capacities [5, 16, 17]. Hipp et

al. [6] calculated contact pressure in 70 dysplastic and 12 normal hips and found that in dysplastic hips the contact area was 26% smaller and contact pressure 23% higher than in normal hips. However, reorientation of acetabulum in the sagittal and frontal planes using simulation by computer-assisted methods decreased the contact pressure twofold. Kotz and Ganz osteotomies are operations that have been found to decrease contact pressure.

Kotz polygonal triple osteotomy [8] achieve good correction due to close proximity of the osteotomies to the acetabulum and the fact that the osteotomies can be performed under direct vision without the need of an image intensifier. An adequate stability can be achieved with only two to three cancellous screws without external support and finally allows earlier weight bearing. The most important complications of Kotz osteotomy [8, 18] are postoperative limping due to the complete stripping of the abductor muscles, risk of pseudoarthrosis at the site of ischial and pubic osteotomy, and the risk of

Table 1 All patient details for Group I (Kotz osteotomy). *PFO* Proximal femoral osteotomy, *CE* Center-edge, *VCE* Vertical center edge

Patient	Age	Previous treatment	Follow-up (months)	Pain	Trendelenburg		Harris hip score		CE angle		VCE angle		Hip arthritis (Pauwels)	
					Preop.	Postop.	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.
NÖ	23	(-)	62	Yes	No	Positive	65	98	5	35	8	48	1	0
NB	28	(-)	74	Yes	No	Negative	75	90	0	40	0	35	1	1
NY	28	Open reduction	56	Yes	Yes	Positive	70	74	-40	6	5	20	3	0
HT	23	(-)	58	Yes	No	Negative	90	90	0	30	10	35	1	1
AK	17	Cast	84	Yes	Yes	Negative	80	85	-3	30	-5	32	2	1
GS (left)	18	Cast and PFO	107	Yes	Yes	Positive	60	70	-30	12	-22	20	2	1
GS (right)	18	Cast and PFO	111	Yes	No	Positive	70	72	-35	5	-25	15	4	4
MU	19	Cast	91	Yes	No	Positive	80	95	0	40	5	42	2	1
MA (right)	33	Open reduction	112	Yes	No	Negative	70	80	5	25	0	30	4	4
MA (left)	33	(-)	102	Yes	No	Negative	80	82	-15	10	-5	20	2	4
MY	17	(-)	79	Yes	No	Positive	80	91	-5	27	15	35	0	0
NC	24	Cast	83	Yes	No	Positive	75	88	-5	35	-15	40	2	0
NP	25	Cast	94	Yes	No	Positive	80	92	6	46	10	30	1	0
RT	27	(-)	67	Yes	No	Negative	85	95	0	40	19	48	1	0
SK	24	Open reduction	78	Yes	Yes	Positive	80	88	2	40	20	50	1	1
HB	27	(-)	86	Yes	No	Positive	80	95	2	35	18	40	1	0
MS	29	(-)	64	Yes	No	Positive	75	88	0	40	20	41	0	0
SC	30	Cast	106	Yes	No	Negative	65	85	0	35	20	45	3	1
NY	28	Open reduction	101	Yes	No	Positive	70	90	4	35	12	43	0	0
AÖ	34	Open reduction	88	Yes	No	Positive	72	95	14	41	17	55	4	2
AT	15	(-)	69	Yes	No	Negative	75	88	-5	28	0	32	0	0
SS	16	Open reduction	59	Yes	Yes	Positive	70	80	0	32	10	42	3	1

Table 2 All patient details for group 2 (Ganz osteotomy). *PFO* proximal femoral osteotomy, *CE* Center edge, *VCE* Vertical center edge

Patient	Age	Previous treatment	Follow-up (months)	Pain	Trendelenburg		Harris hip score		CE angle		VCE angle		Hip arthritis (Pauwels)	
					Preop.	Postop.	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.	Preop.	Postop.
MT	34	Cast	24	Yes	No	Positive	70	85	-20	28	0	36	2	0
EG	28	Cast	48	Yes	No	Positive	85	100	17	35	25	42	1	0
NZ	31	(-)	46	Yes	No	Positive	80	98	0	30	15	48	1	0
NS	17	(-)	24	Yes	No	Positive	75	88	-20	27	8	52	3	1
ZY	28	(-)	34	Yes	No	Positive	80	91	0	30	15	40	2	2
PA (left)	26	(-)	30	Yes	No	Negative	75	90	10	45	12	48	2	1
AA	18	Cast	24	Yes	No	Positive	75	95	5	28	15	33	2	0
AB	17	(-)	45	Yes	No	Positive	75	80	5	25	10	32	2	2
SK	24	(-)	53	Yes	No	Positive	75	100	0	45	10	58	2	0
IP	16	(-)	37	Yes	No	Positive	80	100	12	25	20	48	1	0
EÖ	18	(-)	49	Yes	No	Positive	80	92	-20	28	0	35	2	1
HÖ	24	Cast	35	Yes	No	Positive	75	100	-16	30	-10	32	1	0
KÖ	25	PFO	54	Yes	No	Positive	70	95	-25	30	-15	32	3	1
ST	19	(-)	25	Yes	No	Positive	68	82	-30	25	-5	38	4	2
AT	33	PFO	26	Yes	No	Positive	80	85	5	55	10	50	0	1
HM	17	(-)	34	Yes	No	Positive	80	95	-30	25	-20	30	1	0
YO	15	Salter	28	Yes	No	Positive	85	90	20	35	23	38	0	0
PA (right)	26	(-)	36	Yes	No	Positive	80	100	0	40	5	55	0	0
RG	18	Cast	62	Yes	Yes	Positive	60	65	-10	30	0	40	2	4
MK	19	(-)	24	Yes	No	Positive	78	100	-10	35	0	45	1	0
CS	38	PFO	66	Yes	Yes	Positive	75	70	-30	25	-20	30	3	4
AM	23	Cast	56	Yes	No	Positive	80	100	-10	28	5	42	1	0
TY	20	(-)	62	Yes	No	Positive	80	95	10	33	12	45	2	2

sciatic nerve compression due to impingement of the acetabular fragment at the site of the ischial osteotomy.

Ganz periacetabular osteotomy [4], described in 1988 and modified by Millis and Murphy [12, 13, 14], have many important superiorities. Because the osteotomy is performed around the acetabulum, it is possible to detach the acetabular fragment completely and achieve a larger amount of correction. There is no need for external support due to the stable osteosynthesis, which permits early weight bearing [2, 3, 4, 7, 9, 10, 11, 12, 13, 14, 15, 19, 20, 21]. In a study by Murphy and Millis [13], it was additionally stated that the osteotomy may be more easily performed via a direct anterior approach without abductor dissection and thus without producing abductor dysfunction. Ganz osteotomy has, however, some disadvantages, such as a more difficult learning curve, requirement of fluoroscopy during the osteotomy, risk of the osteotomy going intraarticular, and frequent paralysis of the lateral femoral cutaneous nerve [2, 3, 7, 10, 11, 15, 19, 21].

In our series, the mean correction obtained with Kotz osteotomy was generally satisfactory. However, in four severe dysplastic cases (numbers 3, 6, 7, and 10), we realized that Kotz osteotomy was not appropriate. We admit that this type of osteotomy should not be performed for dysplastic hips with a CE angle below -10° . The correction obtained with Ganz osteotomy was better than with Kotz osteotomy. Cases (numbers 13, 14, 16, and 21), where preoperative CE angles were below -10° , had acceptable postoperative CE angles and were better than in similar cases operated with Kotz osteotomy.

We have found no information in the literature about the influence of Kotz osteotomy on arthrosis of the hip [8]. Since in our series arthrosis regressed in 12 hips (54%), remained unchanged in nine, and progressed in only one, we contemplate that Kotz polygonal triple osteotomy prevented the progression of arthrosis. With respect to Ganz osteotomy, we observed that arthrosis regressed in 15 hips (65%), remained unchanged in five, and progressed in three. It is our opinion that Ganz osteotomy might prevent progression of arthritis. On the other hand, we performed the osteotomies even in patients with grade 4 arthrosis (three in group 1 and one in group 2). We observed that arthrosis regressed in two and preoperative pain resolved in all. We believe that periacetabular osteotomies can be performed even in grade 4 osteoarthritis.

In our series, with Kotz osteotomy, preoperative Trendelenburg limping was cured in only nine out of 14 hips. Limping due to persistent abductor muscle insufficiency is the most important disadvantage of Kotz osteotomy. With Ganz osteotomy, postoperative resolution of Trendelenburg limping was higher.

In patients who underwent Kotz polygonal triple osteotomy, preoperative pain subsided in 17 of 22 hips whereas pain subsided in 21 of 23 hips treated with Ganz osteotomy. The better success rate of Ganz osteotomy with respect to resolution of pain may be due to the better postoperative coverage of femoral head and less morbidity of abductor muscles.

In patients undergoing Kotz osteotomy, fibular nerve palsy, which occurred in three patients, was transient. Ischial or pubic pseudoarthrosis did not adversely affect pelvic stability or cause severe complaints. On the other hand, patients undergoing Ganz osteotomy had major complications. The complication rate of Ganz and modified Bernese osteotomies have been reported to be between 0.17 and 1.28 per patient [2, 3, 7, 10, 11, 15, 19, 21]. It has been pointed out that the majority of these complications occurred during a surgeon's training phase and that the rate gradually decreases. In our series with Ganz osteotomies, 15 complications were observed and our complication rate per hip (0.65) is comparable with those of the literature. Most complications, including the major ones, occurred in the first ten operations, after we started using Ganz osteotomy. Therefore, we are in agreement with the consensus stating that the learning curve of this technique is difficult and the complication rate decreases as experience is gained.

Overall, with both types of osteotomies one can achieve obvious functional and radiological improvement, and progression of arthrosis can be prevented. Although the numbers are small, Ganz osteotomy seems more successful than Kotz osteotomy. Correction obtained with Ganz osteotomy, especially in patients where preoperative CE angles were below -10° , was much better than with Kotz osteotomy.

We chose to start with Kotz osteotomy because of its easier operative technique. Our follow-up revealed some insufficiencies such as abductor limp and inadequate correction in severe dysplasias [18]. Clinical and scientific advantages of Ganz osteotomy as published in the literature led us to try this complex osteotomy. We observed serious complications during the learning curve period. We thought that experience was gained complications would be less, which proved to be true according to follow-up. The aim of this study was not to compare the techniques but to share the messages learned.

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