Is varus osteotomy necessary in one-stage treatment of developmental dislocation of the hip in older children?

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Abstract

Purpose Innominate osteotomy, varisation–derotation osteotomy, and shortening osteotomy are the most common surgical procedures used to achieve pelvifemoral realignment in the treatment of children over three years of age with developmental hip dislocation. It is well known that varus osteotomy can improve the acetabular index but it does have some disadvantages. The aim of this study was to discuss the results obtained with patients treated only with Salter osteotomy, derotation osteotomy, and shortening, without varus osteotomy, and to evaluate the need for varisation on the basis of these results.

Methods Between 1996 and 2001, twenty-four hips, sixteen unilateral and four bilateral, of a total of twenty patients treated with this method and available for final controls were evaluated. The study included sixteen female and four male patients with a mean age of 4 years 2 months (ranging between 2 years 10 months and 8 years). The mean follow-up period was determined as 6.57 years (range 5–10 years). McKay's clinical criteria, Sever's radiological criteria, and the evaluation system modified by Trevor et al. were used for evaluation of the results.

Results Based on McKay's clinical criteria, eighteen hips (75%) were classified as type I, four hips (16%) as type II, and two hips (9%) as type III. According to Sever's radiological criteria, thirteen hips (54%) were graded as

grade I, nine hips (37.5%) as grade II, and two (8.5%) as grade III. According to the modified evaluation system of Trevor et al. the results were categorized as excellent in thirteen hips, good in nine hips, and moderate in two hips. Pre-operative mean acetabular index was measured as 37.3° (28°–50°) and early post-operative mean acetabular index as 26° (18°–38°). In the final radiological examination the mean acetabular index was measured as 18.3° and the mean CE angle as 30.1° (15°–38°). Avascular necrosis affecting the results developed in five hips.

Conclusion It is concluded that in older children with developmental dislocation of the hip (DDH) treated with one-stage combined surgical intervention, adequately stable concentric reduction can be achieved without varisation and that varus osteotomy is not always necessary.

Keywords Developmental dislocation of the hip · One-stage combined operation · Varus osteotomy

Introduction

Generally, congenital hip dislocation can be treated without problem if diagnosed before one year of age. Despite advanced diagnostic methods late-diagnosed cases are still encountered. Late diagnosis leads to soft-tissue contractures in the hip and to displastic changes in the hip joint, paving the way for osteoarthritis during early adulthood. That is why different principles are applied to treatment of children over three years of age as opposed to newborns. Not only should the soft-tissue contractures that inhibit reduction and exert pressure on the hip be corrected, but also pelvifemoral malalignment. Several types of osteotomy have been used for pelvifemoral realignment, either alone or in combination, most common of which are Salter innominate

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osteotomy, derotation–varisation osteotomy, and shortening osteotomy [1–7]. The purpose of all these procedures is to achieve concentric stable reduction in the functional position without inducing avascular necrosis in the hip. Although many authors emphasize that the formation of coxa vara through varus osteotomy contributes to stable reduction of the hip, it itself is a deformity and cannot be deemed as a functional position [1, 2, 5, 6, 8]. It is known that the formation of coxa vara will increase the burden on the medial physis line and this in turn will accelerate medial augmentation leading, probably, to new vague formation in the hip [7, 9–11]. However, varus osteotomy has some drawbacks during or after the operation and at the late stage [12–14]. Therefore, this procedure should be implemented only after thorough risk–benefit evaluation.

In this study, the results obtained with children over three years of age, treated at one-stage with Salter osteotomy, derotation osteotomy, and shortening without varus osteotomy were evaluated and the need for varisation in these patients was discussed.

Materials and methods

The study included patients three years of age and older with complete congenital dislocation (Tönnis Grade III), treated by one-stage surgical intervention, without any varisation, in our clinic between 1996 and 2001. Patients treated either with Salter osteotomy or with femoral osteotomy alone, and patients treated previously, were excluded from the study. In addition to examination of past patient records, the patients were called with a letter in January 2006 for a final clinic and radiological examination.

Twenty-four hips, sixteen (79%) unilateral and four (21%) bilateral, of a total of twenty patients treated with this method and available for final controls were evaluated. Sixteen patients were female (83%) and four male (17%), ranging between 2 years 10 months and 8 years of age (mean age 4.2 years) (Table 1). The mean follow-up period was determined as 6.57 years (minimum five and maximum ten years).

Pre-operative traction was not used on patients. Operation was initiated with open or percutaneous adductor tenotomy. In the surgical operation, double incision, namely Smith–Peterson and lateral proximal femoral incision, was performed. Open reduction, Salter osteotomy, and subtrochanteric derotation, shortening osteotomy procedures, were also applied on all patients included in the study. The extent of derotation was determined on the basis of the stability of the intra-operative hip. In order to decrease the pressure exerted on the hip, the distal femoral segment of each patient was shortened (ranging between 1

and 2 cm in length). The osteotomy line was fixed with a pediatric-type Harris–Mueller plate. Capsule excision and capsulography were performed after reduction. None of the patients required acetabulofemoral fixation with Kirchner wire to protect the reduction. A spica cast was worn full time for 1.5 months, followed by full time abduction bracing for 1.5 months and then night-time only bracing for an additional 1.5 months. Patients were encouraged to move in abduction splints. In bilateral cases, in order to reduce the stiffness on the operated side and to prevent the graft and bone collapsing at the osteotomy line related to immobilization osteoporosis, operation of the other hip was delayed 1–1.5 months after removal of the splint and the patient was rehabilitated during this time interval.

McKay's clinical criteria and Sever's radiological criteria, and the evaluation system modified by Trevor et al. [17] were used for the evaluation of results. According to this evaluation scheme the total score is 20 and the 18–20 range is accepted as excellent, 15–17 as good, 12–14 as moderate, and below 12 as poor (Table 1).

Findings

In the early post-operative and spica cast-worn period, superficial wound infection was observed in one patient, and pressure ulceration in the sacral region due to cast pressure was observed in another. None of the hips demonstrated redislocation and subluxation. According to McKay's criteria, the results were grouped as type I in eighteen hips (75%) (Figs. 1a–d), type II in four hips, and type III in one hip. Based on Sever's radiological criteria, thirteen hips (54%) were graded as grade I (Figs. 2a–c), nine hips (37.5%) as Grade II, and two hips (8.3%) as Grade III. Finally, according to the modified evaluation scheme of Trevor et al., thirteen hips (51.7%) were evaluated as excellent (Figs. 3a–c, 4a–d), nine hips (40%) as good, and two hips (6.8%) as moderate. No patient was evaluated as “poor” (Table 2). Pre-operative mean acetabular index was measured as 37.3° (28°–50°), early post-operative mean acetabular index as 26° (18°–38°), and mean improvement as 11.3°. In the final radiological examinations the mean acetabular index was observed to fall to 18.3°. Again in the final radiological examinations Wiberg's mean CE angle was measured as 30.1° (15°–38°). According to the Kalamachi and MacEwan criteria, AVN was observed in twelve hips (50%). However, seven of these were type I AVN which had no effect on clinical and radiological results. Type II AVN and type IV AVN, both affecting the results, were observed in two and three hips, respectively. Radiological abnormalities were detected in the late stage in hips with type II and type IV AVN, but nevertheless their functional results were good.

Table 1 Method of assessment (modified score system of Trevor et al.)

Symptoms and signs	Severity	Points
Pain	None	3
	Occasional	2
	Persistent	1
Movement	Full	5
	Slight limitation but no fixed deformity	4
	More than half the normal range	3
	Less than half the normal range but some fixed deformity	2
	Little	1
Limp	Absent	1
	Present	0
Function as described by the patient and assessed in the follow-up clinic	Full	3
	Slightly limited	2
	Severely limited	1

Symptoms and signs	Radiological feature		Points
	Age < 14 years	Age ≥ 14 years	
The CE of Wiberg	≥20°	≥25°	4
	15°–19°	20°–24°	3
	10°–14°	15°–19°	2
	<10°	<15°	1
Appearance of the femoral head	Normal		3
	Partial coxa plana or coxa magna		2
	Complete coxa plana or other severe deformity		1
Shenton’s line	Intact		1
	Broken		0

Fig. 1 **a** Radiography of left DDH in a six-year-old girl; **b** early post-operative radiograph after radical reduction without varus osteotomy; **c** one-year follow-up radiography; **d** radiography at six-year follow-up. Clinically and radiologically type I results obtained

Fig. 2 **a** AP radiography of a four-year old-girl with left DDH; **b** early post-operative radiography after radical reduction; **c** seven-year follow-up radiography shows type I results radiologically

Fig. 3 **a** Radiography of a four-year-old girl with bilateral DDH; **b** one-year follow-up radiography; **c** seven-year follow-up radiography

Discussion

A continuous, stable, and concentric reduction is needed in order to achieve optimum acetabular development in the treatment of congenital hip dislocation. In order to achieve this reduction in children over three years of age a combination of operations is suggested, the basic component being varus osteotomy. It has already been reported by a great many authors that varus derotation osteotomy enhances the improvement in acetabular index [1–4, 6, 15]. This procedure is accepted as an important tool in monotreatment of subluxated hips of children below four years

of age and in treatment of congenital hip dislocation in children over four years of age in combination with pelvic osteotomy. This commonly used osteotomy procedure is, however, restricted by some difficulties and potential complications. First of all, for an optimum outcome of varus osteotomy, a maximum 100°–110° neck–shaft angle should be obtained [8, 11, 16]. This, however, is technologically the most difficult part of operation and it may not always be possible to obtain the desired angle, which may lead to extensive varus formation. Particularly in elder children, extensive varus might not be corrected and might require re-operation [2, 5, 6].

Fig. 4 **a** Radiography of a six-year-old girl with right DDH; **b** early post-operative radiograph; **c** one-year follow-up appearance; **d** radiography of the pelvis at the end of the seventh post-operative year shows type I results

Table 2 Surgical and follow-up data for the patients

Case	Sex	Age (year + month)	AI post-operative	AI post-operative	AI last control	CE angle last control	Results (Trevor)
1	K(right)	5	38	25	17	30	20
1	K(left)	5	42	28	15	36	19
2	K(right)	7	32	24	18	30	17
2	K(left)	7	34	26	26	28	17
3	K(right)	3	30	24	19	26	19
3	K(left)	3	31	26	18	26	17
4	K(right)	3 + 6	44	32	17	34	19
4	K(left)	3 + 6	43	31	16	34	20
5	K	3	31	22	14	35	19
6	E	3	35	18	12	38	18
7	K	3	29	22	14	32	20
8	E	3	40	26	14	34	18
9	K	3	40	23	19	38	17
10	K	8	46	38	32	21	14
11	E	3	36	28	19	31	17
12	E	5	40	31	27	27	17
13	K	7	50	35	19	27	16
14	K	2	44	27	14	36	19
15	K	7	40	27	14	32	17
16	E	4	45	29	30	15	15
17	K	2 + 6	29	29	20	20	20
18	E	5	32	24	16	34	18
19	K	3	35	22	16	32	17
20	K	4	30	19	14	30	19

Trandelenburg gait may also persist after the operation; in our opinion this constitutes the second most important problem. In children treated with varus osteotomy,

Trandelenburg gait associated with coxa vara may still persist, despite treatment of hip dislocation [13]. Parents bringing their children with limp complaints for treatment

often end up in desperation seeing that limping still persists after the treatment and, as complete recovery takes a long time, the physician's statements on correction of limping by time are often met with suspicion by such parents.

It is believed that coxa vara created by varus osteotomy evolves to be valgus again in the course of development and even that, due to stimulation of the medial epiphysis line, correction will be excessive according to criteria of the Houter–Wolkman law [9, 10]. However, upon evaluation of 40 children with a mean age of 1 year 10 months treated with varus derotation osteotomy, Sangavi et al. concluded that remodeling will occur within an average of three years, but there is a significant correlation between the age of operation and the final neck–shaft angle and that in older children the final neck–shaft angle is lower than for the normal hip [10].

The fact that varus osteotomy alters the mechanical axis of the lower extremity is another less mentioned problem. Suda et al. [16] demonstrated that varus osteotomy shifts the mechanical axis of the lower extremity to the medial knee and this in turn causes genu valgum deformity in the knee which persists even after the hip is revalgised. The same authors emphasized that problems may occur in the knees of such patients in longer follow-up periods and for this reason, just as for the hip, the knee also should be followed up.

Ogden et al. [14] detected a shift in femur proximal epiphysis in two cases with coxa vara. Again, Lahoti et al. [13] reported that they have observed epiphysiolysis in two children treated with derotation varus osteotomy for developmental hip dislocation and have treated both cases with valgisation osteotomy. The biomechanics of the hip can be altered to a great extent by varisation osteotomy. After this operation proximal femoral epiphysis is exposed to increased shearing stress and it is calculated that up to 2.5 times the shearing stress is imposed on the physis line with formation of 30° coxa vara [12]. Chung et al. stated that this shearing stress increases with age [12]. Particularly when neck–shaft angle is reduced to 90°, the physis line takes an almost vertical position which constitutes a risk with respect to epiphysiolysis [13, 14].

In combined one-stage treatment of older children with congenital hip dislocation, we obtained excellent to good results in twenty-two out of twenty-four hips without varisation osteotomy. These results suggest that concentric reduction and sufficient stability can be achieved by using open reduction, innominate osteotomy, derotation, and femoral shortening procedures in treatment of older children with developmental dislocation of the hip (DDH), and, thus, varus osteotomy is not necessary.

Conclusion

Varus osteotomy alters the hip biomechanics to a great extent and the resulting position is not physiological. Comparisons with varus osteotomy are few. It is possible to eliminate the varus component and here we report our patient outcomes when we leave out the varus. Varus osteotomy is not always necessary in the treatment of older children with congenital hip dislocation, if appropriate open reduction, innominate osteotomy, derotation, and femoral shortening procedures are applied.

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