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Original article

Outcomes of modified Dega acetabuloplasty in acetabular dysplasia related to developmental dislocation of the hip



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ABSTRACT

Developmental dislocation of the hip (DDH) is frequently, even after reduction, associated with residual acetabular dysplasia. Various surgical techniques are used to correct this, one of which is Dega acetabuloplasty. This osteotomy technique has, however, rarely been assessed in this particular indication. The present study therefore sought to describe the technical details, report clinical and radiological results, and present limitations.

Hypothesis: Unlike reorientation osteotomy in children, Dega acetabuloplasty does not lead to a high rate of acetabular retroversion at the end of growth.

Patients and methods: Sixteen Dega acetabuloplasties in 15 patients were assessed on joint range of motion, limp, lower limb length discrepancy and impaired everyday activity, pre-operatively and at end of follow-up. Hips were classified following Wicart et al. (2003). Radiologic assessment comprised Wiberg angle and acetabular index, pre- and post-operatively and at follow-up. Acetabular retroversion was analyzed by crossover sign, and hips were classified following Severin.

Results: Median age at surgery was 3 years (range, 1.1–12.2 years) and 10 years (6.4–17.8) at end of follow-up. At end of follow-up, all hips were pain-free and classified as Wicart A, and all activities were allowed. Radiologically, hips were classified as Severin I, II or IV, in 11 (68.5%), 4 (25%) and 1 (6.5%) cases respectively. Wiberg angle rose from a mean 3.3° (–30° to 30°) to 23° (10° to 38°) and acetabular index fell from a mean 31° (25° to 45°) to 20° (5° to 30°) with surgery, and both continued to improve over follow-up: 26° (12–45°) and 13° (3–24°) respectively ($P < 0.05$). Acetabular retroversion was found in 2 of the 10 hips with Y cartilage fusion.

Discussion: Modified Dega acetabuloplasty was effective in correcting acetabular dysplasia in DDH. Functional and radiological results were good, with a low rate of acetabular retroversion (2/10), unlike with other techniques.

Level of evidence: Level IV. Therapeutic study.

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1. Introduction

Reducing developmental dislocation of the hip (DDH) enables acetabular growth and corrects acetabular dysplasia, which may however persist, constituting a negative long-term prognostic factor requiring surveillance throughout growth and in early adulthood [1]. Salter's innominate acetabular reorientation osteotomy is the most frequently performed procedure [1]. In 1964, Dega [2] described an incomplete transiliac osteotomy to correct acetabular dysplasia following DDH. Since then, few studies [3,4] have

reported results for this procedure in this indication, and none have analyzed the evolution of acetabular retroversion following Dega acetabuloplasty. For more than 15 years, we have been using a modified Dega osteotomy [5] for acetabular dysplasia following DDH. The present study reports technical details and assesses results in terms of the evolution of acetabular parameters at more than 5 years' follow-up.

2. Patient and method

2.1. Patients

The series comprised children managed by modified Dega acetabuloplasty [5] for acetabular dysplasia following DDH and

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Table 1
Patients' data.

Hip No.	Previous treatment	Age at surgery (years)	Associated procedure	Age at FU (years)	Wiberg angle (°)			Acetabular index (°)			Severin	Acetabular retroversion
					Pre-op	Cast removal	FU	Pre-op	Cast removal	FU		
1	CR	3		11	16	22	25	30	25	20	I	NA
2	CR	4		14	28	36	21	28	18	18	I	Yes
3		3	SR	11	30	22	24	30	25	8	II	No
4	CR	3		8.5	-12	21	21	30	20	12	I	No
5		2	SR	8	20	22	22	34	20	20	I	NA
6	CR	2		6.5	10	18	18	33	20	17	II	NA
7	CR	2	FO	8	-10	38	30	30	23	15	I	NA
8	CR	6		16	12	18	26	30	23	10	II	No
9	CR	10	SR	16	15	35	26	25	5	5	I	No
10	CR	2		15	-20	23	45	40	19	3	I	Yes
11	CR	4		9	20	28	45	25	5	8	I	No
12	CR	2	SR FO	8	-20	10	24	28	28	15	II	NA
13	CR	3	SR FO	8	10	19	20	28	20	15	I	NA
14	CR	1	SR FO	11	-25	23	40	35	30	8	I	No
15		2	SR FO	9	-30	10	22	45	30	18	I	No
16		12	SR FO	18	10	24	12	40	24	24	IV	No

CR: conservative reduction (traction and hip spica cast); ST: surgical reduction; OF: femoral osteotomy; NA: non-assessable due to lack of bone maturity (no cartilage closure).

who had no previous history of pelvic osteotomy. Minimum follow-up was 5 years. Between 1990 and 2005, 29 underwent this procedure. Dega acetabuloplasty was indicated for acetabular insufficiency (acetabular index $\geq 25^\circ$) associated with an acetabulum with an ascending iliac part long enough to provide sufficient cover when lowered. Fourteen of these 29 children were excluded for insufficient follow-up (<5 years): these were foreign patients, operated on in our department but followed up in their home country. In all, 15 children (16 hips) were analyzed (Table 1). Eight of these 16 hips received acetabuloplasty to manage dysplasia after conservative reduction, including 1 with femoral osteotomy associated in the same step; the other 8 received 1-step acetabuloplasty and associated surgical reduction of the DDH, including 5 with femoral osteotomy associated in the same step, for severe pre-operative subluxation of the femoral head.

2.2. Surgical technique

Surgery systematically used the Dega procedure [2,5,6], under general anesthesia and radioscopic control, the patient supine on a standard table with the buttock on the operated side raised on a cushion. The whole limb was included in the surgical field. Femoral osteotomy, when planned, was via a lateral incision on the thigh. A Bikini skin approach allowed acetabuloplasty and, when required, surgical reduction of the hip. The skin incision was made 1 cm below the relief of the iliac crest, and curved upward through the space between the sartorius and tensor fasciae latae muscles. The iliac crest was exposed and an incision was made along the cartilage. The lateral side of the iliac crest was exposed subperiosteally up to the great sciatic notch. Pelvic osteotomy was performed under radioscopic control, with a curved osteotomy beginning about 15 mm above the edge of the acetabulum. The osteotomy line was oriented backward toward the triradiate cartilage, beginning facing the antero-inferior iliac spine. Only the lateral table of the iliac wing was involved by the osteotomy line, except in the most anterior and posterior parts, where 2 mm of the medial table of the sciatic notch was also sectioned to facilitate mobilization of the roof of the acetabulum. An approach on the medial side of the iliac wing was unnecessary. The acetabular roof was lowered using a Méary distractor and fixed by a corticocancellous bone graft harvested either from the iliac crest (1 or 2 grafts) or from the femur (1 corticocancellous disk). The graft was introduced in the posterior part of the osteotomy, to lower the posterior part of the acetabulum and correct posterior dysplasia, straddling the cortical part of the crest so as

not to cause correction loss by subsiding into the cancellous bone. No osteosynthesis was performed. At end of surgery, an AP pelvic radiograph was taken to check the positioning of the femoral head and the normalization of Shenton's line. Post-operative immobilization was in a hip spica cast for 6 weeks; in associated surgical reductions of the hip, this was followed by 3 months' nocturnal abduction braces, progressively withdrawn.

2.3. Assessment

Clinical examination of the hip comprised measurement of range of motion (ROM: normal for flexion $>120^\circ$, abduction $45\text{--}50^\circ$, adduction $30\text{--}40^\circ$, internal rotation 45° , external rotation 35° and extension $20\text{--}30^\circ$). Hips were classified by ROM, following Wicart et al. [7]: group A, flexion $120\text{--}140^\circ$; group B, flexion $90\text{--}120^\circ$; group C, flexion $<90^\circ$ or no internal rotation; and group D, angular deformity $>20^\circ$ regardless of degree of flexion. Limp, pain and restricted daily or leisure activity were noted at end of follow-up, by simple interview, as no validated scale exists for these parameters in children.

Pelvic X-ray systematically comprised AP views, supine, with lower limbs in slight internal rotation to point the patella vertically. Assessment was based on the Wiberg angle and acetabular index [8]. Acetabular retroversion was assessed from the crossover sign [9,10]. Views were taken pre-operatively, at 45 days (at cast removal) and at end of follow-up, when hips were also classified following Severin [11].

2.4. Statistics

Pre- and post-operative qualitative clinical assessment classified patients in the above-mentioned groups. Angular values were compared on non-parametric Kruskal-Wallis test (using StatView software: SAS, Cary, USA), with pre- and post-operative and end of follow-up values as 3 independent groups. The significance threshold was set at $P < 0.05$.

3. Results

Median age at surgery was 3 years (range, 1.1–12.2 years), and 10 years (6.4–17.8) at end of follow-up. Sex ratio (M/F) was 1/14. Pre-operatively, no patients showed pain or activity restriction. Patients with pre-operative dislocation of the hip ($n = 8$) limped and showed reduced abduction on the dislocated side pre-operatively.

Table 2

Radiological data (pre-operative, immediate post-operative, end of follow-up): medians and ranges.

	Pre-op	Post-op	Follow-up	P
Wiberg angle (°)	10 (–30 to 30)	22 (10 to 38)	24 (12 to 45)	<0.05
Acetabular index (%)	30 (25 to 45)	21.5 (5 to 30)	15 (3 to 24)	<0.05

Significant difference between pre-operative and end of follow-up angles on Kruskal-Wallis test.

At end of follow-up, no patients showed pain, limping or restriction of normal-for-age activity; all could practice all leisure activities they wished without restriction, including sports. All hips were Wicart group A [7].

Wiberg angle showed significant improvement (by a mean +15°; $P=0.0003$) and acetabular index significant reduction (mean, >50%; $P<0.0001$) (Tables 1 and 2): Wiberg angle rose from a mean 3.3° (–30° to 30°) to 23° (10° to 38°) and acetabular index fell from 31° (25° to 45°) to 20° (5° to 30°), with continued improvements to end of follow-up: 26° (12° to 45°) and 13° (3° to 24°). Crossover sign was investigated only in the 10 hips with Y cartilage fusion, the other 6 lacking sufficient bone maturity. Two of these 10 hips showed acetabular retroversion (hips 2 and 10 in Table 1). At end of follow-up, 11 hips (68.5%) were Severin I (Fig. 1), 4 (25%) Severin II, and 1 (6.5%) Severin IV (broken Shenton's line). The Severin IV hip was in the oldest patient at the time of surgery (Fig. 2): 12 years old at Dega acetabuloplasty with associated varus femoral osteotomy, the family having refused surgery until then; residual subluxation required Chiari's osteotomy at the age of 18 years.

There was only 1 complication: femoral shaft fracture 1 month after cast removal, due to osteoporosis related to immobilization. Radiography found no triradiate cartilage epiphysiodesis or other growth disorder.

4. Discussion

In the present series, modified Dega acetabuloplasty reliably corrected dysplasia following DDH, avoiding retroversion in most

cases. Moreover, the procedure did not impair range of motion, and enabled pain-free resumption of activity at more than 5 years' follow-up.

The study involved limitations:

- notably, mean follow-up was only 7.2 years; however, apart from Ruszkowski and Pucher [12] with 9.4 years' follow-up, other reports of Dega acetabuloplasty in this indication had similar or shorter follow-up [3,4,13,14];
- secondly, acetabular retroversion was not measured reliably in all cases, due to non-fusion of the triradiate cartilage [15];
- finally, the series was small, with diverse associated treatments: surgical reduction of the hip and/or varus femoral osteotomy; the analysis, however, focused on acetabular evolution, independently of associated procedures.

There were no osteotomy complications, and notably no secondary displacement such as reported in innominate osteotomy [16,17]. Again unlike in innominate osteotomy [18], no premature triradiate cartilage closure was found with this technique in the literature or in the present series. The absence of osteosynthesis is a further advantage, avoiding risk of K-wire infection [18] and the need for reintervention to remove K-wires [19]. Moreover, although not demonstrated in the literature, the technique does not require an approach to the medial iliac fossa, making surgery faster and less hemorrhagic than Salter's innominate osteotomy. The main drawback is the need for perioperative radioscopic control.

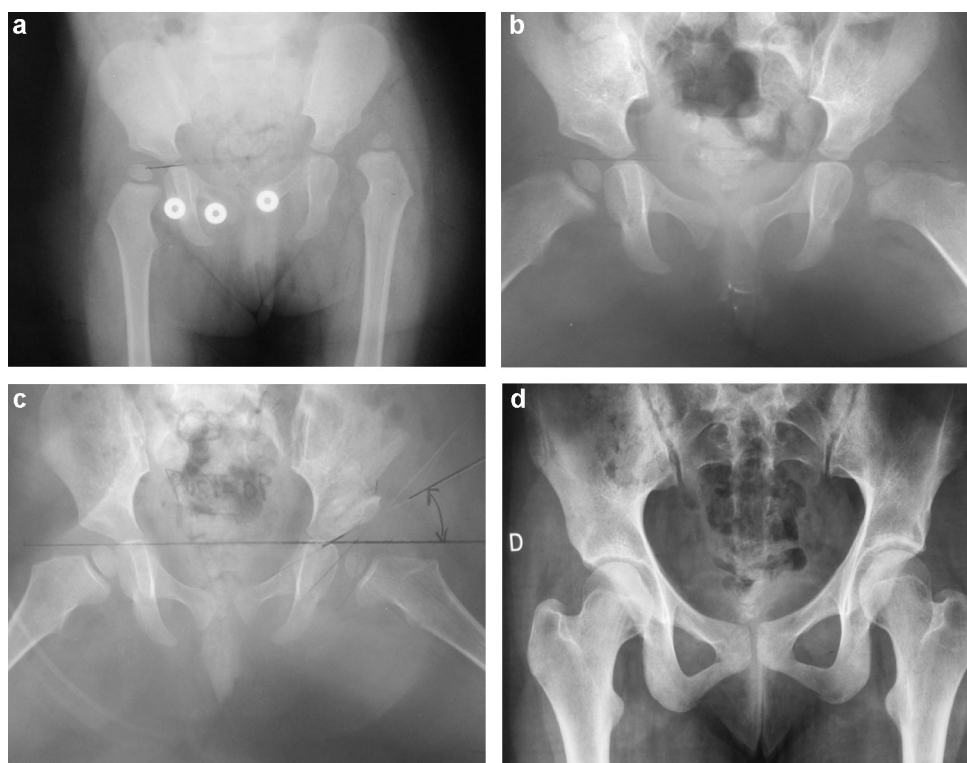


Fig. 1. a: age 18 months. Congenital dislocation of the left hip (Table 1, case No. 10); b: persistent left acetabular dysplasia (IA 40°, ACE –20°) after orthopedic reduction of the hip (traction and cast); c: modified Dega acetabuloplasty at 2 years of age; d: radiological result at 15 years of age. Hip is classified Severin I.

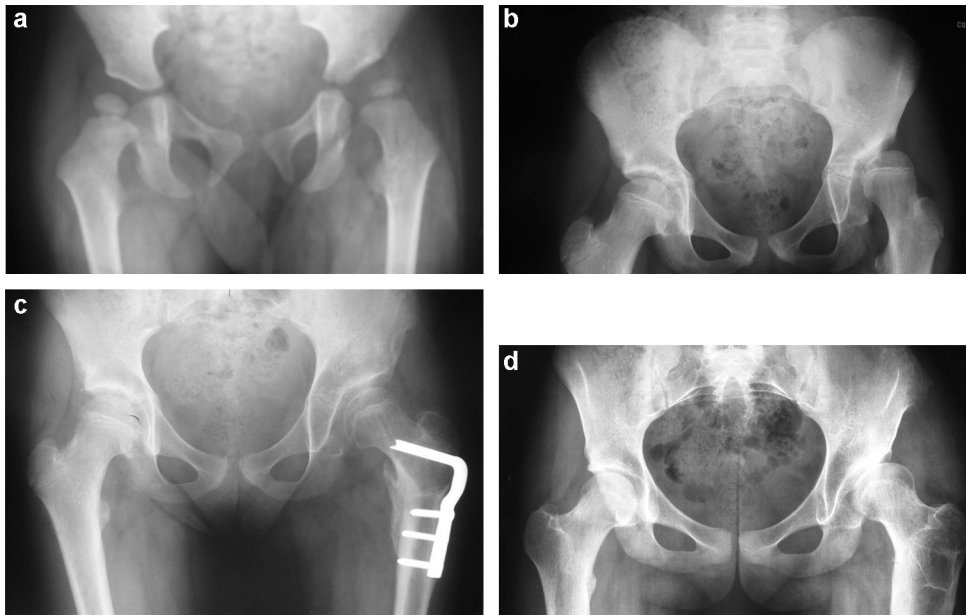


Fig. 2. a: left hip subluxation at age 1.5 years, after orthopedic reduction of congenital dislocation of the hip (Table 1, case No. 16); b: 12 years old. Left hip subluxated; c: post-operative result after modified Dega acetabuloplasty and femoral variation and derotation osteotomy. Note left hip lateralization, related to enlarged deep acetabulum (already present pre-operatively); d: recurrence of subluxation at 18 years of age. Hip is classified Severin IV.

Clinical results were fair, as expected in children, as acetabular dysplasia becomes symptomatic only later, in adulthood. Radiological results were satisfactory: 94% normal or subnormal hips on the Severin classification. The significant corrections found in mean acetabular index and Wiberg angle were similar to those reported by Kitoh et al. [20] after Salter's innominate osteotomy. At end of follow-up, angular values were similar to other reports for Dega acetabuloplasty [3,12–14]. Acetabular dysplasia is known to be circumferential following DDH [21], but with posterosuperior predominance [22,23]. According to Fujii et al. [24], hip deterioration following DDH reduction is due to imperfect reduction associated with insufficient posterior cover. Dega acetabuloplasty lowers the iliac part of the acetabulum, improving posterior cover [13], and usually avoiding acetabular retroversion, unlike other osteotomy techniques. Pemberton osteotomy [6] remodels the acetabulum, without improving posterior cover as the osteotomy hinge is posterior; Salter's osteotomy reorients it, improving anterior cover but reducing posterior cover of the femoral head [15,16,25,26]. Retroversion may induce posterior dislocation of the femoral head following innominate osteotomy [16,17]. The link between the acetabular retroversion induced by innominate osteotomy (27% for Dora et al. [26]) and anterior hip impingement leading to early osteoarthritis is still controversial [26,27], but Dega acetabuloplasty seems better adapted to the pathological anatomy of acetabular dysplasia following DDH. It also increases acetabular cavity volume by about 50%, reducing intra-articular pressure on the femoral head [28,29].

The one poor result illustrates the limitations of this technique: a girl was operated on at the age of 12 years, too old for effective correction of dysplasia by this procedure [12,14]. Pre-operative radiographs showed defects predictive of poor outcome, with predominantly anterior acetabular dysplasia, to which the Dega technique has limited access. An age limit was likewise reported for innominate osteotomy, with better results in patients less than 4 years of age [18,30].

In conclusion, Dega acetabuloplasty is effective and reliable in correcting acetabular dysplasia following DDH. When the patient is under 8 years of age and without significant anterior acetabular dysplasia, it is our attitude of choice in this indication. Insufficient

anterior cover on lateral X-ray or MRI indicates Salter's innominate osteotomy [1] until 4 years of age, after which triple pelvic osteotomy or Chiari's osteotomy are recommended [6].

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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