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ORIGINAL ARTICLE

Dega Osteotomy for Residual Acetabular Dysplasia after Successful Open Reduction of Developmental Dysplasia of the Hip

Mahmoud Badawy, Ahmed M. Nagar, Sami I. Sadek
Orthopedic Department, Faculty of Medicine Zagazig University, Zagazig, Egypt.

Correspondence to *Mahmoud Badawy, MD, Orthopedic Department, Faculty of Medicine Zagazig University, Zagazig, Egypt.*
E-mail: mahmoudbadawy526@gmail.com

Background Up to one-third of successfully reduced developmental dysplasia of the hip are complicated by residual acetabular dysplasia (RAD). RAD is a predictor of early degenerative hip disease. The purpose of this study is to assess the radiological results of Dega acetabuloplasty in RAD.

Patients and Methods A total of 30 hips in 26 patients (23 girls and three boys) with RAD after open reduction of developmental dysplasia of the hip underwent Dega acetabuloplasty with or without plate femur extraction. There were 22 unilateral and four bilateral DDH.

Results Treatment results were evaluated radiologically using the acetabular index, central edge angle, Severin grading, and the development of the acetabular sourcil. All hips at the final follow-up showed well-remodeled acetabulum with normalization of all radiological parameters with the mean final follow-up acetabular index was 23.82º and the mean final follow-up CE angle was 35.48º. We have 25 hips Severin grade 1a and 5 hips grade 2a.

Conclusions Dega osteotomy is an effective tool for treating RAD and preventing its expected degenerative hip changes.

Keywords Dega osteotomy, Developmental dysplasia of the hip, Residual acetabular dysplasia.
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INTRODUCTION

Developmental dysplasia of the hip (DDH) is a spectrum of disorders ranging from isolated acetabular dysplasia to complete hip dislocation. After the successful open reduction of a dislocated hip, the acetabulum starts to remodel due to the molding effect of the femoral head. This results in the gradual deepening of the acetabulum and hence correction of hip dysplasia. However, sometimes this process is incomplete, and residual acetabular dysplasia occurs [1].

Residual hip dysplasia (RAD) as a complication after open reduction of DDH is largely age-dependent. The power of acetabular remodeling decreases with age [1]. Li *et al.,* found that DDH patients who were reduced before the age of 24 months were less likely to develop RAD compared with patients older than 24 months [2]. Up to one-third of the successfully reduced hips have RAD, a significant risk factor for early degenerative hip disease [3].

Pelvic osteotomies are indicated especially in DDH patients older than three years to improve the femoral head coverage and decrease the incidence of RAD. In patients between 18 and 36 months, it depends on the severity of the acetabular dysplasia and the intraoperative femoral head cover test [1,4].

Many types of pelvic osteotomies have been described to treat the acetabular dysplasia. Re-directional osteotomies such as Salter osteotomy increase the anterior and lateral coverage of the hip at the expense of the posterior coverage. However, reshaping osteotomies such as the Dega osteotomy [5] address both the acetabular mal-orientation and the hypoplasia of the acetabulum [6].

PATIENTS AND METHODS

This study was conducted on patients with residual acetabular dysplasia between March 2018 and March 2023. Thirty hips in twenty-six patients (23 girls and three boys) with residual acetabular dysplasia underwent correction with Dega osteotomy. Every child's parent signed an informed consent and our institution's IRB approved the study. There were four bilateral and 22 unilateral cases. The patient's mean age was 5 (ranging from 4 to 7) years. The minimum follow-up period was 1.5 years with a mean follow-up of 24 months. Eligibility criteria required patients who had residual acetabular dysplasia two years after successful open reduction of DDH with or without femoral derotation osteotomy. Patients with residual hip dysplasia after paralytic hip or septic hip reduction were excluded. Also, patients with severe avascular necrosis after open reduction of DDH were excluded.

Preoperative evaluation

A preoperative plain radiography of the pelvis and both hips anteroposterior and lateral views were performed to assess the acetabular index (AI) and the central edge angle of Weiberge (CE angle). In addition, computed tomography (CT) and three-dimensional (3D) CT were done to determine the site and the severity of the acetabular deficiency.

Operative technique

All cases underwent pelvis osteotomy to correct the RAD in the form of Dega acetabuloplasty. This procedure was combined with plate femur extraction in 20 hips that underwent femoral osteotomy at the time of the initial procedure.

The patients were positioned supine. The involved hip was tilted up with a roll under the ipsilateral hemipelvis. The entire lower limb and affected half of the pelvis were prepared and draped to allow the hip to move freely.

In 20 hips, the femoral plate was removed initially via the lateral approach of the femur after the previous scar was excised.

The Dega osteotomy was performed as described by Dega in his original paper [5,7]. We used the lateral part of the modified Smith–Peterson approach with 'bikini' skin incision [8], Dega osteotomy was done for all cases under fluoroscopic guidance. First of all, the outer iliac table was cut in a curvilinear fashion from a point about 1cm proximal to the anterior inferior iliac spine to end at a point about 1cm anterior to the greater sciatic notch. With a straight osteotome, the second cut was performed extending obliquely medially and inferiorly between the two tables of the ilium to exit through the inner iliac table about one centimeter proximal to the triradiate cartilage.

In eight cases (10 hips), we cut the inner cortex over the anterior and middle portions, leaving only the posterior hinge intact. In these cases, anterior coverage was predominantly needed.

In the other 18 cases (20 hips), the lateral deficiency was predominantly present, we cut only the anterior portion of the inner cortex leaving a posteromedial hinge.

By a mean of an osteotome, the opening of the osteotomy site was performed. We fashioned a tricortical graft from the iliac crest into two triangular pieces and then inserted them at the osteotomy site. Correction was then checked under the image intensifier (Figure 1). Closure of the iliac apophysis with continuous locked absorbable sutures was then done. We closed the wound in layers and sutured the skin in a subcuticular manner. A hip-spica cast was then applied. In bilateral cases, we did bilateral Dega osteotomy simultaneously in the same setting.

Figure 1: (A): Plain radiography pelvis anteroposterior view of 5-years-old female showing right residual acetabular dysplasia (AI= 420); (B), and (C): Intra-operative images of Dega osteotomy.

Postoperative and follow-up:

Plain radiography anteroposterior view and CT and 3D CT were done in the immediate postoperative period to assess the correction of the acetabular dysplasia, followed by a plain radiograph was done after 6 weeks to evaluate the union of the Dega osteotomy, and then every 6 months until the final follow-up to assess the sequential remodeling of the acetabulum (Figure 2).

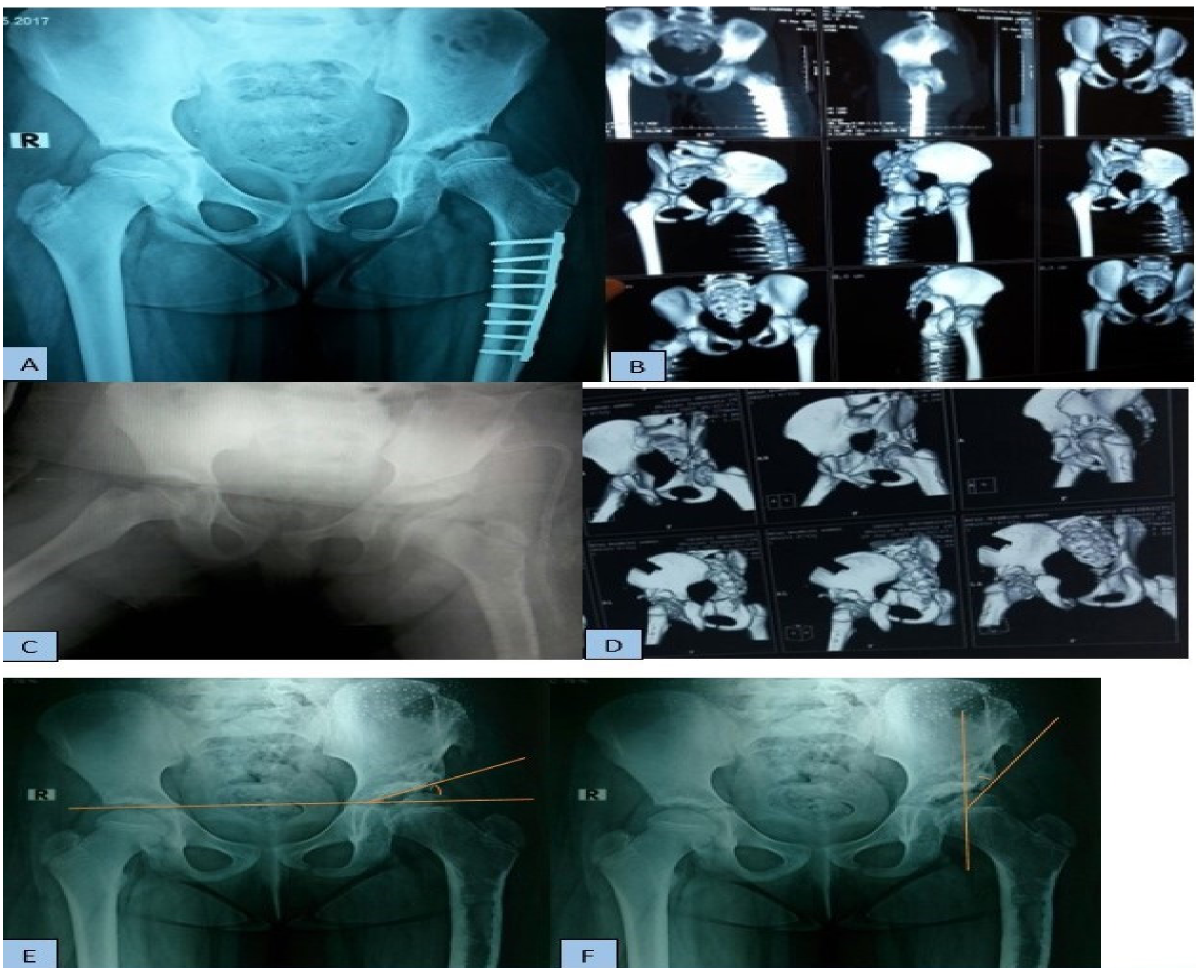

Figure 2: (A): Plain radiography pelvis anteroposterior view of seven years old female showing Lt residual acetabular dysplasia (AI= 350). Open reduction and femoral derotation osteotomy was performed at the age of three years; (B): 3DCT of the same patient shows anterolateral acetabular deficiency; (C): Postoperative plain radiography pelvis anteroposterior view after Dega acetabuloplasty; (D): 3DCT shows the osteotomy site, the position of graft and the correction of the residual acetabular dysplasia; (E), and (F): follow-up radiography shows good remodeling of the acetabulum (AI= 23, CE angle= 32.6) and the correction of acetabular dysplasia.

Statistical analysis

Categorical variables were presented as a number (percentage) and Continuous variables were presented as a mean±SD and range. Shapiro–Walk test checked continuous data for normality. Mann–Whitney *U* test compared two groups of non-normally distributed data. The results were of significant value if the *P* value was less than 0.05. We used SPSS 22.0 for Windows (IBM Inc., Chicago, Illinois, USA) for the performance of the statistics.

RESULTS

Parameters for evaluation of correction of acetabular dysplasia include the AI, CE angle, Severin grading, and the appearance of a well-developed acetabular sourcil that was evident in all cases at the final-follow-up. As regards the AI; the Mean preoperative AI was 38.22º degrees and the mean early postoperative AI was 25.62 degrees with an average acute correction of 12.6º. The mean AI value at the final follow-up was 23.82 degrees with an average final correction of 14.4º (Table 1).

Preoperatively, the mean CE angle was 16.22º. The mean CE angle at the final follow-up was 35.48º with an average correction of 19.26º (Table 1). Also, we used Severin grading at the final follow-up to evaluate the quality and possible longevity of the hip joint with 25 hips being Severin grade 1a and five hips being grade 2a that were complicated by moderate avascular necrosis at the initial open reduction that need no further management till the end of the follow-up of the current study.

Table 1: Assessment of correction of the acetabular dysplasia:

	Acetabular index		Acetabular index		Central edge angle of Weiberg	
	preoperative	Immediate postoperative	preoperative	Final follow-up	preoperative	Final follow-up
Mean+SD In degrees	38.22±3.91	25.62±3.5	38.22±3.91	23.82±3.6	16.22±3.82	35.48±3.5
Average correction	12.60		14.40		19.26	
P value	<0.001a		<0.001a		<0.001a	

aMann–Whitney *U* test.

DISCUSSION

Kim *et al.,* [9] found that the presence of an upward-sloping sclerotic sourcil predicts acetabular dysplasia. Albiñana and colleagues discovered that two years after open or closed hip reduction, 80% of hips with an AI of greater than 30º have poor results and typically develop RAD and degenerative hip changes [10].

Forlin and coworkers observed that Shenton's line disruption, the appearance of a sclerotic triangle at the weight-bearing area of the acetabulum, high AI, and low CE angle lead to a mechanical malfunction that causes RAD. The effect of the RAD on later hip subluxation and early hip osteoarthritis in adulthood was shown by long-term studies [11].

It is evident that if acetabular dysplasia remains at the age of 5, continued acetabular development will be inadequate. Thus, an innominate osteotomy should be done to ensure adequate hip development [12].

Baghdadi and Sankar ascribed the RAD to the age at the time of open reduction and the initial severity of the DDH [3].

Magnetic resonance imaging is recently used especially in equivocal cases, using both the cartilaginous acetabular index and the cartilaginous center edge angle. They consider cartilaginous acetabular inde greater than 18º, and cartilaginous center edge angle less than 13º indications for correction of the acetabular dysplasia [3].

To avoid this complication, in patients older than 3 years old, open reduction should be combined with acetabuloplasty. In patients between 18 and 36 months, an assessment of femoral head coverage intraoperatively after open reduction should be done. Acetabuloplasty should be performed if more than 1/3 of the femoral head is uncovered [1].

There are numerous varieties of acetabular osteotomies, including reshaping (Dega and Pemberton osteotomy) and re-directional (Salter osteotomy). All of these osteotomies are safe and effective and the choice between them is largely according to the surgeon's preference [13].

Li *et al.,* [14] investigated the variables that affect the outcomes of innominate osteotomy for RAD following closed reduction of DDH. They discovered that AVN and a Reimer migration index greater than 33% are risk factors for unsatisfactory results.

López-Carreño *et al.,* [15] found that Dega osteotomy was much better than Salter osteotomy by nearly all means especially in patients under the age of 8.

Dega osteotomy offers stable graft positioning that alleviates the need for fixation. It also increases the anterolateral femoral head coverage as well as the posterior coverage according to the position of the bone graft [16]. It is technically essential to put the graft for Dega osteotomy opposite the cortical iliac bone to avoid graft impaction against the cancellous bone and loss of some degrees of acetabular dysplasia correction [17]. No case of triradiate cartilage injury is present in this study from Dega acetabuloplasty.

In the current study, we found that Dega osteotomy corrects all radiological parameters of the acetabular dysplasia and improves the stability of the hip joint.

Many published studies [18-22] report the results of Dega acetabuloplasty in the correction of acetabular dysplasia (Table 2). In one of the largest case series, Reichel and Hein [22] reported improvement of the AI in 70 hips by a mean of 18º. Karlen *et al.,* [18] achieved the largest correction of AI with a mean of 24º in 26 hips. We have a comparable result with these published series with a mean final follow-up AI of 23.82º and a mean correction of 14.4º.

In the current study, the mean final follow-up CE angle was 35.48º This was consistent with the findings of El-Sayed *et al.,* [20], who reported a mean CE angle of 34º (Table 2).

The main limitations of the current study are the small sample size, short follow-up period, and the absence of a control group for comparison.

Table 2: Results of Dega acetabuloplasty in correction of acetabular dysplasia in the current study compared with previous studies:

Study	Age (years)	Hips numbers	Pre-AI (º)	Follow-up AI (º)	Follow-up CE angle (º)
Aksoy *et al.,* [13]	4.8	43	35	13	–
Grudziak and Ward [16]	5.8	24	33	12	31
Karlen *et al.,* [18]	3.1	26	37	13	-
Al-Ghamdi *et al.,* [19]	4.6	21	37	19	25
El-Sayed *et al.,* [20]	4.1	58	39	25	34
Czubak *et al.,* [21]	3.9	52	39	20	26
Current study	5	30	38.22	23.82	35.480

CONCLUSION

Residual acetabular dysplasia is a considerable complication after successful open reduction of DDH. Dega pelvic osteotomy can effectively correct residual acetabular dysplasia and hence prevent possible degenerative hip changes.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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