Revision of redislocation after primary surgery of developmental dysplasia of the hip

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Background
Revision open reduction following failed open reduction for developmental dysplasia of the hip (DDH) is technically demanding owing to adhesions and secondary changes after redisplacement.
Patients and methods
A total of 28 hips in 28 children were operated on for redislocation after primary open reduction of DDH. The additional procedures to the open reduction in the first operation were six adductor tenotomies and 12 femoral osteotomies. Bony procedures needed after trial of relocation were femoral derotation osteotomy fixed by small dynamic compression plate (DCP) in all hips (15 with femoral shortening and 13 without femoral shortening). Pelvic osteotomy was added to femoral osteotomy in 16 cases: Salter's osteotomy in 10 hips and Dega osteotomy in six cases.
Results
The mean follow-up time after the revision was 66 months. According to McKay's criteria, 11 (39.27%) hips had excellent results. Seven (25%) hips had good results, six (21.43%) hips had fair results, and four (14.3%) hips were graded as having poor results. Radiologically, 14 (49.9%) hips were Severin types I and II, 10 (35.7%) showed types III and IV, two (7.2%) hips were rated as Severin's grade VI, and two (7.2%) hips (Severin grade VI).
Conclusion
Bony procedures such as femoral or acetabular osteotomies can help for coverage and good containment of the femoral head inside the acetabulum in cases of redislocation in DDH.

Keywords:
developmental, failed reduction, hip, revision

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Introduction

The failure of open reduction of developmental dysplasia of the hip (DDH) is uncommon and represents 0–8%, which may be increased to 5–15% in medial approach [1]. This failures may be one of three categories: (a) immediate failures: in these cases, the hips were found to be dislocated directly postoperatively and were primarily not reduced into the acetabulum owing to technical errors and the selection of approach; (b) delayed failures: these hips redislocate after a period from 4 to 6 weeks, which may be owing to inadequate capsulorrhaphy and inadequate immobilization; and (c) late failures: these late failures have been mostly owing to abnormal remodeling of the acetabulum and the proximal femur [2].

Revision surgery following failed open reduction for DDH is technically demanding. Once redisplacement has occurred after primary open reduction, attempts to reduce the femoral head by closed means or by pelvic or femoral osteotomy are usually unsuccessful, and a revision open reduction is necessary [3]. The risk of osteonecrosis of femoral head may increase in second operation with soft tissue contractures [4,5].

A prospective study was conducted on hips in 28 patients who were reoperated after redislocation after open reduction, clarifying the possible causes of redislocation and the operative findings during revision surgery.

Patients and methods

A total of 28 hips in 28 children (20 girls and eight boys) were operated upon after redislocation of primary open reduction of DDH. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Zagazig University, Cairo, Egypt. Overall, 18 patients were

left sided and 10 right sided. Additional procedures to the open reduction in the first operation were six adductor tenotomies and 12 femoral osteotomies (Table 1).

The mean age at the revision operation was 24 months (16–48 months). Revision surgeries were done between January 2004 and May 2010 at Zagazig University Hospital. Preoperative radiographs were taken for all cases and computed tomography scan was done in 18 cases for preoperative preparation before the revision operations. All cases were Tonnis types III and IV of dislocation [6].

The bikini skin incision for anterior Smith-Peterson approach was performed in all cases. Dissection on the inner side of the pelvis continued till the tri-radiate cartilage and the iliopectineal line. The femoral bundle was explored and retracted medially. In soft tissue procedure for relocation of the femoral head, the iliopsoas tendon was found, divided, and adhered to the pelvic brim in 22 hips, and was kept intact in six hips, then released and retracted medially with the femoral bundle to gain a wide exposure of the anterior hip joint capsule. The iliopectineal eminence was identified and used with the triradiate cartilage as landmarks for the true acetabulum. Adhesions around the hip capsule were excised; it was widely opened by T-incision, and the intracapsular adhesions were resected. The femoral head was found dislocated in all hips. Multiple radial incisions were done for inverted labrum, which was found in 18 hips. Hypertrophic ligamentum teres was excised in 10 hips. A fibro-fatty tissue 'pulvinar' filled the acetabular fossa, which was removed by rongeurs in 22 hips to clear the articular cartilage and to deepen the acetabular socket. Intact inferior capsule and tight transverse acetabular ligament were divided in all hips to widen the acetabular socket for a stable concentric reduction of the femoral head. Adductor tenotomy was done in 16 hips.

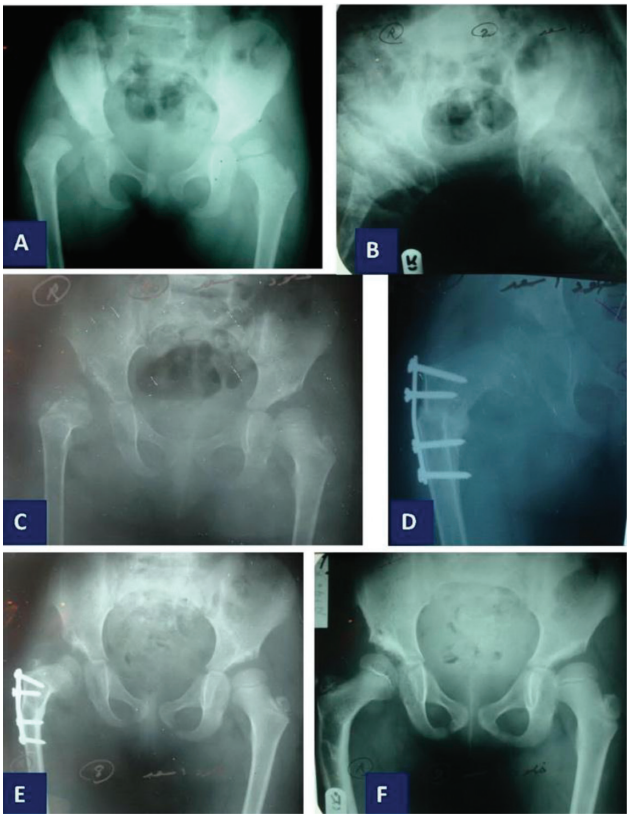
Bony procedures needed after trial of relocation were femoral derotation osteotomy through a lateral femoral incision that was fixed by small dynamic compression plate (DCP) in all hips (15 with femoral shortening and 13 without femoral shortening) (Fig. 1). Pelvic osteotomy was added to femoral osteotomy in 16 cases: Salter's osteotomy [7] in 10 hips (Fig. 2) and Dega osteotomy [8] in six cases (Fig. 3).

Four hips were still suspicious for stability of the reduction after performing all the needed procedures. K-wires were used to maintain a concentric reduction of femoral head for 6 weeks. After the open reduction and the bony osteotomy were done, a thorough capsulorrhaphy was finally performed, and redundant parts of the capsule were excised and capsular adhesions

Table 1 Preoperative data of patients

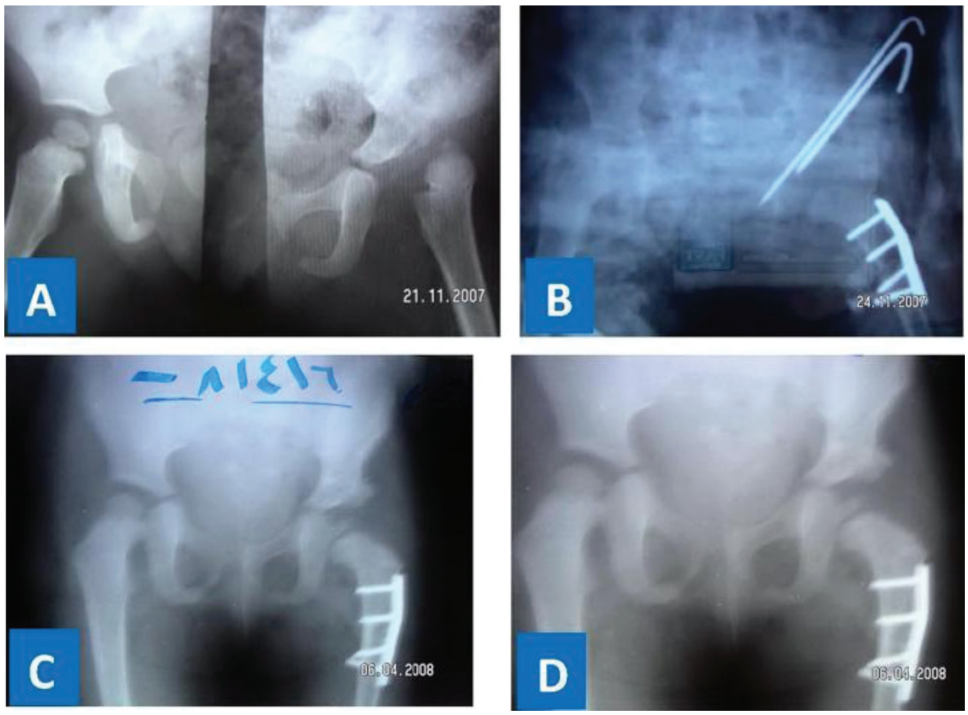
All patients' preoperative data	
Sex	
Male	8
Female	20
Side affected	
Right	10
Left	18
Mean age (range)	
At diagnosis	14 (4–30) months
At first operation	18 (12–24) months
At revision operation	24 (16–48) months
Time for redislocation	
Delayed (6–8 weeks) postoperative	12 patients
Late (12–30 months) after operation	16 patients
Technique added to relocation	
Femoral osteotomy+shortening	15
Femoral osteotomy without shortening	13
Salter pelvic osteotomy	10 patients
Dega pelvic osteotomy	6 patients

Figure 1



Female patient 3 years old with right side DDH; (A&B) pre and postoperative X-ray after open reduction; (C) after 3 months of first operation redislocated; (D) X-ray 6 months postoperative; (E) One year postoperative; (F) Five years postoperative.

Figure 2



Male patient with left side DDH; (A) preoperative X-ray after redislocation; (B) Postoperative X-ray after open reduction + salter osteotomy + femoral osteotomy; (C) Nine months postoperative; (D) Eighteen months postoperative.

to the lateral wall of pelvis were released; the capsule was tightly repaired by strong sutures. After closure of the wound, a double hip spica in optimum position (20° abduction and 40° flexion) was done for all patients for 6 weeks, and changed under light anesthesia for another 6 weeks in 20 patients and without anesthesia in eight patients. Abduction brace was used after removal of the spica in all cases for 6–8 weeks.

Clinically all patients were examined at regular follow-up visits for pain, limp, and range of motion and leg-length inequality. The final clinical assessment was done according to modified Mackay scoring system [9] (Table 2).

Radiographic postoperative evaluation was done for all cases, and computed tomography scan for 12 cases. Follow-up radiographs were taken every 2 months for 1 year to check the reduction and then every 3–6 months until the last follow-up visit to detect the acetabular development after reduction, avascular necrosis of the femoral head, or degenerative arthritis changes, and finally, the patients were evaluated according to Severin criteria [10] (Table 3).

Results

The mean follow-up time after the revision operations was 66 months (36–72 months).

Clinically

According to Barrett's modification of McKay's criteria [9], 11 (39.27%) hips had excellent results, seven (25%) hips had good results, six (21.43%) hips had fair results, and finally, four (14.3%) hips were graded as poor results (Table 4). Leg-length inequality between 2 and 5 cm was present in six hips. Less than 2 cm was considered insignificant. No patient had inequality that exceeded 5 cm.

Radiologic results

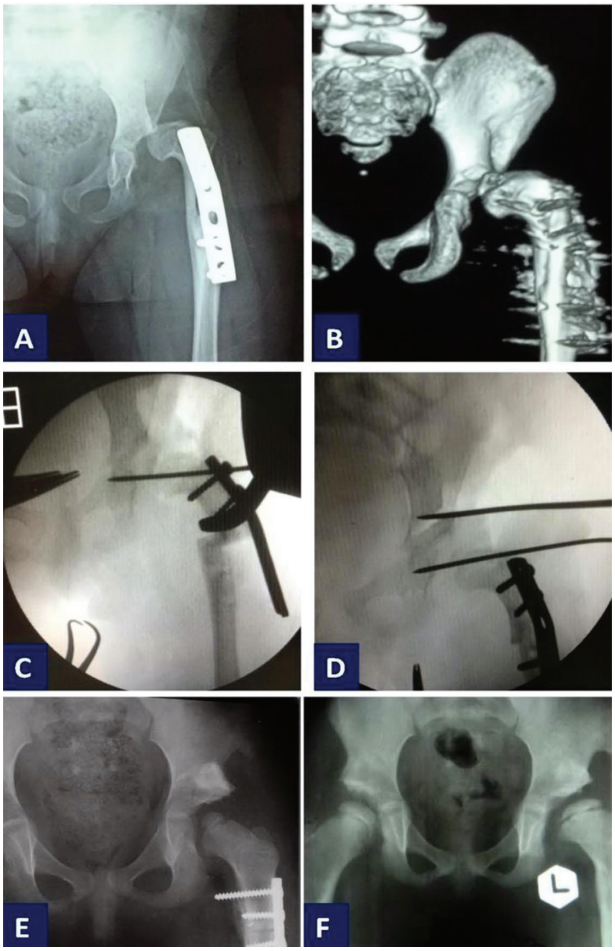
According to Severin criteria [10] for evaluation of radiographic results, 16 (57.1%) hips were types I and II, whereas 10 (35.7%) showed types III and IV, and two (7.2%) hips were rated as Severin's grade VI. Dislocation occurred in the two hips (Severin grade VI), a third had open reduction and femoral shortening was performed, and the two hips showed avascular changes of the femoral head in the late follow-up radiographs. Arthritic acetabulum developed in three hips.

Discussion

Adhesions after the primary operation usually make the revision open reduction more difficult as it obscures the normal anatomy of the area. The proximity of femoral neurovascular bundle and adhesions around the iliopsoas tendon put it in danger at the pelvic brim. Skaggs *et al.* [11] found that the distance between the

femoral bundle and the iliopsoas tendon at the pelvic brim is 4–10 mm in a child with normal anatomy. Exploration and protection of the femoral bundle and iliopsoas tendon with medial retraction can help for wide exposure of the anterior hip capsule in the revision surgery. In this study, the iliopectineal eminence and the triradiate cartilage were used as landmarks to identify the true acetabulum.

Figure 3



Female patient aged 50 months with redislocation; (A) preoperative X-ray; (B) Preoperative C-T scan; (C&D) intraoperative radiology; (E) one year postoperative; (F) three years postoperative.

Failure to gain concentric reduction in the primary operation of DDH may be due to technical errors and mainly related to the soft tissue clearance and release inside and around the acetabulum. The definite factors of failure are difficult to determine, as acetabular socket can become narrow and shallow after a longstanding absence of the femoral head inside the dysplastic acetabulum [4].

In this series, the inferior capsule and transverse acetabular ligament were found tight and released in 12 (42.8%) hips. Clearance of the pulvinar obstructing the acetabular fossa was done in 10 (35.7%) hips. This supports the decision that there is no place for closed manipulation or extra-articular realignment procedures alone in the management of the failed open reduction, but these realignment osteotomy procedures are important to maintain the already achieved concentric open reduction of the femoral head by improving the reduction stability, although Fixsen [12] warned from the possible posterior instability of the femoral head after Salter pelvic osteotomy. Kershaw *et al.* [13] reported that the osteotomy procedures done at the same time with open reduction may cause the maintenance of head reduced difficult and interfere with capsulorrhaphy, so they recommended bony procedures in another sitting after open reduction.

In the present study, all osteotomy procedures were done coincidentally with open reduction. When the stability of the reduction was suspicious in four cases, K-wire fixation was done to add stability until union of osteotomies. The capsular repair was the final step of the operation excising the redundant capsular parts after ensuring concentric reduction.

Table 2 McKay criteria modified by Berkeley and colleagues for clinical evaluation of results

Grades	Rating	Description
I	Excellent	Painless, stable, no limp, more than 15 deg. internal rotation
II	Good	Painless, stable, slight limp or decreased motion, negative Trendelenburg sign
III	Fair	Minimum pain, moderate stiffness, positive Trendelenburg sign
IV	Poor	Significant pain

Table 3 Clinical and radiologic results

Clinical		Radiological		Complications	
MacKay grade	*n* (%)	Severin grade	*n* (%)	Type	*n* (%)
Excellent	11 (39.27)	I and II	16 (57.1)	AVN	2 (7.2)
Good	7 (25)	III and IV	10 (35.7)	Dislocation	2 (7.2)
Fair	6 (21.43)	V	0	Acetabular arthritis	3 (10.7)
Poor	4 (14.3)	VI	2 (7.2)		

AVN, avascular necrosis.

Table 4 Severin criteria for evaluation of radiographic results

Severin criteria for evaluation of radiographic results	
Type I	Normal hips
Type II	Concentric reduction of the joint with deformity of the femoral neck, head or acetabulum
Type III	Dysplastic hips without subluxation
Type IV	Subluxation
Type V	The head articulating with a secondary acetabulum in the upper part of the original acetabulum
Type VI	Redislocation

Luhmann *et al.* [1] reported that better functional results, less growth disturbances, and fewer degenerative changes were achieved with early stable reductions, and the children with worst results reflect the extent of the repeat operations performed for them. These findings were found comparable with the results of this study as the best clinical and radiological results were achieved in patients early discovered and managed with stable open reduction aided by required osteotomy [14].

Conclusion

Bony procedures such as femoral or acetabular osteotomies can help for coverage and good containment of the femoral head inside the acetabulum in cases of redislocation in DDH.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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