Bilateral developmental dysplasia of the hip: setting an upper age limit for open reduction

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Background
Salter innominate osteotomy and Dega acetabuloplasty are considered as two of the most commonly used osteotomies for the management of developmental dysplasia of the hip (DDH) in walking children. Bilateral DDH patients add to the complexity of the problem. There is a worldwide debate about the upper age limit for open reduction, especially in bilateral cases. This study was designed as a trial to set an upper age limit for reduction of bilateral DDH hips, and to show the results of management of such cases using the two main osteotomies at an academic supervised referral university hospital.

Patients and methods
A total of 58 hips in 29 bilateral DDH cases were managed by a team of orthopedic surgeons. The cases were grouped into a Salter and a Dega group and were followed up for a mean of 10 ± 9 years. The same surgeons operated both sides in each case using the same osteotomy to limit the variables. The cases were evaluated clinically and radiographically.

Results
Radiographic and clinical evaluations were compared during and at the final follow-up visit. Favorable end results were found in 69% of cases (75% Dega and 66.6% Salter). Nevertheless, there were major complications encountered, including redislocation, avascular necrosis, pain, limb-length discrepancy (LLD), and the need for another surgery during the follow-up period.

Conclusion
Both Salter and Dega osteotomies provided good clinical and radiographic results when a good preoperative assessment and skillful open reduction performed by an experienced surgeon was executed. However, more complications and unfavorable results are expected despite all precautious if performed in children older than 6 years. Level of evidence: IV.

Keywords:
bilateral, Dega, developmental dysplasia of the hip, osteotomy, Salter

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Introduction

Developmental dysplasia of the hip (DDH) encompasses a wide spectrum of anomalies ranging from mild dysplasia to high riding dislocations. The aim of management of such cases is to restore the harmonious balance and a normal relationship between the head of the femur and the acetabulum, to have a normal growth pattern of the hip. The problem is even more demanding in older children after the walking age. Late presenting cases require surgical intervention to reduce the dislocated head into the true acetabulum [1–5]. Bilaterality of the condition is even more challenging and controversy exists about the upper age limit for reduction in bilateral cases. This study was designed to show the clinical and radiographic results of management of bilateral DDH patients after the walking age, and to suggest an upper age limit for reduction in neglected bilateral cases.

Patients and methods

Between October 1997 and November 2008, there were 29 bilateral cases of DDH first presenting after walking. There were 20 female patients, and only nine male patients included. The age of the patients at their first presentation ranged from 2 to 10 years, with a mean of 4 ± 6 years. The follow-up period ranged from 3 to 15 years, with a mean of 10 ± 9 years. All included cases had no previous surgery before their presentation. Open reduction, a pelvic osteotomy, femoral shortening, and capsulorrhaphy were performed in all of the included cases. Salter innominate osteotomy was performed in 21 cases, whereas Dega acetabuloplasty was performed in only eight bilateral cases. Teratologic hip dislocation cases were excluded from this study. Moreover, cases presenting with previous surgical interventions were also excluded from the current study. A minimum follow-up period of 3 years was an inclusion criterion in this study. The second hip was operated upon after a period of 6–16 weeks from the first surgery, with a mean

of 7 weeks. Threaded or smooth Kirschner wires were used for fixation in cases treated with Salter osteotomy, whereas no fixation was used with Dega patients. Preoperative radiographs were evaluated according to the Tönnis grading system for grading the DDH [5]. The same surgical technique was used for the same patient – that is, if Salter osteotomy was performed after reduction of the first hip, Salter osteotomy was then performed for the other side, and the same was done in cases treated with Dega acetabuloplasty. Moreover, for each patient included in this study, the same surgeon treated both hips and identical surgical technique and surgical steps were used. No preoperative traction was performed for any of the included cases, to decrease the risk for avascular necrosis (AVN) of the femoral head. Autologous iliac crest bone grafts, or the bone segment taken from the femoral shortening, were used for both types of osteotomies. Postoperative immobilization in one and a half spica cast was applied for 6 weeks, and then the other side was operated upon and the Kirschner wires from the first surgery were removed, in cases treated with Salter osteotomy, at the same setting. After another 6 weeks, the wires from the second side were removed. Thereafter, the child was subjected to a high above-knee bilateral cast, with a transverse bar in abduction. This allows for hip flexion, but maintained hip abduction, and without weight-bearing. This cast was then removed after another 6 weeks.

Radiographically, the Acetabular Index (AI) values were evaluated preoperatively, immediately after the operation, and at the last follow-up visit. Reimer's Migration Index was measured, and the Shenton line was evaluated at the last follow-up visit. AVN of the femoral head if present was graded according to the Bucholz and Ogden classification system [5].

For clinical evaluation, the Barrett modification of McKay's criteria (Table 1) was used for each hip of every patient [6].

For the evaluation of descriptive values obtained in the study frequency accountings, percentages, mean values, and SDs were used. The data were statistically documented using the Mann–Whitney *U*-test and the χ^2-test. Statistical significance was determined as *P* value less than 0.05 with 95% confidence interval.

Results

A total of 58 hips in 29 patients with bilateral dislocated hips were grouped according to the pelvic osteotomy type that was performed. A total of 42 hips were grouped as the Salter group (21 patients) and 16 hips were grouped as the Dega group (eight patients). According to the Tönnis grading system there were 20 hips of grade III and 38 grade IV hips. Open reduction and femoral shortening were performed in all included hips because there were all either Tönnis grade III or IV.

The mean follow-up period for all hips included in this study was 10 ± 9 years (range: 4–15 years). There was no statistical significance between the two groups ($P = 0.46$) with regard to follow-up period. The mean AI values preoperatively, immediately after surgery, and at the last follow-up visit were 44 ± 3.08° (range: 39–53°), 25.2 ± 1.92° (range: 23–28°), and 16.4 ± 0.89° (range: 14–20°), respectively, in the Salter group and the corresponding values were 40.2 ± 4.60° (range: 30–50°), 20.2 ± 2.45° (range: 16–22°), and 16.6 ± 1.67° (range: 12–18°), respectively, in the Dega group.

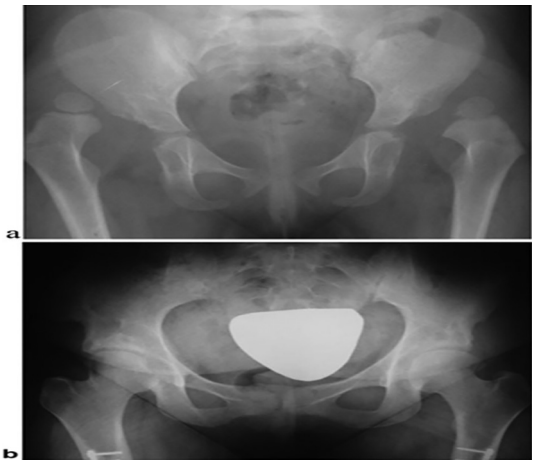
The final clinical outcome results were excellent in 12 hips (Fig. 1a and b), good in 16 hips, fair in 10 hips, and poor in four hips in the Salter group. In the Dega group of patients, there were 10 excellent, two good, no fair, and four poor clinical results. In other words, there were 40 (69%) hips with favorable results, whereas unfavorable results were recorded in 18 (31%) hips.

During the follow-up period, eight hips needed another surgery, four from the Salter group and four from the Dega group, and those cases were considered as failure

Table 1 Clinical end results according to McKay criteria [6]

Results	Salter<6 years	Salter>6 years	Dega<6 years	Dega>6 years	Total
Excellent	10	2	10	—	22
Good	16	—	—	2	18
Fair	2	8	—	—	10
Poor	—	4	—	4	8
Total	28	14	10	6	58

Figure 1



(a) Neglected bilateral developmental dysplasia of the hip. (b) Follow-up after 8 years.

and poor outcome. Six of the eight hips were operated upon due to redislocation, whereas the other two cases were due to progressive pain and severe arthrosis; a Chiari medial displacement osteotomy was performed in one case and a triple innominate osteotomy for the last case.

There were many complications encountered in this study (Table 2).

It was noted that more than one major complication can take place in the same hip, and that more complications were found in children older than 6 years, irrespective of the osteotomy used.

When the preoperative and last AI values were compared with respect to ratio differences, there was no statistical difference between the two groups ($P = 0.25$). Shenton lines were intact in all but four cases: two cases from the Salter group and two cases from the Dega group. These four cases (eight hips) were older than 6 years at the time they were operated upon.

Discussion

While the Salter osteotomy provides reorientation of the acetabulum, Dega osteotomy provides both reorientation and reshaping of the acetabulum [5,7]. This study was designed to evaluate the clinical as well as the radiographic results of management of bilateral DDH cases using these common osteotomy types and we tried to reach an upper age limit for reduction in bilateral cases. As compared according to the AI values, the mean decrease at the immediate postoperative and final measurements was 18.8° and 27.4°, respectively, for the Salter group and 20° and 23.6°, respectively, for the Dega group with progressive improvement in the AI values for both groups as the skeletal maturity progress. There was no statistical difference with respect to preoperative and last rational difference of improvement in AI values between the two groups. The immediate and final postoperative average reduction of AI values has differences in the literature, especially for the Salter osteotomy. With regard to preoperative values with Salter osteotomy, El-Sayed [4] reported an average of 21° of reduction immediately after surgery and 25° after an average of 5 years and 4 months of follow-up. López-Carreño *et al.* [8] reported an average reduction of 11° and 18° with Salter and Dega osteotomies, respectively, just after the operation. Barrett *et al.* [6] reported an average of 16° of improvement with Salter osteotomy after an average of 7 years of follow-up of four different groups. Ozgur *et al.* [9] reported an average of 17° of improvement with Dega osteotomy. Ruszkowski and Pucher [5] reported an average of 25° of improvement of the AI values after Dega osteotomy with a mean follow-up of 9.4 years. Grudziak and Ward [7] reported 21° of average reduction with Dega osteotomy.

Table 2 Complications encountered in this study

Osteotomy used and age at presentation	Salter<6 years	Salter>6 years	Dega<6 years	Dega>6 years
Redislocation	—	4	—	2
Avascular necrosis	2	4	—	2
Arthrosis and early osteoarthritis	—	6	—	2
Pain	—	6	—	2
Limb-length discrepancy	2	6	—	2
Need for another surgery	—	4	—	4

With regard to clinical evaluation, we obtained 75 and 66.6% good or excellent results with Dega and Salter osteotomies, respectively. There were 10 hips with fair results in the Salter group only, whereas there were four hips with poor results in each group. López-Carreño *et al.* [8] reported a statistically significant better clinical results in favor of Dega osteotomy. Barrett *et al.* [6] and El-Sayed [4] reported 75 and 87% good or excellent clinical results, respectively, with Salter osteotomy. Ruszkowski and Pucher [5] reported 89% good or excellent results with Dega osteotomy using the McKay criteria. Grudziak and Ward [7] reported satisfactory final clinical results for all patients who underwent Dega osteotomy. The risk for AVN of the femoral head will increase with open reduction, pressure created on the femoral head by transiliac osteotomy, and forced immobilization of the hip [5,6,10]. The reported incidence of AVN is diverse in the literature with different types of pelvic osteotomies, age-related variabilities, inclusion of the femoral shortening and/or derotational osteotomies, requirement for the open or closed reduction, and the classification systems used [4–6]. In this study, there were eight hips with AVN, six in the Salter group, whereas only two in the Dega osteotomy. It was noted that six of the eight hips were older than 6 years at the time of first surgery.

In this study, we compared two of the most commonly used osteotomies for the management of DDH patients after the walking age. However, there are limitations in this study, as the study is retrospective and not all cases were followed up until skeletal maturity. This study focused on bilateral DDH in a trial to set an upper limit for open reduction in neglected cases. During this middle-term results, both types of osteotomies showed favorable results when performed by the same surgeon for children under 6 years of age. This was not true in patients older than 6 years. It was noted that six of the eight hips that ended with AVN were older than 6 years. Moreover, eight out of 10 hips with fair results in the

Salter group were also older than 6 years. In the same order, all clinically poor end result in both groups occurred in children older than 6 years at the time of surgery.

Conclusion

Salter osteotomy and Dega acetabuloplasty are both good treatment alternatives in cases with DDH presenting late after the walking age. This study supports the opinion of performing open reduction and a generous femoral shortening, and a pelvic osteotomy in walking-neglected DDH cases under the age of 6 years. As for children with bilateral DDH older than 6 years at the time of presentation, a more cautious approach is necessary and more major complications are to be anticipated if surgery was decided.

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Conflicts of interest

There are no conflicts of interest.

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