Acta Orthop. Belg., 2015, **81**, 375-383

ORIGINAL STUDY

Outcome of one-stage surgical treatment of developmental dysplasia of the hip in children from 1.5 to 6 years old
A retrospective study

Qiang CHEN, Yu DENG, Bin FANG

From the Nan fang hospital, The southern medical University, Guangzhou, P.R.China

This study aimed to evaluate the outcome of one-stage treatment for developmental dysplasia of the hip (DDH) in patients after walking age. A Total of 58 children (67 hips) were retrospectively investigated to assess the efficacy and safety of one-stage treatment of developmental dysplasia of the hip (DDH) in children from 1.5 to 6 years of age with a mean follow-up of 4.00 ± 0.43 (range 3-6.8) years. Eleven (19%) were male, forty-seven (81%) were female. Our method consisted of open reduction, Salter innominate osteotomy, femoral shortening and derotation. The patients were distributed into three groups according to the age at which they were operated : 12 (20.7%) patients with 12 hips (17.9%) were operated between 1.5 and 2 years of age (Group I), 35 (60.3%) patients with 44 hips (65.7%) were operated between 2 and 4 years (Group II), 11 (19%) patients with 11 hips (16.4%) were operated between 4 and 6 years (Group III).

Clinical and radiological assessment at final follow-up showed that the outcome was not significantly different between group I and group II. But clinically, there was significant difference between group I and group III, and also between group II and group III. Although in the outcome of radiological assessment there was no significant difference between group I and group II compared with group III.

The rate of avascular nerosis in group I was lower than in group II or in group III. Children with DDH between 1.5 and 6 years of age were treated successfully with one-stage treatment, but in our hands the best age at surgery is before 4 years of age.

This study is supported by the fond of science and technology developing plan of Guangdong 2012B060300018. No benefits or funds were received in support of this study. The authors report no conflict of interests.

Keywords : developmental dislocation of the hip ; open reduction ; pelvic osteotomy ; older children.

INTRODUCTION

The primary goal of correction of developmental dysplasia of the hip is concentric reduction of the hip. The principles of the treatment of DDH for a child after walking age are different from those for a newborn (*2,3,11*). In a child of walking age and beyond, achieving a concentrically reduced hip while minimizing complication is more challenging. In the older child the reduction of the hip is

■ *Qiang Chen*, MD, Assistant Professor.
■ *Yu Deng*, MD, Orthopaedic Surgeon.
Nan fang hospital,department of Orthopaedic of Huiqiao building, The southern medical University, Guangzhou, P.R. China
■ *Bin Fang,* MD, Assistant Professor.
The first affiliated hospital, Guangzhou Chinese medical University, Guangzhou, P.R.China.
Correspondence : Qiang Chen, The southern medical University, Nan fang hospital, department of Orthopaedic of Huiqiao building, Num 1838 North Guanzhoudadao, Guangzhou, P.R.China. E-mail : cqnfyy@sina.com

difficult because of adaptive shortening of the extra-articular soft tissues, acetebular dysplasia, capsular constriction, increased femoral anteversion, fibro-fatty tissues in the acetabulum, hypertrophied ligamentum teres, and fixed inversion of the limbus.

The one-stage surgical treatment for DDH, consisting of open reduction, femoral shortening, and pelvic osteootomy, is an effective and safe treatment method in DDH. Many authors have reported success with one-stage surgical treatment for DDH in children from two to five or six years old (*1,5,7, 13,14,15,16,24,25*), and clinical and radiological assessment at final follow-up showed that the outcome was not significantly different between the patients aged < 3 years and patients aged > 3 years (*4*).

We aimed to evaluate the outcome of one-stage surgical treatment for DDH aged from 1.5 to six years old. Patients were evaluated clinically and radiologically. All patients in this study were operated by a single experienced paediatric surgeon.

MATERIAL AND METHODS

58 cases who underwent one-stage surgical treatment for DDH between January 2000 and December 2010 were retrospectively reviewed. The patients who were initially treated in another hospital were excluded. Patients with neurologic diseases or teratological dislocations were not included. This study was approved by the institutional ethics committee.

We retrospectively reviewed a total of 58 (67 hips) patients. 11 (19%) patients were male, 47 patients (81%) were female. 14 (24.1%) patients had dislocation on the right side, 35 (60.4%) patients had dislocation on the left side, 9 (15.5%) patients had bilateral dislocation.

The patients were distributed into three groups according to the age at which they were operated : Group I included 12 (20.7%) patients with 12 (17.9%) hips aged between 1.5 years and 2 years, and Group II 35 (60.3%) patients with 44 (65.7%) hips between 2 years and 4 years, Group III 11 (19%) patients with 11 (16.4%) hips between 4 years and 6 years.

The operative treatment consisted of open reduction, Salter innominate osteotomy (SIO), femoral shortening, and derotation osteotomy.

We used Severin's criteria for radiological assessment (Table III) and modified McKay's criteria for clinical assessment (Table I) (*4,8*). Dislocation on the preoperative radiograph was evaluated according to the grading system defined by Tönnis (*22*). In Group I there were 4 Tönnis type III and 8 Tönnis type IV hips, in Group II there were 15 Tönnis type III and 29 Tönnis type IV hips, in Group III there were 3 Tönnis type III and 8 Tönnis type IV hips.

Avascular necrosis (AVN) was classified by the criteria of Kalamchi and MacEwen (*9*). To evaluate acetabular dysplasia at the time of follow-up, the centre edge angle (CE angle) (*26*), and the acetabular head index (AHI) (*21*) were calculated. We defined satisfactory results as those in Severin groups I and II and unsatisfactory results as those in Severin groups III, IV and V.

Finally, the modified Trevor score (*23*) was applied for overall clinical and radiological evaluation (Table VI).

All radiographs were performed in the supine position. The patient's feet were internally rotated with the toes at 15 ± 5 degrees to ensure that the X-ray beam was

Table I. — Modified McKay criteria

Grade	Criteria
Excellent	Stable, painless hip, no limp, negative Trendelenburg sign, and a full range of movement
Good	Stable, painless hip, slight limp, negative Trendelenburg sign, and a slight decrease in range of movement
Fair	Stable, painless hip, limp, positive Trendelenburg sign, and limitation of movement
Poor	Unstable or painful hip, or both ; positive Trendelenburg sign

Table II. — Clinical assessment results

Grade	Group I 12 hips	Group II 44 hips	Group III 11 hips	Total 67 hips	%
Excellent	11	32	2	45	67.2
Good	1	9	5	15	22.4
Fair	0	2	3	5	7.5
Poor	0	1	1	2	3

Fig. 1a. — Preoperative radiograph of a 3-year-old child with developmental dysplasia of the right hip.

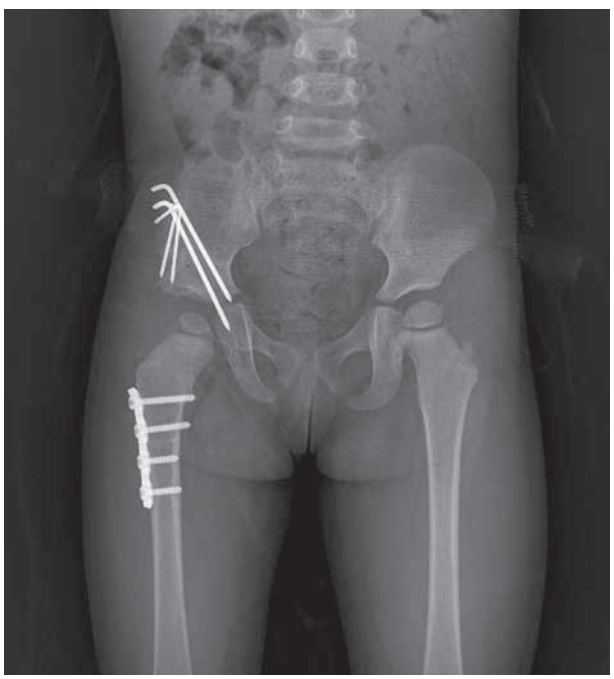

Fig. 1b. — Six months after one-stage combined surgery

centred on the superior aspect of the pubic symphysis. Anteroposterior radiographs were taken with a source-to-film distance of 100 cm to assure the reproducibility of the radiographic measurements.

Fig. 1c. — After removal of material, six months after operation, good clinical result.

Fig. 1d. — Four years after operation, good clinical result

The follow-up ranged from 3 to 6.8 years, the mean follow-up was 4.00 ± 0.43 years. The mean follow-up was 4.54 ± 0.51 years (range 4-6.8 years) for Group I and 3.58 ± 0.32 years (range 2-6.5 years) for Group II, 3.24 ± 0.43 years (range 2-6.0 years) for Group III.

Table III. — Severin's table

Grade		Criteria
Excellent	IA	CE angle > 19°, age 6-13 years ; CE angle > 25°, age > 14 years
Good	IB	CE angle 15-19°, age 6-13 years ; CE angle 20-25°, age > 14 years
	II	Moderate deformity of femoral head, femoral neck, or acetabulum, but otherwise the same as grade IA or IB
Fair	III	Dysplastic hip, no subluxation ; CE angle < 15°, age 6-13 years ; CE angle < 20°, age > 14 years
Poor	IV	Subluxation
	V	Femoral head in false acetabulum
	VI	Redislocation

Table IV. — Radiological assessment results

Grade	Group I 12 hips	Group II 44 hips	Group III 11 hips	Total 67 hips	%
Excellent	11	30	7	48	71.6
Good	1	10	2	13	19.4
Fair	0	3	1	4	6.0
Poor	0	1	1	2	3.0

Surgical technique

Patients were placed in supine position. The whole limb was included in the surgical field. The one-stage procedure consisted of open reduction, Salter osteotomy, femoral derotation, and shortening osteotomy. The surgical approach was made with two incisions. One of them was a Smith-Peterson incision and the other was a lateral proximal femoral incision. We performed the soft tissue procedure according to the technique described by Salter in his first report (*18*). Extending from the inferior to the posterosuperior aspect of the acetabulum, the capsule was incised in a T-shape, and a transverse incision along the femoral neck. The transverse acetabular ligament was divided (*12,20*). The anterior part of the capsule down to the femoral neck was excised together with the hypertrophied ligamentum teres. The psoas tendon was detached near its insertion. Pelvic osteotomy, psoas tendon release, femoral derotation, and shortening osteotomy were performed under radio-scopic control. In order to achieve a force-free reduction, femoral osteotomy was performed at the level of the subtrochanteric femur and the femur was shortened by 1 cm to 2 cm. In association with the shortening, the derotation of the femur was performed. The amount of correction of derotation or femoral shortening was decided intraoperatively under direct visualization. Varus position was not added to decrease the neck shaft angle. None of the femoral heads were fixed to the acetabulum by a Kirschner wire for maintenance of reduction.

Postoperatively we applied a full-time abduction brace for 12 weeks.

Statistical analysis

The statistical analyses were performed using the Statistic Package for Social Sciences (version 12.0, SPSS Inc., Chicago). Means for more than two groups were compared by ANOVA for normally distributed data and Kruskal-Wallist test for data without normal distribution (Post-hoc tests for subgroup comparisons). Categorical variables are compared by Chi-square test. Pared samples were compared by Wilcoxon's test. $P < 0.05$ was accepted as statistically significant.

RESULTS

According to the modified McKay criteria, functional results were excellent at last follow-up in 45 hips (67.2%), good in 15 hips (22.4%), fair in 5 hips (7.5%) and poor in 2 hips (3%).

In Group I, clinical results were excellent in 11 hips (91.7%) and good in one (8.3%). In Group II, clinical results were excellent in 32 hips (72.7%), good in 9 hips (20.5%), fair in two hips (5.0%), and poor in one hip (2.3%). In Group III, clinical results were excellent in two hips (18.2%), good in five hips (45.5%), fair in three hips (27.3%), and poor in one hip (9.0%). 12 hips in Group I (100%) and

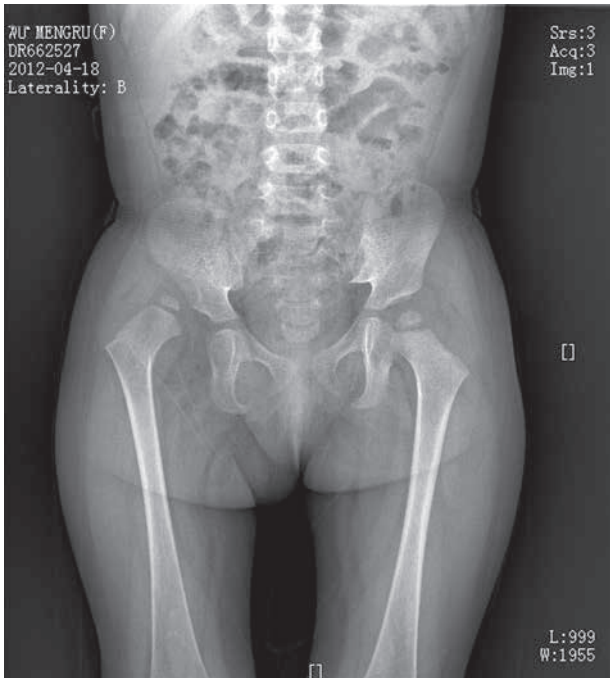

Fig. 2a. — Preoperative radiograph of a 2.5-year-old child with developmental dysplasia of the right hip.

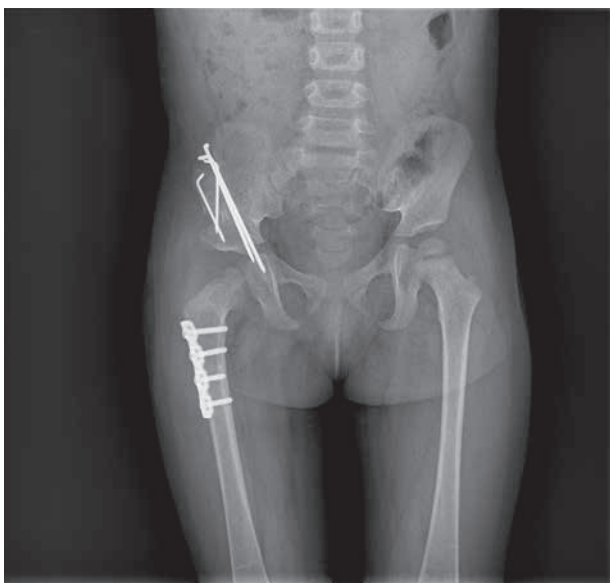

Fig. 2b. — Six months after one-stage combined surgery

Fig. 2c. — After removal of material, six months after operation, good clinical result.

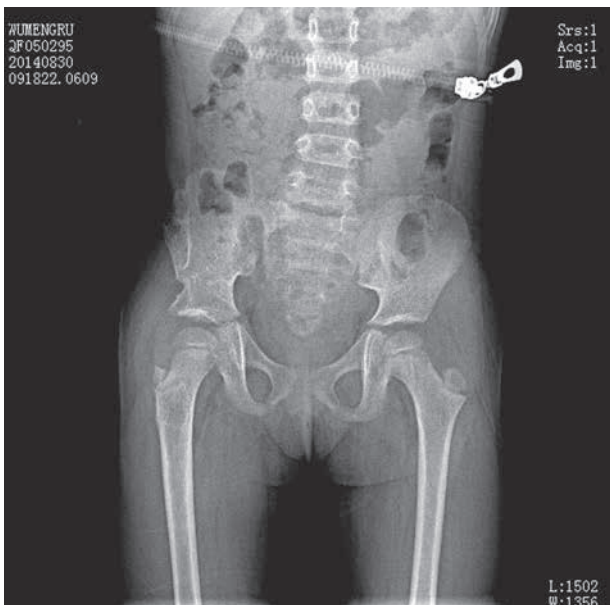

Fig. 2d. — 2 years after operation, good clinical result

41 hips (93.2%) in Group II, 7 hips (63.6%) in Group III yielded satisfactory results clinically, whereas no hips in Group I and three hips (6.8%) in Group II, 4 hips (36.4%) in Group III yielded unsatisfactory results.

However, there was no significant difference between group I and group II according to McKay's clinical criteria at final follow-up ($p > 0.05$).

Table V. — AVN results

Group	AVN cases		incidence of AVN (%)
	Grade I	Grade II	
Group I (12 hips)	0	0	0
Group II (44 hips)	1	1	5.7
Group III (11 hips)	1	1	18.1

There was however a significant difference between group I and group III according to McKay's clinical criteria at final follow-up ($p < 0.05$). Also, there was significant difference between group II and group III according to McKay's clinical criteria at final follow-up ($p < 0.05$).

Radiological results were excellent in 48 hips (71.6%), good in 11 (19.4%), fair in six (6.0%), and poor in two (3.0%).

In group I, radiological findings were excellent in 11 hips (91.7%) and good in one hip (8.3%), there were no fair nor poor hips. In Group II, they were excellent in 30 hips (68.2%), good in 10 hips (14.9%), fair in 3 hips (6.8%) and poor in one hip (2.3%).

In group III, they were excellent in 7 hips (63.6%), good in two hips (18.2%), fair in one hip (9.1%) and poor in one hip (9.1%).

12 hips (100%) in group I, 40 hips (90.9%) in group II and 9 hips (81.8%) in group III yielded satisfactory results radiographically, whereas no hips in group I and 4 hips (9.1%) in Group II, 2 hips (18.2%) in group III yielded unsatisfactory results. At final follow-up according to Severin's radiographic criteria, there was no significant difference in all the studied subgroups ($p > 0.05$). We found satisfactory results, clinically in 60 hips (85%) and radiographically in 61 (91%).

In group I, the mean value of the acetabular index (AI) preoperatively was 38.9° (19°-46°), the mean immediately postoperative value was 26.3° (15°-32°), In group II, the preoperative mean AI was 37.3° (23°-47°), the mean immediately postoperative value was 23.2° (17°-29°), In group III the mean AI preoperatively was 37.8° (18°-45°), the mean immediately postoperative value was 21.3° (16°-30°).

The final radiological examination in group I, showed a mean AI of 18° (12°-29°), in group II final AI was 16.3° (12°-27°) and in group III it was 19° (12°-28°).

In group I, at final radiological examination the Wiberg's mean CE angle was 27.8° (0°-42°), in group II it was 28° (19°-40°)and in group III the mean CE angle was 26.7° (17°-38°).

There was no significant statistical difference between the mean preoperative and postoperative AI values. There was also no significant statistical difference between the immediately postoperative mean values and the mean AI and CE angle at final follow-up, in all the studied subgroups ($p > 0.05$).

AVN was detected in 4 cases (6.9%) during follow-up. In group I, no AVN was detected. In group II, AVN was detected in two hips (5.7%) : one of them had grade I and one grade II. In group III AVN was detected in two hips (18.1%) : one of them had grade I and one grade II. There was a significant statistical difference between group I, group II and group III, respectively ($p < 0.05$). No patient with AVN had subsequent surgery.

Limb lenth discrepancy of less than 1.5 cm was found in four cases, without need for further surgical intervention till the last follow-up.

According to the evaluation scheme of Trevor *et al* (*23*), the mean score of group I was 18.4, eleven hips (91.7%) were rated excellent, one hip (8.3%) good, no hips fair nor poor. The mean score of group II was 17.0, 32 hips (72.7%) were rated excellent, 9 hips (20.5%) good, 2 hips (5.0%) fair, and one hip (2.3%) poor. The mean score of group III was 15.2, two hips (18.3%) were rated excellent, five hips (45.5%) good, three hips (27.3%) fair, and one hip (9.0%) poor.

There was no significant difference between group I and group II according to the evaluation scheme of Trevor *et al* (*23*) at final follow-up ($p > 0.05$). There was however a significant

Table VI. — Method of assessment using the modified scoring system of Trevor *et al* (*23*)

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		2
	little		1
Limp	Absent		1
	Present		0
Function as described by the patient and assesed in the follow-up clinic	Full		3
	Slightly limited		2
	Severely limited		1
Radiological feature	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
	Intact		1
Shenton's line	Broken		0

difference between group I and group III, and also between group II and group III ($p < 0.05$).

There were no complications such as infection or graft displacement. Two hips redislocated and were classified as poor clinical result.

DISCUSSION

The aim of treatment in DDH is to obtain concentric and stable reduction as soon as possible without complications such as avascular necrosis (*3,8*). Reduction must be obtained, redislocation must be prevented, and optimum relationship between acetabulum and femoral head must be protected (*4*). If concentric reduction is obtained, acetabular dysplasia can improve in time (*8*). Early treatment of dislocation is necessary for acetabular development (*3*).

The single-stage surgery has advantages that include reducing the risk of severe AVN of the femoral head while correcting associated femoral and acetabular deformities. The Salter osteotomy provides anterolateral coverage of the femoral head that allows the acetabulum to develop and the hip joint to stabilize. It is generally accepted that innominate osteotomy should be performed in children older than 18 months of age and it usually provides correction of acetabular direction in terms of the AI (*3,4,8*).

The best time to perform an osteotomy of the acetabulum for DDH patients is however still a concern (*18,27*). Several authors suggest a one-stage procedure consisting of open reduction, pelvic osteotomy and femoral osteotomy (*4,5,10,9,13,17,19,25,26*), particularly in children older than three years of age (*1,7,23,26*). Many studies (*2*) found that it could be done safely for children between 12 and 18 months of age without major disadvantages. Galpin *et al* (*7*) reported a series of 33 dislocated hips in patients older than two years of age who were treated with a one-stage open reduction, femoral shortening, and pelvic osteotomy. They found satisfactory results clinically in 85% of hips and radiographically in 75%. Salter and Dubos (*19*) showed 93.6% good to excellent results in children of younger age group. Karakas *et al* (*10*) operated on 47 patients (55 hips), who were 4 years and more,

with 67% good or excellent clinical results and 65% good or excellent radiological results.

Saleh *et al* (*17*) demonstrated that the acetabulum remodels quickly after the Salter innominate osteotomy in a range of age groups. The lower limit of surgical timing is still under debate.

The advantages of immediate acetabular alignment include the probability that stability will be enhanced if a careful capsulorrhaphy is carried out after the open reduction, and that later surgery will be avoided.

Enan Ahmed *et al* (*6*) reported that open reduction combined with Salter osteotomy does not impede the acetabular remodeling of the hip in children between 12 and 18 months of age.

AVN is the most important complication seen during treatment of DDH, Particularly in a higher grade of dislocation combined with an inverted limbus, hypertrophic soft tissue in the acetabulum and older age of the patient at treatment onset, AVN of the femoral head is more often to occur (*6,10,13,15*). Galpin *et al* (*5*) reported a rate of AVN of 9.0%. El-Sayed (*7*) reported 4.2%,

Some studies show that femoral shortening can facilitate reduction and reduce the risk of AVN (*9,10, 23,25*).

Demirhan *et al* (*5*) operated 33 hips in 24 patients aged < 18 months. AVN was observed in 10 patients (30%) and 4 (12%) cases underwent secondary interventions. They found a significantly lower incidence of AVN in patients whose treatment was started at 12 months of age when compared with those treated at a relatively older age. Ehan *et al* (*6*) reported that in patients with DDH who underwent an operation under 18 months of age, the risk of developing AVN was relativeiy low. In our study, AVN was detected in 4 cases (6.9%).

Our study support that complications are limited and could be avoided if care is given to the technical details. This entails a generous clear exposure of the hip and upper femur, performing adequate femoral shortening, with correctly estimated derotation allowing the femoral head to be easily reduced into the well-reconstructed acetabulum, preventing undue pressure exerted over the head.

The younger the patient at the time of diagnosis and proper management, the better the final clinical outcome would be, because of the better growth and remodeling potential of the acetabulum in infancy and eary childhood (*5,6,7*).

The authors found no method to determine the specific reason for the fact that clinical results were statistically different between the age groups, but that the radiological findings showed no significant difference. Could it be attributed to the following reasons : abnormal walking habit has not corrected, the unbalance of the pelvis can not be corrected in the short term, the weak muscles on the dislocated side ?

The mean period of follow up in this study ranged from 3-6.8 years, which is not a long enough period for evolving osteoarthritic changes to show up in young patients. Prospective randomised controlled trials with larger sample sizes are needed to support our findings.

Our clinical results were not as good as those noted by other authors, especially the variation in the clinical outcome between the patients less than 4 years and older than 4 years of age.

There was a significant difference between the group less than 4 years and the group older than 4 years of age according to the evaluation scheme of Trevor at final follow-up.

Therefore, we believe that a one-stage open reduction, femoral shortening, capsulorrhaphy, and pelvic osteotomy corrects associated femoral and acetabular deformities is convenient and effective in children older than 18 months of age. This operation improves the cover of the femoral head and provide stability in the weight-bearing position. This procedure can be done safely, with reliable results and without an increase in the risk of avascular necrosis, but in our hands the best age at surgery is before 4 years of age.

REFFERENCES

1. **Altay M, Demirkale I, Senturk F *et al.*** Results of medial open reduction of developmental dysplasia of the hip with regard to walking age. *J Pediatr Orthop B* 2013 ; 22 (1) : 36-41.
2. **Berkeley ME, Dickson JH, Cain TE *et al.*** Surgical therapy for congenital dislocation of the hip in patients who are twelve to thirty-six months old. *J Bone Joint Surg* 1984 ; 66-A : 412-420.

3. **Brougham DI, Broughton NS, Cole WG *et al.*** Avascular necrosis following closed reduction of congenital dislocation of the hip : review of influencing factors and long-term follow-up. *J Bone Joint Surg Br* 1990 ; 72 : 557-562.
4. **Cimil E, Mehmet AA, Raci Y *et al.*** one stage treatment of developmental dysplasia of the hip in untreated children from two to five years old, a comparative study. *Acta Orthopaedica Belg* 2011 ; vol 77-4 : 464-471.
5. **Demirhan M, Dikici F, Eralp L *et al.*** A treatment algorithm for developmental dysplasia of the hip for infants 0 to 18 months of age and its prospective results. *Acta Orthop Traumatol Turc* 2002 ; 36 : 42-51.
6. **Ehan A, Abo-hegy M, Hammad W.** Surgical treatment of late-presenting developmental dislocation of the hip after walking age. *Acta Ortop Bras* 2013 ; 21 (5) : 276-280.
7. **El-Sayed MM.** Single-stage open reduction, Salter innominate osteotomy, and proximal femoral osteotomy for the management of developmental dysplasia of the hip in children between the ages of 2 and 4 years. *J Pediatr Orthop* 2009 ; 18-B : 188-196.
8. **Ganger R, Radler C, Petje G *et al.*** Treatment options for developmental dislocation of the hip after walking age. *J Pediatr Orthop B* 2005 ; 14 : 139-150.
9. **Kalamchi A, MacEwen GD.** Avascular necrosis following treatment of congenital dislocation of the hip. *J Bone Joint Surg* 1980 ; 62-A : 876-888.
10. **Karakas ES, Baktir A, Argün M *et al.*** One-stage treatment of congenital dislocation of the hip in older children. *J Pediatr Orthop* 1995 ; 15 : 330-6.
11. **Macnicol MF, Bertol P.** The Salter innominate osteotomy : should it be combined with concurrent open reduction ? *J Pediatr Orthop* 2005 ; 14-B : 415-421.
12. **McKay DW.** A comparison of the innominate and the pericapsular osteotomy in the treatment of congenital dislocation of the hip. *Clin Orthop Relat Res* 1974 ; 98 : 124-132.
13. **Mehmet B, Murat G, Oktay B *et al.*** Management of developmental dysplasia of the hip in less than 24 months old children. *Indian J Orthop* 2013 ; 47 (6) : 578-584.
14. **Nakamura M, Matsunaga S, Yoshino S *et al.*** long-term result of combination of open reduction and femoral derotation varus osteotomy with shortening for developmental dislocation of the hip. *J Pediatr Orthop* 2004 ; 13- B : 248-253.
15. **Onley B, Latz K, Asher M.** Treatment of hip dysplasia in children with a combined one-stage procedure. *Clin Orthop Relat Res* 1998 ; 347 : 215-223.
16. **Ryan MG, Johnson LO, Quanbeck DS *et al.*** One-stage treatment of management of congenital dislocation of the hip in children three to ten years old : Functional and radiographic results. *J Bone Joint Surg Am* 1998 ; 80 : 336-344.
17. **Saleh JM, O'Sullivan ME, O'Brien TM.** Pelvic remodeling after Salter osteotomy. *J Pediatr Orthop* 1995 ; 15 (3) : 342-5.
18. **Salter RB.** Innominate osteotomy in the treatment of congenital dislocation and subluxation of the hip. *J Bone Joint Surg* 1961 ; 43-B : 518-539.
19. **Salter RB, Dubos JP.** The first fifteen year's personal experience with innominate osteotomy in the treatment of congenital dislocation and subluxation of the hip. *Clin Orthop Relat Res* 1974 ; 98 : 72-103.
20. **Severin E.** Contribution to the knowledge of congenital dislocation of the hip joint ; late results of closed reduction and arthrographic studies of recent cases. *Acta Chir Scand* 1941 ; 84 (Suppl 63) : 1-142.
21. **Sharp IK.** Acetabular dysplasia : the acetabular angle. *J Bone Joint Surg* 1961 ; 43-B : 268-272
22. **Tonnis D.** *Congenital Dysplasia and Dislocation of the Hip in Children and Adults*. Springer-Verlag, Berlin, 1987,pp233-240.
23. **Trevor D, Johns DL, Fixsen JA.** Acetabuloplasty in the treatment of congenital dislocation of the hip. *J Bone Joint Surg* 1975 ; 57-B : 167-174.
24. **Umer M, Nawaz H, Kasi PM *et al.*** Outcome of triple procedure in older children with developmental dysplasia of hip (DDH) *J Pak Med Assoc* 2007 ; 57 : 591-595.
25. **Vallamshetla VR, Mughal E, O'Hara JN.** Congenital dislocation of the hip. A re-appraisal of the upper age limit for treatment. *J Bone Joint Surg Br* 2006 ; 88 : 1076-1081.
26. **Wiberg G.** Studies on dysplastic acetabula and congenital subluxation of the hip joint with special reference to the complication of osteoarthritis. *Traumatol Turc* 2007 ; 41 Suppl 1 : 25-30.
27. **Yagmurlu MF, Bayhan IA, Tuhanioglu U *et al.*** Clinical and radiological outcomes are correlated with the age of the child in single-stage surgical treatment of developmental dysplasia of the hip. *Acta Orthop Belg* 2013 ; 79 (2) : 159-65.