

Management of developmental dysplasia of the hip in less than 24 months old children

Mehmet Bulut, Murat Gürger¹, Oktay Belhan¹, Omer Cihan Batur¹, Suat Celik¹, Lokman Karakurt¹

ABSTRACT

Background: There is no consensus on the treatment of developmental dysplasia of the hip in children less than 24 months of age. The aim of this study was to present the results of open reduction and concomitant primary soft-tissue intervention in patients with developmental dysplasia of the hip in children less than 24 months of age.

Materials and Methods: Sixty hips of 50 patients (4 male, 46 female) with mean age of 14.62 ± 5.88 (range 5-24 months) months with a mean followup of 40.00 ± 6.22 (range 24-58 months) months were included. Twenty five right and 35 left hips (10 bilaterally involved) were operated. Open reduction was performed using the medial approach in patients aged < 20 months (with Tönnis type II-III and IV hip dysplasias) and for those aged 20-24 months with Tönnis type II and III hip dysplasias ($n = 47$). However for 13 patients aged 20-24 months with Tönnis type IV hip dysplasias, anterior bikini incision was used.

Results: Mean acetabular index was $41.03 \pm 3.78^\circ$ (range 34° - 50°) in the preoperative period and $22.98 \pm 3.01^\circ$ (range 15° - 32°) at the final visits. Mean center-edge angle at the final visits was $22.85 \pm 3.35^\circ$ (18° - 32°). Based on Severin radiological classification, 29 (48.3%) were type I (very good), 25 (41.7%) were type II (good) and 6 (10%) were type III (fair) hips. According to the McKay clinical classification, postoperatively the hips were evaluated as excellent ($n = 42$; 70%), good ($n = 14$; 23.3%) and fair ($n = 4$; 6.7%). Reduction of all hip dislocations was achieved. Additional pelvic osteotomies were performed in 14 (23.3%) hips for continued acetabular dysplasia and recurrent subluxation. (Salter [$n = 12$]/Pemberton [$n = 2$] osteotomy was performed). Avascular necrosis (AVN) developed in 7 (11.7%) hips.

Conclusion: In DDH only soft-tissue procedures are not enough, because of the high rate of the secondary surgery and AVN for all cases aged less than 24 months. Bone procedures may be necessary in the walking age group with high acetabular index.

Key words: Anterior bikini incision, developmental dysplasia of the hip, medial approach

INTRODUCTION

The goal of treatment in developmental dysplasia of the hip (DDH) is to achieve concentric reduction without disrupting the circulation of femoral head. Early reduction is known to accelerate development of both the femoral head and the acetabulum. Open reduction is indicated when closed concentric reduction cannot be achieved or achieved with the hip kept in extreme flexion,

abduction or internal rotation. Two basic approaches have been used for open reduction, i.e. medial and anterior approach.¹⁻⁴

Medial approach was first introduced by Ludloff in 1913.⁵ This approach was then termed as the anteromedial approach. Another type of medial approach is posteromedial approach described by Ferguson.⁶ In both types, branch of the medial femoral circumflex artery might require identification and ligature. Ligature of this arterial branch does not lead to avascular necrosis (AVN), but still its preservation has been recommended.⁷ Rates of AVN in cases managed with the medial approach have been reported from 0% to 67%.^{6,8-11} Open reduction in hip dysplasia using anterior approach is a popular method with proven success rates which ensures a comprehensive approach to the hip joint.¹²⁻¹⁴ Anterior approach can be performed in all age groups with its advantage of performing both capsular plication and pelvic osteotomy in the same session. The incidence of AVN and need for secondary intervention increases when medial approach was performed after the walking age. Therefore, the medial approach in children older than 12-18 months is not recommended generally.¹⁵⁻¹⁷

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There are studies which reveal good results with simultaneous open reduction along with pelvic osteotomies in older children.¹⁸⁻²⁰ In our study, we present treatment results of open reduction and concomitant primary soft-tissue intervention in patients with DDH aged less than 24 months.

MATERIALS AND METHODS

Seventy two cases who underwent open reduction for DDH between 2000 and 2009 were retrospectively reviewed. Sixty hips of 50 patients with acceptable followup periods (minimum 24 months), physical examination findings and radiographs were included in the study. Teratologic and neuromuscular dislocations were excluded. Open reduction was performed with medial approach (Ludloff method) in patients aged <20 months with Tönnis type II, III and IV hip dysplasias and those aged 20-24 months with Tönnis types II and III hip dysplasias (total $n = 47$). However, for 13 patients aged 20-24 months (with Tönnis type IV hip dysplasias), anterior bikini incision was used. Ten cases with bilateral involvement were operated in the same session. In 4 cases, bilateral anterior bikini and in 6 cases medial approaches were used for open reduction.

Operative procedures

In the medial approach a 5-6 cm long transverse incision was made 1 cm distal to the insertion point of adductor longus. Tendon of adductor longus was cut at its insertion. With blunt dissection, cleavage between adductor brevis and pectineus was made while taking care to preserve the obturator nerve. Lesser trochanter was exposed to reach the iliopsoas tendon, which was dissected from its insertion. Arthrography was performed. In Tönnis type I hips and also Tönnis type II hips having a wide safe zone, spica cast was applied. In Tönnis type II hips with a narrow safe zone and in Tönnis type III hips, joint capsule was opened with a "cross sign" incision. Then ligamentum teres

and pulvinar were resected and the tranverse acetabular ligament was cut. Spica cast was applied with the hip fixed in a 90° flexion and 45° abduction [Figure 1]. In the anterior approach, a bikini incision was used. Plane is developed between tensor fascia lata and sartorius. Lateral cutaneous nerve of thigh was identified and retracted medially. The apophysis of the iliac wing was divided anteromedially and the rectus femoris dissected away from its insertion to the anteroinferior iliac spine to access the joint capsule. Femoral nerve was identified and the iliopsoas was lengthened at its musculotendinous junction. The joint capsule was opened through an inverted "T" incision. Thickened ligamentum teres and pulvinar were removed and the tranverse acetabular ligament was excised. Following reduction of the femoral head into the acetabulum, adequacy of the safe zone and articular pressure were evaluated. Capsular plication was performed. Reduction was controlled on fluoroscopy. The hip was immobilised in a spica cast in 30° abduction and 80°-90° flexion [Figure 2]. In both approaches, the casts were removed 45 days later under general anesthesia and the patient was instructed to use an abduction orthosis during the night time for a total of 3 months.

The patients were followed up every 3 and 6 months during the 1st and 2nd years and then annually. Pre and postoperative radiological evaluation was carried out. On preoperative radiographs, acetabular index (AI) and on postoperative radiographs, center edge angle (CEA) and AI were measured. In the postoperative period clinical evaluation was using the modified McKay²¹ criteria. Radiological evaluation was done using the Severin²² classification. Postoperative diagnosis of AVN was made based on Salter²³ criteria.

Cases were divided into two groups according to the requirement for a second intervention and development of AVN and then the groups were compared to each other.



Figure 1: X-ray pelvis with both hip joints in a 9 months old infant showing (a) Tönnis type IV developmental dysplasia of the hip; (b) The same case at 4 years followup after open reduction using a medial approach showing well maintained reduction

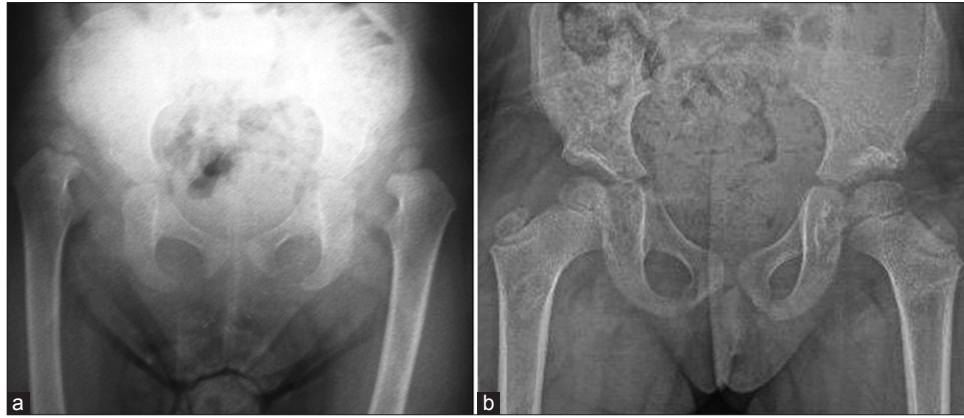


Figure 2: X-ray pelvis with both hip joints in a 21 months old patient showing (a) Tönnis type IV hip dysplasia; (b) Appearance of the same case 27 months after the operation

In statistical evaluations for groups with dependent variables, student *t* test was used. Chi-square test was used for comparison of the groups. $P \leq 0.05$ was considered statistically significant.

RESULTS

We had a total of 60 hips of 50 patients (4 male, 46 females) bilateral involvement was seen in 10 cases. 25 right hips and 35 left hips were operated. Mean age of the patients was 14.62 ± 5.88 (range 5-24 months) months and the patients were followed up for an average of 40.00 ± 6.22 (range 24-58 months) months. Based on the Tönnis classification, Type II ($n = 3$; 5%), III ($n = 34$; 56.7%) and IV ($n = 23$; 38.3%) cases were operated. Mean acetabular index (AI) was $41.03 \pm 3.78^\circ$ (range 34° - 50°) in the preoperative period and $22.98 \pm 3.01^\circ$ (range 15° - 32°) at the final followup visit. Mean CEA at the final followup visit was $22.85 \pm 3.35^\circ$ (range 18° - 32°). Based on Severin radiological classification, 29 (48.3%) hips were type I (very good), 25 (41.7%) were type II (good) and 6 (10%) hips were type III (fair). According to McKay clinical classification, postoperative condition of the hips were evaluated as excellent ($n = 42$; 70%), good ($n = 14$; 23.3%) and fair ($n = 4$; 6.7%). Reduction of all hip dislocations was achieved.

When the cases were evaluated for the surgical approach employed, medial ($n = 47$) or anterior ($n = 13$) surgical approaches were used for reduction. Mean age of the patients operated by a medial approach was 12.64 ± 5.04 (range 5-20 months) months. In medial approach, the mean operative time was 42.55 ± 5.20 min for unilateral and 68.72 ± 7.35 min for bilateral surgeries. The mean blood loss in medial approach was 34.15 ± 8.10 cc for unilateral and 61.06 ± 8.74 cc for bilateral surgeries. Hips operated by medial approach were of Tönnis type II ($n = 3$), III ($n = 34$) and IV ($n = 10$). Preoperative AI angle in this

approach group was $40.30 \pm 3.46^\circ$ and at the final followup the mean AI angle and CEA were $22.96 \pm 3.04^\circ$ and $22.53 \pm 3.33^\circ$ respectively. The patients were followed up for an average of 38.98 ± 5.72 months in this group. At the final followup, postoperative outcomes achieved were categorized as type I and II in 44 (44/47; 93.6%) patients as per McKay classification. Severin radiological classification evaluated the outcomes as type I and II in 43 (91.5%) patients. Superficial infection was seen in two cases, which responded to antibiotics.

Mean age of all the patients operated by anterior approach was 21.77 ± 1.42 (range 20-24 months) months. The mean operative time in this approach was 60.38 ± 9.46 min for unilateral and 97.52 ± 12.87 min for bilateral surgeries. The mean blood loss was 81.92 ± 17.62 cc for unilateral and 152.63 ± 21.07 cc for bilateral cases. All these hips were of Tönnis type IV with a mean preoperative AI angle of $43.69 \pm 3.79^\circ$. At the final followup visit of these patients followed up for an average of 43.69 ± 6.80 months, the mean AI and the CEA angles were $23.08 \pm 2.99^\circ$ and $24.00 \pm 3.29^\circ$, respectively. According to the McKay classification, type I and II outcomes were achieved in 12 of 13 cases (92.3%). Based on the Severin radiological classification, type I and II outcomes were achieved in 11 (84.6%) cases. A statistically significant difference was found between preoperative and postoperative acetabular indices of hips in both groups ($P < 0.001$) [Table 1].

Additional pelvic osteotomies were performed on 14 (23.3%) hips with acetabular dysplasias. These hips demonstrated unsatisfactory improvement or recurrent subluxation with lateralization (based on Salter [$n = 12$] and Pemberton [$n = 2$] criteria). Pelvic osteotomies were performed at an average of 15 (range 6-27 months) months after open reductions. Pelvic osteotomies and open reductions were performed by anterior approach for 8 hips with subluxations. In 6 cases with persistent acetabular

dysplasias without subluxation, pelvic osteotomies were performed by anterior approach without opening the joint

Table 1: Characteristics of the hips with medial and anterior approach

Parameters	Medial approach	Anterior approach	P value
Age (mean months)	12.64±5.04	21.77±1.42	<0.001
Gender (male/female)	3/44	1/12	NS
Tönnis' classification			NS
II	3	0	
III	34	0	
IV	10	13	
Duration of surgery (min)	42.55±5.20	60.38±9.46	<0.001
Mean blood loss (cc)	34.15±8.10	81.92±17.62	<0.001
Followup duration (month)	38.98±5.72	43.69±6.80	0.035
Acetabular index			
Preoperative (°)	40.30±3.46	43.69±3.79	0.009
Postoperative (°)	22.96±3.04	23.08±2.99	0.900
Center-edge angle (°)	22.53±3.33	24.00±3.29	0.172
McKay classification			
I	33	9	NS
II	11	3	
III	3	1	
IV	0	0	
Severin classification			
I	23	6	NS
II	20	5	
III	4	2	
IV	0	0	

NS=Not significant

capsule [Figure 3]. As expected, it was difficult to reduce the hip joint in re-operation cases, due to adhesion and fibrosis. Statistically, significant difference was not found between age at operation, gender of the patients, Tönnis classification, type of surgical approach and requirement for a secondary intervention. However, in cases with higher preoperative AI, the need for a secondary surgical intervention was significantly increased ($P = 0.050$) [Table 2].

AVN developed in 7 (11.7%) hips which were managed using anterior ($n = 4$) or medial ($n = 3$) approach. A statistically significant relationship was not found between age at operation, gender of the patients, Tönnis classification, preoperative acetabular indices and development of postoperative AVN [Table 3]. However, the development of AVN was significantly higher in cases operated using the anterior approach when compared to hips operated by a medial approach ($P = 0.034$) [Table 3]. A statistically significant difference did not exist between patient groups operated with medial or anterior approach regarding McKay clinical and Severin radiological classification results ($P > 0.05$)

DISCUSSION

Hip in DDH can be approached based on a number of factors – timing of intervention, operation types and treatment modality. In closed reduction, if hip has a narrow

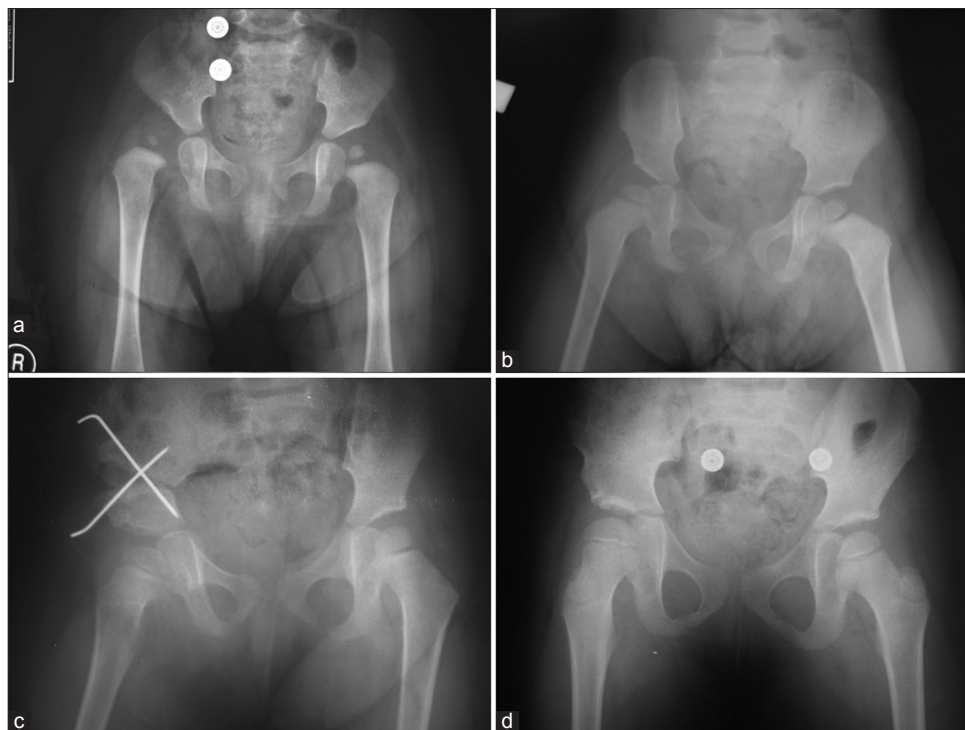


Figure 3: X-ray pelvis with both hip joints in a 10 months old infant showing (a) Tönnis type II developmental dysplasia of the hip; (b) X-ray of same patient 18 months after open reduction performed with a medial approach showing acetabular dysplasia persists; (c) Salter osteotomy was performed for persistent acetabular dysplasia; (d) Anterior-posterior pelvic X-ray of the same patients' 30 months after the Salter operation

Table 2: Comparison of hips with or without requirement for a secondary intervention

Parameters	Cases with requirement for a secondary intervention	Cases without requirement for a secondary intervention	P value
Mean age (month)	16.50±5.00	14.04±6.06	0.139
Gender (male/female)	2/12	2/44	NS
Tonnis' classification			NS
II	0	3	
III	8	26	
IV	6	17	
Preop Acetabular index (°)	43.07±4.81	40.30±3.57	0.023
Surgical approach (medial/anterior)	10/4	37/9	0.353

NS=Not significant, Preop = Preoperative

Table 3: Comparison of hips with or without development of avascular necrosis

Parameters	Cases with avascular necrosis	Cases without avascular necrosis	P value
Mean age (month)	15.71±6.26	14.47±5.88	0.634
Gender (male/female)	1/6	3/38	NS
Tonnis' classification			NS
II	0	3	
III	3	31	
IV	4	19	
Preop Acetabular index (°)	43.43±3.87	40.72±3.69	0.074
Surgical approach (medial/anterior)	3/4	44/9	0.034

NS=Not significant, Preop = Preoperative

arc unsuitable for reduction and a concentric reduction could not be achieved, then open reduction is indicated.²⁴⁻²⁶ Nowadays, medial and anterior approaches have been used for open reduction. Kiely *et al.*³ evaluated 49 hips they operated using a medial approach in patients with ages ranging between 6 months and 23 months. According to the Severin classification, they obtained radiologically excellent and good results in 92% of their cases. Ucar *et al.*¹⁰ achieved radiologically excellent and good results in 79% of their cases ($n = 44$ hips) aged between 2 months and 19 months, using open reduction with a medial approach. Zamzam *et al.*²⁷ operated both hips of 23 children (age range 6-17 months) using a medial approach and achieved clinically and radiologically acceptable results at a rate of 95.7 and 93.5% respectively. In our study, we obtained clinically (93.3%) and radiologically (90%) excellent and good results. Although, our upper age limit for soft-tissue interventions was a little higher (24 months) than that reported in literature, our outcomes were in compliance with the findings of other studies in respect of clinical and radiological classifications. We operated 10 patients (20 hips) with bilateral involvement in the same session. AVN developed in two hips.

Castillo and Sherman⁸ reported the outcomes of 13 unilateral hip dysplasias, with an average of 7 years followup. They concluded that acetabular indices of the operated hips improved continually and approached the acetabular indices of naive control hips. These outcomes were key indicators of sustained success of soft-tissue interventions regarding normalization of AI. Mean preoperative AI in our study was $41.03 \pm 3.78^\circ$ (34° - 50°) while it was $22.98 \pm 3.01^\circ$ (range 15° - 32°) at final followup. At final followup, the mean CEA was $22.85 \pm 3.35^\circ$ (range 18° - 32°). We suppose that higher than normal final values in our series are associated with our short followup period.

The most important complications seen during treatment of DDH, are subluxation, redislocation and AVN. Many studies related to complications have been cited. Roose *et al.*²⁸ performed open reductions on 26 hips of 23 patients with a mean age of 10.2 months. No, AVN was seen in the study while redislocation was observed in 6 hips. Kalamchi *et al.*² performed open reduction on 11 children aged 3-12 months and followed up their patients for 4.5 years. AVN occurred in their cases at a rate of 67%.

In a study by Zamzam *et al.*²⁷ 15 cases (32.6%) in this study underwent secondary operations due to persistence of acetabular dysplasia 6 (13%) of patients developed AVN. Demirhan *et al.*²⁹ operated 33 hips of 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. Tumer *et al.*³⁰ had felt the need for an additional procedure at a rate of 2% in 13-18 month-old patients they treated using a medial approach. In our study, statistical difference was not detected between age groups and development of AVN. In the series of Ucar *et al.*¹⁰ 11 (25%) of their patients required a reoperation. Kiely *et al.*³ performed open reduction with medial approach on 49 hips and they observed AVN in 7 (14.3%) hips while 11 (22.4%) hips had to be intervened for the second time. In our study, AVN was seen in 7 (11.7%) cases. The development of AVN was significantly higher in cases operated using the anterior approach when compared to hips operated by a medial approach ($P = 0.034$). Secondary intervention in 24 out of 34 (70.6%) hips were reported by Sener *et al.*¹⁶ The mean age in their study was 23.7 months and they had managed the cases using a medial approach. Based on these results, they stated that open reduction using the medial approach above is inadequate in patients aged ≥ 18 months. However, we think that 18-54 month age group is an extremely wide age range. We conceive that investigations should involve a narrow time frame in order to get better outcomes. Besides, we think that it

is very difficult to maintain favorable results of reduction without capsular plication in high dislocations and in the advanced ages. We performed secondary interventions in 14 cases (23.3%) because of persistence of acetabular dysplasia and subluxation. Based on our findings preoperative AI angle was significantly different between cases with and without the requirement for a secondary intervention ($P = 0.023$). According to us, if preoperative AI angle is higher and patient age is suitable, bone surgery must be chosen.

Koizumi *et al.*¹ performed open reduction on 35 hips in 33 patients with a mean age of 14 months, with a followup of 19.4 years. They detected AVN in 42.9% of hips. They attributed these poor outcomes to their failure to cut the iliopsoas tendon and to maintenance of spica cast at 90°-90° for 1 month. Some authors reported that the most dreadful risk for AVN is excessively forced manipulations for reduction and casting techniques with the hip and lower extremity held in extreme positions.^{31,32} Kalamchi and MacEwen³³ reported that occurrence of AVN, deteriorated the outcomes of open reduction and increased the need for secondary surgical interventions. In our study, we performed iliopsoas and adductor longus tenotomies with the medial approach and in the anterior approach we only lengthened the iliopsoas tendon at its muscle-tendon junction. In both approaches following open reduction, a satisfactory hip stability was achieved and femoral head was not exposed to excessive pressures. Despite all this, secondary surgical intervention was performed on 14 (23.3%) cases because of persistence of acetabular dysplasia and subluxation.

In conclusion, only soft-tissue procedures are not enough for all cases aged less than 24 month and each case should be treated as per merit with appropriate bony procedures in the first instance. Bone procedures may be necessary in the walking age group with high acetabular index.

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