Treatment of developmental dysplasia of the hip before walking: Results of closed reduction and immobilization in hip spica cast

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SUMMARY: Aksoy MC, Özkoç G, Alanay A, Yazıcı M, Özdemir N, Surat A. Treatment of developmental dysplasia of the hip before walking: results of closed reduction and immobilization in hip spica cast. Turk J Pediatr 2002; 44: 122-127.

We retrospectively evaluated 200 hips of 129 patients with the diagnosis of developmental dysplasia of the hip treated with closed reduction and hip spica cast. There were 153 female and 47 male hips in the group. The mean age of the patients at the time of the reduction were six (range. 2-13) months and mean follow-up was 51 (range: 16-240) months. All the patients were treated with closed reduction and were immobilized in hip spica cast. The mean time of immobilization in the cast was 102 (range: 45-190) days. Avascular necrosis was observed in 15% of the hips. Clinical and radiological end results of the patients were evaluated with modified McKay criteria and Severin classification. Eighty-two percent of the patients had satisfactory results according to modified McKay criteria and 76% of the patients according to Severin classification. The most important parameters affecting the end result were pre-reduction location of the hip, pre-operative acetabular index values and avascular necrosis. Based on the results of this study, treatment of developmental hip dysplasia with closed reduction and hip spica cast is a relatively safe and effective method.

Key words: hip dislocation, closed reduction.

The term developmental dysplasia of the hip (DDH) refers to a spectrum of clinical and anatomical deformities ranging from capsular laxity to an irreducible dislocation. The pathological changes in a dysplastic hip in a newborn infant are generally reversible, with a 95% success rate with a simple means of treatment[1,2]. If the diagnosis is delayed, the obstacles to reduction become increasingly difficult to overcome, and recovery of the acetabulum after reduction is less predictable. The goal of the treatment of a dysplastic hip is to attain a concentric reduction to allow normal femoral and acetabular development[3]. It is very well known that a stable and concentrically reduced femoral head is the primary stimulus for the development of the acetabulum[4]. Closed reduction and immobilization of the hip in a spica cast is one of the most commonly used treatment methods of DDH. This method can be used before a child walks. But inappropriate use of the method commonly causes complications that affect long-term prognosis of the joint. Clinical results are generally better than radiological results in children. But the long-term prognosis of the joint is generally related to the radiological appearance[5]. Avascular necrosis, which increases delay in reduction, is the most important parameter affecting long-term clinical and radiological outcome of the disease. The aim of this study was to evaluate the functional and radiological results of closed reduction in one of the biggest series in the literature patients in mid-term.

Material and Methods

We retrospectively evaluated 200 hips of 129 patients with the diagnosis of developmental dysplasia of the hip (DDH) treated with closed reduction and hip spica cast. Arthrogrypotic patients and patients with chromosomal anomalies or multiple congenital anomalies were excluded from the study. The mean age of

the patients at the time of the diagnosis was six months [(range 2-13 and the mean follow-up was 51 months (range: 16-240)]. There were 153 female and 47 male hips in the group.

The position of the hip was evaluated according to Tonnis[6]. Tonnis divided the position of the hip into four groups: Type I describes dysplastic hips; type II, subluxated hips; type III, dislocated hips; and type IV, high dislocation. Radiographs of 184 hips before the treatment were evaluated with the radiological criteria as described above. According to Tonnis displacement grading system 56 hips had type I displacement, 116 hips had type II displacement, 10 hips had type III displacement, and 2 hips had type IV displacement in this study group[6].

The acetabulum was evaluated with acetabular index values. The mean acetabular index value was 35 degrees (range 15-52) before the treatment.

Home skin traction was applied for 155 hips for a period of 16 days (range 5-45) before the closed reduction. All closed reductions were performed under general anesthesia. Adductor tenotomy was necessary in only 76 hips. The reduction quality was evaluated with a direct radiograph in the operating room. If the femoral assific nucleus or shaft of the femur was directed to the triradiate cartilage, the reduction was accepted as a concentric reduction. Patients were immobilized in the human position, meaning 90-100 degrees flexion and 30-50 degrees of abduction. A secondary hip spica cast was applied for 58 hips. The mean time of the immobilization was 102 days (range 45-190). An abduction brace was used after the removal of the cast for an additional four months (range: 1-15).

Functional outcome of the patients was evaluated according to the modified McKay criteria[7,8] (Table I). Last radiographs of the patients were graded according to Severin classifications[9] (Table II). Severin class I and II hips and McKay type I and II hips were accepted as a good result. End results of the patients who needed surgical treatment after closed reduction were accepted as poor results. Avascular necrosis was classified according to Salter et al.[10] and Bucholz and Ogden[11]. Bucholz and Ogden identified four radiographic patterns of avascular necrosis in the proximal femur. Type I is characterized by either temporary fragmentation of the capital femoral ossified nucleus or delay in appearance of the ossified nucleus. The prognosis of type I avascular necrosis is good, and a skeletal maturity, it can be accepted as normal. In type II avascular necrosis damage to the lateral part of the physis causes premature fusion of the superolateral part of the physis. The outcome is a short femoral neck in valgus angulation with marked uncovering of the femoral head by the acetabulum. Type III avascular necrosis is whole head involvement. The femoral head is flattened and deformed and the hip joint is incongruous.

Type IV avascular necrosis affects the medial part of the capital femoral epiphysis and resulted in coxa magna and breva.

All the radiographic parameters were compared with the functional modified McKay criteria, Severin grade and avascular necrosis to determine the most important parameter affecting the end results.

Table I. Severin classification

		Center-edge angle	Radiographic appearance
Class I	Ia	>19⁰ (16-13 yrs) >25⁰ (>14 yrs)	Normal
	Ib	15-19⁰ (6-13 yrs) 20-25⁰ (>14 yrs)	Normal
Class II	IIa	>19⁰ (6-13 yrs) >25⁰ (>14 yrs)	Mild deformity in femoral head, neck or acetabulum
	IIb	15-19⁰ (6-13 yrs) 20-25⁰ (>14 yrs)	Same as IIa
Class III		<15⁰ (6-13 yrs) <20⁰ (>14 yrs)	Subluxation without dysplasia
Class IV	IVa	>0⁰	Mild subluxation
	IVb	<0⁰	Severe subluxation
Class V			Femoral head located at false acetabulum
Class VI			Re-dislocation

Table II. Modified McKay Criteria

Grade	Result	Description
I	Excellent	Painless, stable hip, normal range of motion, Trendelenburg's sign (–)
II	Good	Painless, stable hip, mild limping, mild loss of motion, Trendelenburg's sign (–)
III	Fair	Mild pain, mild loss of motion, Trendelenburg's sign (+)
IV	Poor	Severe pain

Results

Of the 200 hips 189 could be classified according to Severin classification in the latest follow-up[9]. There were 123 class I hips, 20 class IIa hips, 3 class IIb hips, 3 class III hips, 3 class IVa hips, 6 class IVb hips and 1 class VI hips. Thirty hips needed surgical treatment and were not graded according to Severin classification. Class I and II hips were described as good results and others were accepted as poor results according to Severin radiological classification (Fig. 1a, b). Seventy-six percent of the patients had good results and 23% of the patients had poor results.

One hundred and sixty-one hips could be classified according to modified McKay criteria[7,8]. There were 148 type I hips, 10 type II hips, and 3 type III hips. There were no type IV hips in the study group. Eighty-two percent of the patients had good results and 18% of the patients had poor results according to modified McKay criteria. Twenty-five hips 15% of the 164 for which sufficient radiographs were available had avascular necrosis. These hips were graded according to Bucholz and Ogden[11]. There were 11 type I, 5 type II, 5 type III, and 4 type IV avascular necrosis hips (Fig. 2a, b).

Fig. 1a: Nine-month-old female patient with left hip dislocation.

Fig. 1b: The same patients in Fig. 1a, 10 years after the closed reduction. The hip is normal.

Fig. 2a: Seven month old female patient with right hip dislocation.

Fig. 2b: Same patient in Fig. 2a, 11 years after the closed reduction. There is a sequelae of whole head involvement avascular necrosis, and trochanteric overgrowth. Trochanteric apophyseodesis was performed to stop trochanter growth.

The mean acetabular index after removal of the cast was 23 degrees (range: 10-42) and the mean acetabular index at the end of the follow-up was 19.54 degrees. (range: 10-40). The mean center-edge angle was 20.51 degrees (range:15-48) after the treatment.

There was no statistically significant difference in the end results in terms of sex, or clinical and radiologic findings ($p>0.05$).

In the group for whom home skin traction was applied, there were 16 hips with avascular necrosis; in the group receiving no home skin traction, there were nine hips with avascular necrosis.

There was no statistically significant difference between home skin traction and avascular necrosis ($p=0.5$). There were statistically significant differences between the position of the hip before reduction and Severin anatomic classification ($p=0.001$); modified McKay criteria ($p=0.001$); and avascular necrosis ($p=0.001$). There were 106 hips treated before six months of age and 101 of them healed with satisfactory outcome. There were 83 hips treated after six months of age and 75 of them healed with satisfactory outcome according to Severin classification and McKay criteria. The difference between patients treated before six months of age and after six months of age was statistically significant ($p=0.006$); the end results of the patients were evaluated with either Severin classification or modified McKay criteria. The mean acetabular index before the treatment in the cases with good results (according to Severin) was 34.8 degrees. The mean acetabular index before the treatment in cases with poor results (according to Severin) was 38.5 degrees. The difference was statistically significant ($p=0.001$). There was no statistically significant difference between the acetabular index values and avascular necrosis.

There was a strong and statistically significant relationsip between avascular necrosis, Severin classification and modified McKay criteria ($p<0.001$), meaning if there were no avascular necrosis the result would be better.

Discussion

Treatment of DDH is often challenging, and evaluation of the results in the published series is difficult because there is no universally accepted, standard system for the assessment of function and of radiographs of patients who have hip disease[9,12,13]. Severin Class I and II are generally accepted as excellent and good results[5]. Similar diversity in the systems of classification for function also makes comparison of results difficult. There is a discrepancy between excellent clinical results and radiographic results that are not excellent anatomically, especially in children[14,15]. Radiologic results better predict the long-term prognosis of the joint[5].

Preoperative hospital or home skin traction is a debatable issue in the treatment of DDH. Fish et al.[16] surveyed the members of the Pediatric Orthopedic Society of North America on this topic. Most pediatric orthopedic surgeons thought that traction reduces the incidence of necrosis in the treatment of DDH. But contrary to that belief, several articles on closed reduction without use of preliminary traction report incidences of

proximal femoral damage comparable to those found in series in which traction was used[17,18]. The result of this study also indicates that there is no correlation between avascular necrosis and preliminary home skin traction.

Perereduction position of the hip was also found to be an important parameter related to the end result. In high dislocations the reduction may be more forceful, and this may explain this result. Tonnis[6] hip grading system is useful for predicting difficult and complication-prone cases and can be used in the preoperative evaluation of the patients as shown in this study.

Prereduction acetabular index values were found to be related with the end result. This illustrates that treatment of severe dysplasia is difficult and that these patients should be followed-up closely; secondary procedures may be necessary for further treatment. An insignificant relationship between avascular necrosis and severity of the disease supports the idea that avascular necrosis is an iatrogenic complication.

The most disastrous complication associated with the treatment of DDH involves various degrees of growth disturbance of the proximal femur, including the epiphysis and the physeal plate. In the current study avascular necrosis was found in 15% of the patients. The reported incidence of proximal femoral growth disturbance varies from 0 to 73% in the literature[5,8,19]. Different opinions exist about the reasons for this variation. The use of prereduction traction, adductor tenotomy, and open or closed reduction; the force of reduction; the position of the postoperative immobilization; and the age at reduction have been implicated as etiologic factors[19]. Prereduction traction was not found as an etiologic factor in that study. Adductor tenotomy was not evaluated because in this study group adductor tenotomy was performed only if it was necessary. Position in the cast after reduction may be a factor, but no patient was immobilized in an extreme position. The problem is that there is no universal position safe for every patient. We believe the most important factor affecting the rate of avascular necrosis is the force of reduction. The force of reduction is not a quantitative factor affecting results, and it can only be evaluated by position of the stable reduction. Reductions, which are stable in extreme positions, generally need much more force. In these hips, closed reduction is not an appropriate method of treatment. Age of the patient at the time of the reduction is also an important factor. The low rate of avascular necrosis in this group might be attributed to the low mean age of the patients, because younger patients have a lower rate of growth disturbances and because the incidence of avascular necrosis increases with delay in reduction[20]. The method of reduction may be related to the rate of avascular necrosis, but the method of reduction alone is not. We believe that open reduction is indicated if closed treatment fails, or if there is persistent subluxation, soft tissue interposition, or reducible but unstable reductions other than extreme positions of abduction. The avascular necrosis rate obtained in this series is one of the lowest rates published[19]. It is known that type I avascular necrosis has a good prognosis for the joint; if the hips with type I avascular necrosis were excluded, the rate of avascular necrosis would have been 7% in this group.

The results of the current study indicate that 76% of the patients had acceptable results with this method radiographically. According to modified McKay criteria, 82% of the patients had acceptable results. Patients with high dislocations and high acetabular index values, and patients older than six months of age at the time of the reduction had a poorer prognosis. There is a strong correlation between these criteria and avascular necrosis. As a result of this approach, the most important parameter affecting results is avascular necrosis of the femoral head.

The results of this present study showed that treatment of developmental dysplasia of the hip with closed reduction and immobilization in hip spica cast before a child walks is an effective and relatively safe method. Orthopedic surgeons should be very careful about patients with high acetabular index values and high dislocations, and who are older than six months of age at the time of reduction, as shown in this study. These cases should be evaluated very carefully under general anesthesia with the aid of dynamic arthrography in order to avoid avascular necrosis, and open reduction should be performed if forceful reduction is necessary.

REFERENCES

1. Barlow TG. Early diagnosis and treatment of congenital dislocation of the hip. J Bone Joint Surg 1972; 44: 621-625.
2. Hensinger RN. Congenital dislocation of the hip. Clin Sympos 1979; 31; 1-31.

3. Weinstein SL. Natural history of congenital hip dislocation and hip dysplasia. Clin Orthop 1987; 225: 62-76.
4. Harris NH, Lloyd-Roberts GC, Gallien R. Acetabular development in congenital dislocation of the hip. With special reference to the indications for acetabuloplasty and pelvic or femoral realignment osteotomy. J Bone Joint Surg 1975; 57: 46-52.
5. Malvitz TA, Weinstein S. Closed reduction for congenital dysplasia of the hip. J Bone Joint Surg 1994; 76: 1777-1792.
6. Tonnis D. Pathologic anatomy of the congenital dislocation of the hip. In: Tonnis D (ed). Congenital Dysplasia and Dislocation of the Hip. Berlin Heidelberg: Springer Verlag; 1987; 71-83.
7. McKay DW. A comparison of the innominate and pericapsular osteotomy in the treatment of congenital dislocation olf the hip. Clin Orthop 1974; 98: 124-132.
8. Berkeley ME, Dickson JH, Clain TE, Donovan MM. Surgical therapy for congenital dislocation of the hip in patients who are twelve to thirty-six months old. J Bone Joint Surg 1984; 66: 412-420.
9. Severin E. Contribution to the knowledge of congenital dislocation of the hip joint. Late results of closed reduction and arthrogarphic studies of recent cases. Acta Chir Scandinavica 1941; (Suppl) 63: 84.
10. Salter Salter RB, Kostuik J, Dallas S. Avascular necrosis of the femoral head as a complication of treatment for congenital dislocation of the hip in young children: a clinical and experimental investigation. Canadian J Surg 1969; 12: 44-62.
11. Bucholz RW, Ogden JA. Patterns of ischmic necrosis of the proximal femur in nonoperatively treated congenital hip disease. In: Proceedings of the sixth open scientific meeting of the hip society. St Louis: CV Mosby; 1978: 43-63.
12. Anderson G. Hip assessment: a comparison of nine different methods. J Bone Joint Surg 1972; 54: 621-625.
13. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end result study using a new method of result evaluation. J Bone Joint Surg 1969; 51: 737-755.
14. Esteve R. Congenital dislocation of the hip. A review and assessment of results of treatment with special reference to frame reduction as compared with manipulative reduction. J Bone Joint Surg 1969; 42: 253-263.
15. Ishii Y, Ponseti IV. Long term results of closed reduction of complete congenital dislocation of the hip under one year of age. Clin Orthop 1978; 86: 167-174.
16. Fish DN, Herzenberg JE, Hensineger RN. Current practice in use of prereduction traction for congenital dislocation of the hip. J Pediatr Orthop 1991; 11: 149.
17. Coleman S. A critical analysis of the value of preliminary traction in the treatment of CDH. Orthop Trans 1987; 13: 180-181.
18. Quinn RH, Renshaw TS, DeLuca PA. Preliminary traction in the treatment of developmental dislocation of the hip. J Pediatr Orthop 1994; 14: 636-641.
19. Weinstein SL. Developmental hip dysplasia and dislocation. In: Morrissy RT, Weinstein SM (eds). Lovell and Winter's Pediatric Orthopaedics (5th ed) Vol. 2. Philadelphia: Lippincott Williams & Wilkins Co; 2001: 906-956.
20. Weiner DS, Hoyt WA, Odell HW. Congenital dislocation of the hip: the relationship of premanipulation traction and age to avascular necrosis of the femoral head. J Bone Joint Surg 1977; 59: 306-315.