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Our experience with closed reduction management in Pavlik harness failure cases

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Abstract

Aim: Developmental Hip Dysplasia (DDH) refers to a set of abnormalities involving the developing hip. These abnormalities range from mild instability to overt dislocation of the joint. It is important to treat this condition effectively to promote normal development of the hip and achieve good long-term results. Surgical and non-surgical methods are available as treatment methods. Closed reduction and casting in the "human position" under general anesthesia under operating room conditions are effective methods for DDH patients who fail with non-surgical methods. The purpose of this article is to share the clinical and radiological results of the patients we treated with closed reduction and casting in our clinic.

Materials and Methods: Radiological and clinical evaluation of 176 hips of 117 patients who applied to İnönü University Faculty of Medicine Department of Orthopedics and Traumatology between January 2010 and October 2017 and were treated with closed reduction and pelvipedal casting was performed retrospectively.

Results: The average preoperative acetabular index of the operated hips was 35.88 degrees, and the final follow-up acetabular index values were 22.09 degrees. Avascular necrosis was detected in 2 of the patients (1.7%). According to the modified McKay classification, very good results were obtained in 105 (90%) of 117 patients followed for closed reduction, good results were obtained in 11 (9%), and fair results were obtained in 1 (0.85%).

Conclusion: Closed reduction and cast treatment in developmental hip dysplasia is an effective treatment method due to its low complication rate and high success rate in the appropriate patient group.



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Introduction

Developmental hip dysplasia (DDH) encompasses a range of hip abnormalities in which the femoral head and acetabulum fail to develop and articulate anatomically. The aim of DDH (treatment is to achieve stable and concentric reduction of the hip as early as possible. The reduction achieved during skeletal maturation is maintained during growth to achieve a normal hip. The diagnosis and management of DDH vary according to age at presentation. When DDH is detected in the first months of life, treatment is usually simple and successful [1]. Devices that hold the hip in flexion and abduction are the gold standard treatment for reducible hips younger than 6 months [2]. These devices are divided into two categories: dy-

namic or static splints. Pavlik harness are the most popular of the dynamic splints [2]. Surgical treatments are performed when nonsurgical treatment fails. Currently, closed reduction under general anesthesia and pelvipedal cast immobilization are the gold standard treatment for children older than 6 months and for children in whom good reduction cannot be achieved with a Pavlik harness [3-5]. For patients who do not benefit from closed reduction, open reduction is considered [3]. Depending on the age of the patient, osteotomies can also be added [3]. Our aim in this study is to evaluate the clinical and radiological results of patients with DDH who underwent closed reduction and pelvipedal casting. When we looked at the literature, we saw that there were very few studies with the same number of patients as our study. We thought that a higher number of patients would reveal more objective results. We believe that this is an encouraging study

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for surgeons interested in pediatric orthopedics

Materials and Methods

The clinical research article was started after obtaining permission numbered 2018/3-4 from the Inonu University Clinical Research Ethics Committee. Consent was obtained from the parents of the patients who would participate in the study. Radiological and clinical evaluation of 176 hips of 117 patients who applied to Inonu University Faculty of Medicine Department of Orthopedics and Traumatology between January 2010 and October 2017 and were treated with closed reduction and pelvipedal casting was performed retrospectively. Babies younger than 6 months, for whom the Pavlik bandage was not effective and/or the family did not comply, and those with semi-dislocated or fully dislocated DDH between the ages of 6 and 18 months, in whom a concentric hip joint was obtained in closed reduction, were included in our study. In addition, 2 more patients were included in our study because they benefited from closed reduction even though they were older than 18 months (21 and 22 months). Patients with teratological, neuromuscular, syndromic hip dislocations, patients whose radiographs were missing in the archive search, those who could not be reached, and those who did not want to be included in the study were excluded from the study. Of the 117 patients participating in the study, 12 were boys and 105 were girls. 19 patients had right involvement, 39 patients had left involvement, and 59 patients had bilateral involvement. The average age of the patients when closed reduction and pelvipedal cast application was started was 7.5 (2 - 22) months. Our average follow-up period was 35.72 (9 - 100) months. Pre-reduction radiographs of the patients participating in the study were examined, and the dislocation levels of these hips were grouped according to the Tönnis [6] classification.

Modified MacKay criteria [7] were used for postoperative clinical evaluation of the patients, and Kalamchi MacEwen criteria [8] were used for radiological evaluation of avascular necrosis. The percentage of acetabular index angle improvement was calculated by comparing the acetabular index angle obtained from the patients' preoperative AP pelvis radiographs with the acetabular index angles in the postoperative control radiographs. In addition, in the radiological evaluation, the acetabular index angle, the location of the capital femoral epiphysis according to Perkin's quadrants, and the presence of the capital femoral epiphysis were evaluated.

All patients underwent preoperative examination. Additionally, the patients were re-evaluated under general anesthesia. Closed reduction under fluoroscopy was attempted in the patients. The safe zone was determined as described by Ramsey [9]. Pelvipedal cast was applied to patients whose reduction was stable and the safe zone was wide. Arthrography was performed in all cases where the femoral head was suspected to be reduced and congruent with the acetabulum. Adductor tenotomy was performed on patients with adductor tension, that is, hip abduction less than 40 degrees. After appropriate reduction, the patient was placed on the plaster table. A cast was applied to the patient in the "human position". The patients were called

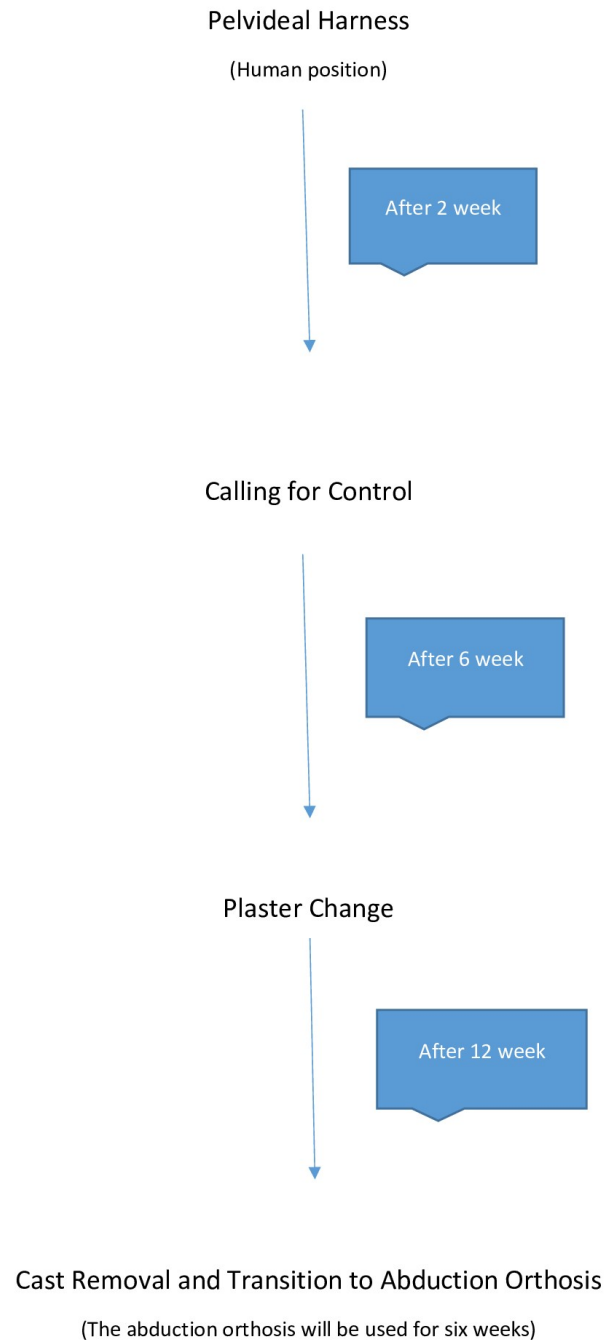


Figure 1. Figure showing the treatment algorithm,

for a follow-up at the 2nd week to evaluate the cast condition and radiological evaluation. Pelvipedal casts were changed under anesthesia after 6 weeks of fixation. The second cast was again made in the "human position". At the end of the 12th week, the cast was terminated in the outpatient clinic. Rhino Crusier type abduction orthosis [10] was recommended to the patients after the cast was removed (Figure 1).

Statistical analysis

SPSS program (version: 16) was used for statistical evaluation. The difference between the acetabular index before and after reduction was evaluated with Student's t-test,

and differences with a "p" value of 0.005 were considered statistically significant.

Results

Dislocation levels of the hips were grouped according to Tönnis' [7] classification system. According to Tönnis, 24 hips were found to be stage 1, 78 hips were stage 2, 54 hips were stage 3, and 20 hips were stage 4.

It was determined that the capital femoral epiphyseal nucleus was not formed in 54 of 117 patients.

Closed reduction was performed on 176 hips of 117 patients. Adductor tenotomy was performed on 19 of these hips and arthrography was performed on 74 of them. In the last follow-up radiographs, 31 hips had acetabular dysplasia with an acetabular index angle above 29 degrees. 11 of these hips were treated with Pelvic Osteotomy, an average of 15.5 months after the first cast application. Three of them were treated by open reduction, approximately 7 months after the first cast application. The remaining 17 hips are being followed. Postoperative acetabular index angles and follow-up periods of the 14 hips that underwent secondary surgery were not included in the averages.

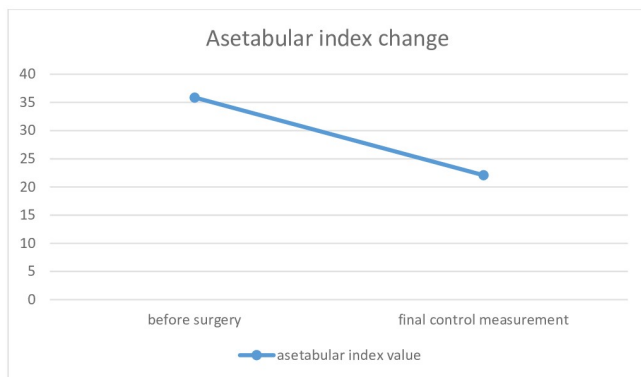


Figure 2. Figure showing the change in acetabular index.



Figure 3. Figure showing surgical results.

The average preoperative acetabular index of the operated hips was 35.88 degrees (Figure 2), and the final control acetabular index values were 22.09 degrees on average (Figure 2). A statistically significant difference was found between preoperative and postoperative acetabular index.

According to the modified McKay classification [7], very good results were obtained in 105 (90%) of 117 patients

followed up due to closed reduction, good results were obtained in 11 (9%) and fair results were obtained in 1 (0.85%) (Figure 3).

Avascular necrosis was detected in 2 of the patients (1.709%). According to Kalamchi and MacEwen's classification [8], type I avascular necrosis was present in 1 patient (0.85%) and type II avascular necrosis was present in 1 patient (0.85%).

Discussion

When we look at the results of our patients, we have achieved a high success rate. There is a very low complication rate. The need for secondary surgery in patients was also found to be low.

The goal of DDH treatment is to achieve stable and concentric hip reduction as early as possible. Today, closed reduction and spica cast application under general anesthesia is the primary treatment method for patients younger than 18 months who do not benefit from dynamic or static orthoses [11]. When soft-tissue contracture limits the amount of abduction available to achieve a stable reduction and sufficient safe zone, adductor tenotomy may provide a minimally invasive and effective option. Generally, adductor tenotomy is needed in hips with soft-tissue contractures independently from the previous treatment approach performed before closed reduction. It may be proposed that patients who need adductor tenotomy during closed reduction would have poorer prognosis than the ones without need for adductor tenotomy [12]. We applied adductor tenotomy in patients in whom we could not achieve the abduction required for reduction. However, we did not separate the patients in whom we performed adductor tenotomy and those in whom we did not perform tenotomy into two separate groups. If we had, we could have evaluated whether there was a significant difference in clinical or radiologic aspects in the patient group in which tenotomy was performed or not.

Closed reduction and cast immobilization are largely successful. However, it may cause complications such as AVN, loss of reduction, and nerve damage [13]. Avascular necrosis that develops after closed reduction is an important complication. Treatment methods used for DDH and diagnostic criteria used to define AVN may differ. Therefore, the reported prevalence of avascular necrosis varies greatly. The treatment method is an important factor that predisposes to AVN [14].

Malvitz et al. [15] found an AVN rate of 60% in their study. In the case series, patients were immobilized in more than 60 degrees of abduction. Sometimes abduction casts with 45-degree internal rotation have been used. An AVN rate of 21% was reported by Gregosiewicz [16]. The study found that the 'frog leg' position after reduction was a risk factor for iatrogenic necrosis. Similar results were reported by Schur [17]. In their study, Sibiński et al. [18] concluded that laterality, absence of proximal femoral ossific nucleus, use of traction before reduction, and hip abduction brace do not affect the risk of AVN. However, the degree of initial dislocation (according to the Tönnis classification) and age at initiation of treatment were concluded to be significant risk factors for AVN. Bozkurt et

al. [19] in research paper, They concluded that it is not correct to wait for the ossific core to form radiologically before applying closed reduction and spica casting to prevent femoral head AVN. They emphasized that age range does not matter. Additionally, the absence of a bone core has been shown to be a risk factor for the development of AVN in children older than 10 months. In our study, AVN developed at a rate of 1.7%. A strikingly low rate of AVN has been observed according to the literature. We associated such a low ratio with less than 50 degrees of hip abduction. Additionally, our average follow-up period for patients is 35 months. Perhaps we may encounter a higher rate of AVN patients as a result of longer follow-up. We used Kalamchi MacEwen criteria for radiological evaluations of avascular necrosis. We think that the diagnostic methods used for avascular necrosis may also vary in results. We do not use the formation of bone nuclei to determine the time to start treatment. We think that waiting will cause delays in treatment. 54 (46.153%) of the patients treated by our clinic were treated without ossific nucleus and AVN rates were found to be very low.

One of the main factors for acetabular growth and development is achieving and maintaining concentric reduction [13, 20]. Although there is potential overlap, unsuccessful initial reduction rates in the literature range from 6% to 25% and reduction loss rates range from 0% to 18% [13]. In their study, Murray et al reported a stable hip reduction rate of 94% (33 of 35 hips). has provided. 70% of hips (23 of 33 hips) did not require secondary surgery. In 10 of the other 33 hips (30%), a second surgery was required an average of 22 months after the cast was removed because the acetabulum was not sufficiently developed after closed reduction [21]. In their study, Sankar et al. found a 9% failure rate in closed reduction and spica cast application [13]. They used 2 criteria to say unsuccessful. First, there was a failure of closed reduction at any time and conversion to open reduction. Secondly, there were hips with IHDI [7] (international hip dysplasia institute) grade 3 and 4. The presence of any or both of these two reasons was counted as a failure. An 11 percent incidence of further corrective surgery was found. In the study conducted by Domos et al., certain risk factors that cause reduction loss after closed reduction were listed. Among these, gender, being in a high class in the classifications used for developmental hip dysplasia can be mentioned. It was observed that unilateral or bilateral dislocation, previous conservative treatment, age and the presence of ossific nucleus in the femoral head were not risk factors for reduction loss [22].

In our study, 176 hips of 117 patients were reduced closed. Our average follow-up period was 35.72 (9 - 100) months. After the first closed reduction, open reduction was performed in only 3 (4%) patients. Initial closed reduction and casting were successful in 114 (96%) patients. Secondary surgery was performed in 11 of 117 patients in whom stable hip reduction was achieved, due to dysplasia, and 17 patients are being followed up due to dysplasia. In light of these data, stable hip reduction performed in 73.50% (86 of 117 patients) in our study (without acetabular dysplasia and/or open reduction). No secondary surgery was required in 88.03% of the patients (103 of 117

patients). Using the modified McKay classification table [8], very good results were obtained in 105 (90%) of 117 patients followed up due to closed reduction, good results were obtained in 11 (9%) and fair results were obtained in 1 (0.85%). Since the average follow-up period of our study was 35 months, although it is guiding for early-term results, more studies are needed for medium and long-term results. We believe that future multicenter studies that include long-term results will yield more objective and valuable results.

Limitations

The limitations of the study are that we share the early results of the patients and that the patients are from a single center.

Conclusion

1. Closed reduction accompanied by a spica cast remains the most successful method for the targeted age group.
2. The exact reasons for avascular necrosis, one of the most feared complications, occur have not been fully determined and no consensus has been reached. More clinical and experimental studies are needed to ensure minimal or no avascular necrosis.
3. Since success rates vary according to studies, the criteria that measure success must be precisely determined and used by everyone.

Disclosure

While preparing this study, the specialty thesis titled "Clinical and Radiological Evaluation of Patients with Developmental Hip Dysplasia Treated with Closed Reduction and Pelvipedal Cast" with permission number 2018/3-4 from the clinical research ethics committee was used.

Ethical approval

Ethical approval was received for this study from the Inonu University Clinical Research Ethics Committee (Decision no: 2018/3-4).

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