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Comparison of salter osteotomy results in two different age groups in the treatment of developmental hip dislocation

Gelişimsel kalça çıkığı tedavisinde salter osteotomisinin iki farklı yaş grubundaki sonuçlarının karşılaştırılması

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Abstract

Aim: Surgical treatment of developmental hip dislocation is highly challenging in children of walking age. The most common complications following surgery include avascular necrosis and redislocation. In this study, we aimed to compare the preoperative and postoperative acetabular index, avascular necrosis (AVN) and redislocation rates between two age groups of open reduction and Salter osteotomy in DDH (Developmental Dysplasia of the Hip).

Methods: This prospective cohort study included patients who underwent open reduction and salter osteotomy for DDH between 2014 and 2017. Patients were grouped based on age as follows: Group 1: 18 -30 months old (n=44), Group 2: 31-48 months old (n=41). Preoperative, postoperative, and final acetabular indexes, AVN and redislocation rates were compared.

Results: Among 85 patients included in the study, 20 were male and 65 were female. The mean ages of Groups 1 and 2 were 21.6 months and 38.5 months, respectively. Following surgery, Group 1 mean acetabular index reduced to 25.9 degrees from 35.1 degrees, while that of Group 2 decreased to 22.1 degrees from 33 degrees. AVN was present in 10 patients (22.72%) in Group 1 and 4 patients (9.75%) in Group 2.

Conclusion: The acetabular index was adequately corrected in both groups. AVN was more frequent in children who had early interventions. We believe that the higher rate of avascular necrosis in children who underwent early intervention is due to surgical technique and using tighter sutures in the hip joint capsule.

Keywords: Hip dislocation, Acetabular index, Avascular necrosis, Redislocation

Öz

Amaç: Yürüme dönemi çocuklarda gelişimsel kalça çıkığının cerrahi tedavisi oldukça zordur. Avasküler nekroz ve kalça çıkığı tekrarlaması, cerrahi sonrası en sık karşılaşılan problemlerdir. Bu çalışmadaki amacımız GKD (Gelişimsel Kalça Çıkığı) tedavisinde uyguladığımız açık redüksiyon ve Salter osteotomisi yönteminin 2 grup arasındaki ameliyat öncesi ve sonrası asetabuler indeks, avasküler nekroz (AVN) ve redislokasyon oranlarını karşılaştırmaktır.

Yöntemler: Bu prospektif kohort çalışmaya 2014-2017 yılları arasında GKD nedeniyle açık redüksiyon ve salter osteotomisi yapılan hastalardan elde edilen verilerle yapıldı. Grup 1: 18 ay -30 ay (44), Grup 2: 31 ay-48 ay arası (41) hasta mevcuttu. Grupların ameliyat öncesi, ameliyat sonrası ve final asetabuler indeksleri, AVN ve redislokasyon oranları karşılaştırıldı.

Bulgular: Çalışmaya alınan 85 kalçanın 20'si erkek, 65'i kadın idi. Grup 1 hastaların yaş ortalaması 21,6 ay, Grup 2 hastalarının yaş ortalaması ise 38.5 ay idi. Ameliyat sonrası Grup 1 asetabuler indeks ortalama 35.1 dereceden 25,9 dereceye düşürülürken, Grup 2 de ise 33 dereceden 22,1 dereceye kadar düşürüldü. Grup 1 de 10 hastada (%22,72), Grup 2 de ise 4 (%9,75) hastada AVN vardı.

Sonuç: Asetabular indeks her iki grupta da yeterince düzeltildiği gözlendi. AVN'in erken müdahale yapılan çocuklarda daha yüksek oranda olduğu görüldü. Erken müdahale yapılan çocuklarda AVN'in daha yüksek olmasının kalça eklemi kapsülünün daha sıkı sütüre edildiği ve yapılan cerrahi teknikten kaynaklandığına inanıyoruz.

Anahtar kelimeler: Kalça çıkığı, Asetabuler indeks, Avasküler nekroz, Redislokasyon

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Ethics Committee Approval: This study was conducted with the approval of Van Yüzüncü Yıl University non-interventional clinical research ethics committee dated 07/26/2017-01. All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.
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Introduction

Developmental dysplasia of the hip (DDH) is one of the most critical and difficult orthopedic conditions. The term DDH includes broad-spectrum anomalies ranging from mild acetabular dysplasia and high hip dislocation. Treatment is quite difficult due to increased tightness of the joint capsule, the presence of extraarticular soft tissues, acetabular dysplasia, increased femoral anteversion, and inversion of the limbus. It may accompany congenital anomalies with acetabular dysplasia. When DDH is not diagnosed and treated early, it leads to progressive deformities in the hip joint and defective development of the acetabular cavity [1-3].

The aim of DDH treatment is to obtain a stable and painless hip joint, as well as provide a radiologically normal acetabular index [3,4]. Although DDH treatment is often successful in infants, it is still difficult to achieve success in late diagnoses [5].

While many surgical methods have been reported in DDH cases diagnosed at walking age, the most frequently used methods are Salter, Pemberton, and Dega [6]. Successful results have been reported with open reduction, capsulography, femoral shortening and pelvic osteotomies [7,8]. Although single-stage methods are used in late-diagnosed DDH surgeries, many unpredictable problems may arise in the treatment of older children [9]. In our study, we aimed to compare the acetabular index angle, frequency of avascular necrosis and redislocation rates of our patients in 2 different age groups that we treated with open reduction and salter osteotomy.

Materials and methods

Patients who were referred to our clinic, a tertiary healthcare institution, due to DDH between November 2014 and November 2016 and underwent Salter osteotomy, were included in this study. Inclusion criteria included patients with Tönnis grade 3-4 DDH we followed for at least 24 months who had not undergone any previous intervention due to hip dislocation. Exclusion criteria consisted of patients with bilateral hip dislocation, teratological hip dislocation, patients we could not follow up after treatment and Tönnis grade 1- 2 patients.

Table 1: Tonnis scoring system [10]

Grade 1	The femoral head is medial to the Perkin's line
Grade 2	The femoral head is lateral to the Perkin line, below the superolateral corner of the acetabulum.
Grade 3	The femoral head is at the level of the superolateral corner of the acetabulum.
Grade 4	The femoral head is above the superolateral corner of the acetabulum

The patients were categorized into two groups based on age as follows: Group 1 consisted of patients between 18-30 months of age, while Group 2 included patients between 31-48 months of age. The study was performed in accordance with the principles of Declaration of Helsinki and approved by the local Ethics committee (no: 2017/01).

All our patients were operated under general anesthesia and open reduction and the original osteotomy technique defined by Salter [11] were performed. For open reduction, Smith Peterson incision was utilized in some cases, while in others, a modified ilioinguinal anterior approach was used. Patients requiring femoral osteotomy were incised with a direct lateral approach. After the operation, pelvipedal cast was applied to all hips at 10-15 degrees of flexion and 20-30 degrees of abduction. Postoperative routine pelvis AP radiographs were obtained in a cast position. Casts of all patients were removed on the 45th postoperative day. After removing the pelvipedal cast, Dennis Brown splint was used for 45 days. The acetabular index measurement was performed on pelvis AP radiographs of patients who came to routine controls, and patients with avascular necrosis and redislocation were recorded. Revision surgery was planned immediately for the redislocated hips. Osteotomy was performed between the sciatic notch and the spina iliaca anterior inferior with the help of the Gigli saw. The triangular graft was taken from the superior of the iliac wing and placed between the proximal and distal ends of iliac osteotomy. After the graft was placed in the opened osteotomy line, it was attached with two K-wires directed from the edge of the iliac wing towards the back of the acetabulum.

Acetabular index

The acetabular index defined by Hilgenreiner in 1925 is a common method for evaluating the acetabular roof. In this measurement, the lowest side point of the ilium in the Y cartilage and the most lateral point of the sclerotic part of the acetabulum are determined. The angle between the line connecting these two points and the line (Hilgenreiner) connecting the two ilium points is defined as the acetabular index (Figure 1). Tönnis [12] defined acetabular index values until the age of seven.

Figure 1: Measurement of the acetabular index in a pelvic anterior-posterior (AP) radiography of a patient with DDH

Statistical analysis

The differences between the groups were compared using the normal distribution values of the Student t-test. A Chi-square test was used to compare categorical variables. Results are presented as mean and range. *P*-value <0.05 was considered statistically significant. All analyses were performed using SPSS 11.0 version software (SPSS Inc. Chicago, IL, USA).

Results

Among 85 patients included in our study, Groups 1 and 2 comprised of 44 and 41 patients, respectively. The mean ages of Groups 1 and 2 were 21.6 months and 38.5 months, respectively. Thirty-seven patients had right hip dislocations and 48 had left hip dislocations (*P*=0.824). The demographic data of our patients is presented in Table 2.

A statistically significant difference was detected between the preoperative, early postoperative (Figure 2) and final acetabular (Figure 3) indexes of Groups 1 and 2. The degree of acetabular index correction was 9.2 degrees in Group 1 and

10.8 degrees in Group 2. Analysis of the final average acetabular indexes revealed that the average AI corrections in Groups 1 and 2 were 14.5 degrees and 16.3 degrees, respectively, the difference between which was significant (*P*=0.005).

Table 2: Demographic data of our patients

	Group 1	Group 2	*P*-value
Number of patients (n)	44	41	0.828
Male/Female ratio	6/38	14/27	0.04
Mean age (month) (SD)	21.6 (3.02)	38.5 (9.31)	0.001
Right hip/Left hip	20/24	17/24	0.824
Preoperative AI (SD)	35.1 (5.91)	32.9 (5.66)	0.109
Early postoperative AI (SD)	25.9 (7.39)	22.1 (5.89)	0.009
Final AI (SD)	20.6 (7.39)	16.6 (5.01)	0.005
Average follow-up period (SD)	49.3 (21.2)	46.5 (20.9)	0.538
Avascular necrosis	10	4	0.146
Redislocation	3	2	0.704

AI: Acetabular index

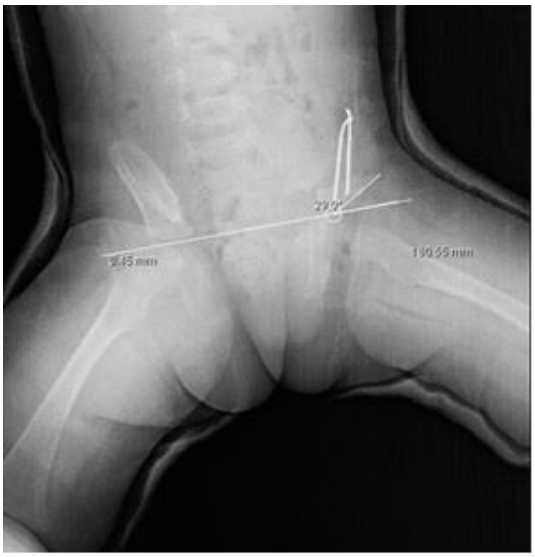

Figure 2: Measurement of the acetabular index on early postoperative pelvis anterior-posterior (AP) radiography

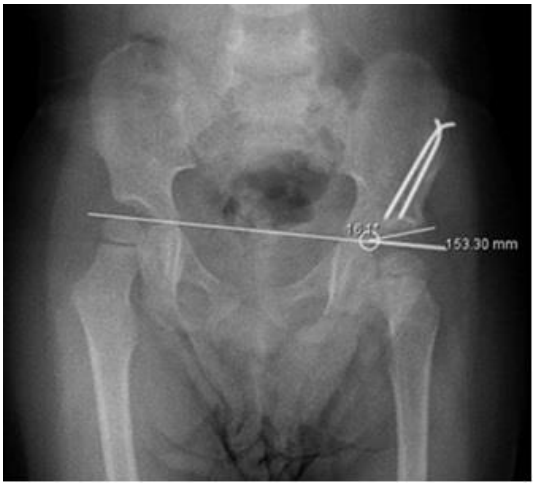

Figure 3: Final acetabular index measurement on pelvis anterior-posterior (AP) radiography of the same patient

The mean follow-up times of both groups were similar (*P*=0.538). Avascular necrosis was observed in 10/44 (22.72%) patients in Group 1 and 4/41 patients (9.75%) in Group 2. Three patients from Group 1 (6.8%) and 2 patients from Group 2 (4.8%) had redislocation, the difference between which was statistically insignificant (*P*=0.704).

Discussion

Although many methods have been described in developmental hip dislocation surgery, there are discussions about which to prefer [13,14]. In this study, we aimed to compare the results of open reduction and salter osteotomy technique, which we use most frequently in our clinic, in two groups of patients at different age groups. Lopez-Carreno et al. [15] reported that in patients undergoing salter osteotomy, the acetabular index decreased by 11 degrees on the radiographs after surgery. Barrett et al. [16] stated that in the 7-year follow-up of 4 different groups undergoing Salter osteotomy, they reduced the acetabular index by an average of 16 degrees. El-Sayed et al. [17] reported that they achieved 18-19-degree corrections in two different groups under and over 4 years of age using Salter osteotomy. In a study by Ahmed Essam et al. [18] it was stated that they reduced the preoperative mean acetabular index from 47.8 degrees to 26.7 degrees after Salter osteotomy in patients with DDH. Saqip et al. [19] reported that they reduced the preoperative mean acetabular index from 40.3 degrees to 23.4 degrees with Salter osteotomy in their study in which they followed patients for approximately 8 years. In our study, there was a statistically significant difference between the preoperative, mean early postoperative and final acetabular index measurements. Our acetabular index correction angles were compatible with the literature.

The most unfavorable complication in developmental hip dislocation surgery is avascular necrosis. In general, avascular necrosis rates of 1-13% have been reported in the literature after hip dislocation surgery [20,21]. Regardless of the treatment method used in DDH surgeries, surgical timing is important to avoid this complication. Some studies have reported that avascular necrosis is lower in the older age group [22]. In cases where femoral shortening is neglected, avascular necrosis is reportedly more frequent [23], and increased hip joint pressure has been reported to contribute to its development [24]. When pelvipedal plaster is made, difficult reduction, excessive internal rotation and abduction of the hip joint also increase avascular necrosis [25]. In our study, avascular necrosis occurred more in Group 1 (22.72%) than in Group 2 (9.75%).

In DDH, the femoral head is large, the acetabulum is shallow, femoral anteversion is increased, all of which are risk factors for dislocation, along with inadequate pelvic osteotomy [26,27]. In a study reporting that the rate of redislocation after hip dislocation is between 1-8 percent, it was concluded that the best results in pelvic osteotomies can be obtained between 2.5 years and 8 years of patient age [28]. In our study, 3 patients (6.8%) in group 1 and 2 patients (4.8%) in group 2 had redislocations.

Limitations

The small number of patients was one of the limitations of our study. Also, we could not compare the Salter osteotomy method with the other two frequently used methods, such as Dega and Pemberton, due to insufficient sample size. Further studies are needed to determine the association of Salter osteotomy results with age.

Conclusion

DDH treatment is highly challenging for children at walking age. Although the postoperative acetabular index values were compatible with the literature in both groups, avascular necrosis rates were particularly high in younger ages. We believe that the reason for high avascular necrosis in salter osteotomies performed in this group is related to the surgical technique rather than the age of the child.

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