Acta Medica Alanya

RESEARCH ARTICLE

ARAŞTIRMA

Acta Medica Alanya

2021;5(1):75-80

DOI:10.30565/medalanya.838843

Relationship between Treatment Age and Poor Outcome in Slipped Capital Femoral Epiphysis

Femur Başı Epifiz Kaymasında Tedavi Yaşının Kötü Sonuç ile İlişkisi

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ABSTRACT

Aim; Slipped capital femoral epiphysis(SCFE) is an adolescent disease characterized by the slippage of the femoral head epiphysis from the femoral neck. The aim of this study is evaluate the factors affecting clinical outcome the surgical treatment of patients diagnosed with SCFE.

Methods; Patients who were admitted to the orthopedic outpatient clinic with the complaint of gait disturbance and underwent surgery with a diagnosis of SCFE and were followed for minimum one year were screened between January 2015 and December 2019. A total of 11 patients, 7 boys and 4 girls, included in the study, were followed mean 27 months (12-47). The degree of deviation was measured with Southwick's method. Both preoperative and postoperative hip clinical evaluation was performed using Heyman and Herndon Classification.

Results; The mean age of the patients was 12.45 (10-14). In the perioperative period, the mean BMI of the patients was measured as 26.15 (20.45-32.34) kg/cm2. Lateral radiographs of the affected hips were taken and measured using the Southwick method, and the mean angle was 45,490 (24,30-65,70). Heyman and Herndon classification was evaluated in two main groups clinically. There was no statistically significant difference between the first group and the second group in terms of gender, side, BMI, Southwick value, time between the first symptom and presentation, and the time between presentation and diagnosis. However, the mean age of the first group, whose postoperative Heyman and Herndon classification was evaluated as excellent and good, was statistically lower than the second group ($p = 0.016$). In addition, while no negative change was observed in the clinical score in any of the treated patients, improvement was observed in 6 patients and it was found that the preoperative score was significantly increased compared to the postoperative evaluation ($p = 0.014$).

Conclusion; In situ fixation with a single cannulated screw and early surgical treatment are two important factors in achieving good clinical results in patients with SCFE. It should be kept in mind that patients diagnosed with SCFE at an older age may also be associated with poor clinical results.

Keywords: Slipped Capital Femoral Epiphyses, treatment outcome, Heyman and Herndon Classification, single screw.

ÖZ

Amaç; Femur başı epifiz kayması (FBEK), femur başı epifizinin femur boynundan kayması ile karakterize bir adolesan dönem hastalığıdır. Bu çalışmada amaç; FBEK tanısı almış hastaların cerrahi tedavi sonuçlarını klinik ve radyolojik olarak inceleyerek klinik sonuca etki eden faktörleri değerlendirmektir.

Yöntem; 2015-2019 tarihleri arasında polikliniğe başvuran, FBEK tanısı ile cerrahi tedavi uygulanan ve en az takip süresi bir yıl olan hastalar çalışmaya alındı. 7 erkek ve 4 kız toplam 11 hasta, ortalama 27 ay (12-47) takip edildi. Southwick yöntemi ile kayma miktarı ölçüldü. Preoperatif dönemde ve postoperatif dönemde kalça klinik değerlendirmesi Heyman ve Herndon Sınıflaması kullanılarak yapıldı.

Bulgular; Hastaların yaş ortalaması 12,45(10-14) idi. Peroperatif dönemde hastaların VKİ ortalaması 26,15(20,45-32,34) kg/cm2 olarak ölçüldü. Etkilenen kalçaların yan grafileri çekildi ve Southwick değerleri ortalama 45,490(24,30-65,70) olarak ölçüldü. Klinik olarak Heyman ve Herndon sınıflaması iki grupta değerlendirildi. Birinci grup ile ikinci grup arasında cinsiyet, taraf, VKİ, Southwick değeri, ilk semptom ile başvuru arası süre ve de başvuru ile tanı arasında geçen süre ile ilişkili anlamlı bir fark tespit edilmedi. Postoperatif Heyman ve Herndon sınıflaması mükemmel ve iyi olarak değerlendirilen birinci grubun yaş ortalaması, orta ve kötü olan ikinci gruba göre istatistiksel olarak daha küçüktü ($p=0.016$). Ayrıca tedavi edilen hiçbir hastada klinik skor olumsuz yönde değişim gözlenmezken 6 hastada iyileşme gözlendi ve preoperatif skor postoperatif değerlendirmeye göre anlamlı olarak artmış olduğu tespit edildi ($p=0.014$).

Sonuç; FBEK olan hastalarda tek kanüllü vida ile olduğu pozisyonda tespit ve erken cerrahi tedavi iyi klinik sonuçların elde edilmesinde önemli iki faktördür. Daha büyük yaşta FBEK tanısı konan hastaların da kötü klinik sonuçlar ile birlikte olabileceği öngörülebilir.

Anahtar kelimeler: Femur başı epifiz kayması, tedavi sonuçlar, Heyman-Herndon sınıflaması, tek vida

Received: 10.12.2020 Accepted: 08.02.2021 Published (Online): 23.04.2021

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To cited: Katı YA, Dikmen İ. Relationship between Treatment Age and Poor Outcome in Slipped Capital Femoral Epiphysis. Acta Med. Alanya 2021;5(1):75-80. doi:10.30565/medalanya.838843

INTRODUCTION

Slipped capital femoral epiphysis (SCFE) is an adolescent disease characterized by the displacement of the capital femoral epiphysis from the femoral neck on the physeal plate level [1]. It is common before Tanner Stage 4 in boys and before menarche in girls. It is more common in boys than in girls, in the left hip than in the right, and in Blacks compared to Caucasians [2,3]. It is most frequently seen at the age of 10 to 16 years, and it is bilateral in 20 to 40% of cases [4,5]. Obesity is a significant risk factor. The risk increases, particularly in children whose percentile curves are ≥60 [3]. Apart from mechanical stress in the hip caused by obesity, renal failure, hormonal disorders such as hypothyroidism and growth hormone disorders, and some genetic diseases are considered risk factors in the etiology of SCFE [1]. The most common symptoms at the time of admission are hip pain and claudication. Hip pain can radiate to the groin, medial of the patella, and femur. Knee pain is also one of the initial symptoms [6]. There are four types depending on the formation type and duration of the clinical presentation as pre-slip, acute slip, chronic slip, and acute-on-chronic slip [7]. In addition, patients who are able to walk with the aid of crutches are considered stable, and patients with restricted pain who are unable to walk are considered unstable SCFE cases [8].

The main goal of SCFE treatment, which should be treated with appropriate methods as early as possible following the diagnosis, is to prevent slippage and early fusion of the epiphysis. Although there are numbers of treatment options, single-screw fixation in situ is frequently included in the current literature and is widely used [9,10]. However, there are numbers of factors affecting clinical success and surgery-related morbidity.

In the present retrospective study, we aimed to evaluate clinical and radiographic outcomes, to investigate the factors affecting the surgical treatment outcomes, and to examine the possible relationship between delay in diagnosis and morbidity in patients with SCFE.

MATERIAL AND METHOD

This single-center, retrospective study was conducted at Antalya Training and Research Hospital between January 2015 and December 2019. Patients who were admitted to the orthopedic and traumatology outpatient clinic with the complaint of gait disturbance and underwent surgery with a diagnosis of SCFE and were followed for minimum one year were screened. Those who had missing follow-up data and who underwent surgical procedures in external centers were excluded from the study. A total of 11 patients (7 boys and 4 girls) who met the inclusion criteria were included in the study. A written informed consent was obtained from each parent and/or legal guardian. The study protocol was approved by the Antalya Training and Research Hospital Ethics Committee (Ethics Committee number: 2020-219) The study was conducted in accordance with the principles of the Declaration of Helsinki.

The affected side, body weight, height, and body mass index (BMI) values of the patients were retrieved from the hospital database. The initial symptoms of the patients, the first admission to the outpatient clinic, date of first diagnosis, and date of surgery were recorded. All patients were followed for minimum one year. Endocrinological examination of the patients was made before the treatment. All patients were fixed with cannulated screws of 6.5 mm in diameter and 16-mm thread in length. The range of motion (ROM) of the hip and radiographic images were evaluated before and after surgery. The degree of deviation was measured using the Southwick's angle on preoperative lateral hip radiographs [11]. Clinical evaluation of the hip both preoperatively and postoperatively was performed using the Heyman and Herndon classification [12] (Table 1). The patients were further divided into two subgroups according to the Heyman and Herndon classification as follows: the first group with excellent and good results with close quantitative evaluation, and the second group with moderate and poor results along with at least 1-cm shortness and severe limitation of movement.

In addition, the length measurement and gait evaluation of the affected limb were compared with the unaffected limb. Postoperative clinical and radiographic evaluation was performed at 6, 12, and 24 weeks and at one year and in the final control visit. The patients were partially mobilized

at six weeks and completely mobilized by weight bearing at 12 weeks.

Table 1. Heyman – Herndon Classification.

Group	Degree	Definition
Group 1	Excellent	Excellent result has a normal range of hip movement, no limp, no pain, and leg shortening.
	Good	Good result had slight limitation of internal rotation, occasional pain, and leg shortening of < 1 cm.
Group 2	Fair	Fair result had persistent mild pain, loss of internal rotation, abduction, and leg shortening of > 1 cm.
	Poor	Poor result did not meet any of the above criteria

Surgical technique

All patients were operated by a single experienced surgeon under general anesthesia. A plan for screw position was made based on the computed tomography (CT) or magnetic resonance imaging (MRI) scans in the preoperative period. All patients were placed in the supine position. Acute reduction was not performed in any of the patients and fixation was performed in situ. The hip region was entered with a lateral straight incision of 2 to 3 cm. First, the lateral femoral cortex and the appropriate location for the femoral head were visualized by fluoroscopy using a Kirschner wire (K-wire). Drilling was performed on the K-wire in the appropriate position and fixation was, then, performed with a cannulated screw with a diameter of 6.5 mm and a thread length of 16 mm accordingly. Fixation was done with a single screw in all patients. Positional suitability and length of the screw were evaluated on anteroposterior and lateral radiographs after screw insertion(Figure 1).

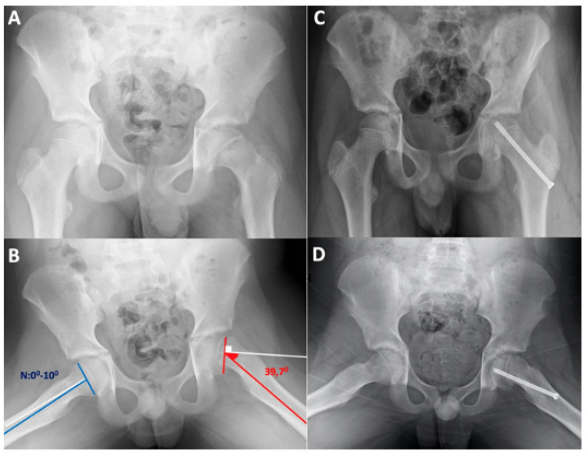

Figure 1. Slipped capital femoral epiphysis on the left hip in a 14 years old girl. A; Preoperative Anterior/Posterior pelvis X-ray. B; Preoperative lateral hip x-rays. Left side Southwick angle measurement is 39,70 degree. Right side is normal. C; Postoperative 6th month Anterior/Posterior x-ray view and D; lateral view.

Statistical analysis

Data analysis was performed using IBM SPSS Statistics version 17.0 software (IBM Corporation, Armonk, NY, USA). Whether the distributions of continuous variables were normally or not being determined Shapiro-Wilk test. Descriptive statistics for continuous variables were expressed as mean ± SD and number of cases with (%) were used for categorical data. While the mean differences between groups were compared Student's t test, otherwise the Fisher's exact test was applied for the comparison of categorical variables. Whether the differences in hip movement status between pre- and post-op was statistically significant or not was evaluated Wilcoxon Sign Rank test. A p value less than 0.05 was considered as statistically significant.

RESULTS

The median age of the patients was 12.45 (range, 10 to 14) years. The median follow-up was 27 (range, 12 to 47) months. The right side was affected in three patients and the left side was affected in eight patients. The median preoperative BMI was 26.15 (range, 20.45 to 32.34) kg/m2. Lateral radiographs of the affected hips were measured by the Southwick's angle and the median value was measured as 45.49° (range, 24.3° to 65.7°). The median time from the onset of the first symptom to the first admission to the outpatient clinic was 2.45 (range, 0 to 4) months, the median time from the admission to the outpatient clinic to diagnosis was 5.63 (range, 0 to 13) months, and the median time from the diagnosis to surgery was 0.5 (range, 0 to 2) months. One patient had a history of hypothyroidism requiring treatment, and one patient had a history of obesity under the control of pediatric endocrinology. According to the Heyman and Herndon classification before and after 12 months, none of the patients had worse results compared to baseline. The shortening was 1 cm in three patients and 2 cm in two patients. One of the patients having a 2-cm shortening had a clinical symptom(Table 2). The patients were

Table 2. Southwick angle measurement and demographic data of patients.

Patinets (n)	Age	Gender	Side	BMI* (Kg/m2)	Southwick Angle Degree (0)	Interval between first symptom to application (month)	Interval between application to diagnosis (month)	Endocrinopathy
1	10	F	Right	29.33	45.5	1,0	10,0	--
2	14	F	Left	32.34	39.7	3,0	7,0	--
3	12	M	Left	22.48	24,3	4,0	0,0	--
4	12	F	Left	20.45	54,8	2,0	5,0	--
5	13	M	Left	28.34	50,1	3,0	9,0	--
6	14	M	Left	28.91	65,7	4,0	5,0	Hypothyroidism
7	11	M	Left	24.78	44,9	4,0	0,0	Obesity
8	13	M	Left	23,46	46,2	0,0	10,0	--
9	14	M	Right	26,78	48,7	3,0	13,0	--
10	12	M	Left	26,3	34,4	1,0	0,0	--
11	12	F	Right	24,56	46,1	2,0	3,0	--

BMI: Body Mass Index

further divided into two subgroups according to the Heyman and Herndon classification as follows: the first group with excellent and good results with close quantitative evaluation, and the second group with moderate and poor results along with at least 1-cm shortness and severe limitation of movement. There was no statistically significant difference in terms of sex, affected side, BMI, Southwick's angle, and median time from the onset of the first symptom to the first admission to the outpatient clinic and from admission to diagnosis. However, the median age of the first group with excellent and good results according to the postoperative Heyman and Herndon classification was statistically lower than the second group (p=0.016). In addition, no worsening in the clinical scores was observed in any of the patients. An improvement was observed in six patients and the postoperative scores significantly improved compared to baseline (p=0.014).

DISCUSSION

Although SCFE is a rare disease in adolescents; it can lead to severe morbidity in case of possible delay in treatment. In its etiology, autosomal-dominant inherited genetic disorders, as well as structural and environmental factors have been proposed to play a role [13-15]. In our study, the male:female ratio was found to be 1.75. The median BMI was 26.15 kg/m2, consistent with the literature [1,14]. Although BMI is considered a predisposing factor, it showed no clinically significant effect on the results in this study. Hypothyroidism was detected in one patient and this patient was the one with the highest Southwick's angle measurement.

Treatment options vary both chronologically and depending on the clinical and radiographic findings. These options include fixation with plaster, closed internal fixation in situ, open epiphysiodesis, proximal femur osteotomies, and secure dislocation of the hip and epiphysis fixation. Plaster fixation is an earlier treatment method and has been abandoned in the current practice due to the long-term immobilization and high chondrolysis rates [16,17]. Closed fixation in situ is the most commonly used method in the current literature [9,10,18]. Except for studies suggesting the use of two threaded Steinmann nails due to the fact that they can be removed easily as described in the study of Nonweiler[19], the accepted method is fixation with a partially threaded, 6.5-mm cannulated screw [20]. In clinically and radiographically more advanced cases, epiphysiodesis or proximal femoral osteotomy is another treatment option [21,22]. In recent studies conducted in Turkey, the main fixation method is closed fixation in situ [6,23,24]. In all our patients, we used 6.5-mm screws in the supine position under the guidance of fluoroscopy and avoided the use of special traction tables.

In addition to the genetic causes in the etiology and the systemic effects of concomitant hormonal diseases, the fact that 20 to 40% of the cases are bilateral brings to mind the contralateral prophylactic fixation. The presence of accompanying hormonal causes and the chronological age of the patients are the main determinants of the possibility of slipping in

the contralateral hip [25]. Some authors have advocated that prophylactic surgery should be preferred in high-risk patients, while some others have claimed that a second surgery is associated with higher risks and more frequent clinical and radiographic follow-up alone is sufficient in these patients [25-27]. Currently, there is no consensus on this issue in the literature yet. In our study, prophylactic surgery was not performed in one patient with obesity and another with hypothyroidism. During follow-up, no slip was detected in any of the patients. In addition, no significant endocrinological factor affecting the clinical results was observed.

Loder Classification is one of the classification system used in SCFE(28). Patients are divided into two group as stable and unstable in this classification. The stable group was defined as patients who could be mobilized with or without crutches. And the unstable group was defined as patients who could not be mobilized not even with crutches. Loder showed in his study that the risk of developing avascular necrosis was observed in the unstable group. In other words, Loder Classifications provides prognostic information for complication of femoral head osteonecrosis. In our study, instead of the Loder classification, we used the Heyman Herndon Classification, which provides more clinical information. Considering the clinical evaluation, we quantitatively divided the patients into two subgroups based on the Heyman and Herndon classification. The first group had excellent and good results with no or mild limitation and no shortness. The second group had moderate and poor results with at least 1-cm shortening and moderate to severe clinical limitations. Accordingly, the median age of the first group with good postoperative clinical results was significantly lower than the second group with poor results. In a study evaluating BMI-for-age percentile, a significant correlation was found between bilateral SCFE and high BMI-for-age percentile [28]. However, there is no study in which a significant correlation was found between postoperative clinical results and age. According to our study, SCFE disease, which occurs at a late age has a worse prognosis than the group that occurs at an early age. In other words, development of SCFE in late age could be seen as a poor prognostic factor. To the best of our knowledge, therefore, our study is the first showing a significant correlation between the increase in age and poor clinical results of the treatment.

Besides the age of the patient, early diagnosis is an important factor for the clinical outcomes of treatment [1]. There are many publications in the literature showing that early diagnosis is associated with favorable clinical results [1,4,5]. In our study, it is a spectacular finding that all patients who were treated surgically within the first three months of diagnosis showed better clinical results. However, some of the patients who were operated after four months of diagnosis showed no improvement in the clinical outcomes. Nonetheless, no statistically significant difference was found between the patient groups (p=0.208). This can be attributed to the small sample size of the study.

Furthermore, fixation with a single screw yielded favorable results in our study, indicating statistical significance. Compared to the preoperative clinical evaluation, the clinical outcomes remained unchanged in five of 11 patients without any worsening, and a favorable progression was observed in six patients in the postoperative period. These findings confirm that fixation with cannulated screws, which is the treatment option that is at the forefront in the literature in recent years, seems to be a useful method.

Limitations of study: Nonetheless, there are some limitations to this study. First, it has a retrospective design with a small sample size. However, review of the literature on SCFE reveals studies using sample sizes similar to our study, except for those conducted in pediatric orthopedic centers [6,15,24]. The main strength of our study is its relatively long follow-up (median: 27 months) and the investigation of factors affecting the clinical outcomes, which have been very rarely examined in the literature. Long-term follow-up is valuable to obtain more accurate clinical results.

Conclusion: In conclusion, fixation in situ with a single cannulated screw and early surgical treatment are the main factors to achieve favorable and satisfactory clinical results in patients with SCFE. It should be also kept in mind that patients diagnosed with SCFE at an older age may experience poor clinical results.

Conflict of Interest: No conflict of interest was declared by the authors.

Funding sources: The authors declared that this study received no financial support.

Ethics Committee Approval: The study protocol was approved by the Antalya Training and Research Hospital Ethics Committee(Ethics Committee number: 2020-219)

Peer-review: Externally and internally peer-reviewed.

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