

# RADIOLOGICAL RESULTS OF SEVERE SCFE TREATMENT AT IOT-FMUSP FROM 2012 TO 2018

## RESULTADOS RADIOLÓGICOS DO TRATAMENTO DE EPIFISIOLISTESE GRAVE NO IOT-FMUSP ENTRE 2012-2018

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### ABSTRACT

**Objective:** To assess the complications in patients with severe slipped capital femoral epiphysis treated with the Dunn or modified Dunn procedure from 2012 to 2018 at the Institute of Orthopedics and Traumatology, Medical School, Universidade de São Paulo. **Methods:** Analysis of medical records, preoperative and postoperative radiographs with at least one year of radiographic follow-up of patients with severe slipped capital femoral epiphysis. **Results:** We reviewed the complications in 19 operated cases from 2012 to 2018, out of which 36.8% had osteonecrosis of the femoral head, one patient had chondrolysis, and another had postoperative infection. **Conclusion:** The osteonecrosis rate observed in this series of cases is similar to that described in other orthopedic facilities. We assessed factors that could potentially influence this outcome, including other characteristics of the patient (obesity, endocrine diseases, and history of sports activities) and of the health system. **Level of Evidence III, Retrospective Case Series.**

**Keywords:** Slipped Capital Femoral Epiphyses. Osteonecrosis. Osteotomy. Dunn Procedure. Modified Dunn Procedure. Southwick Angle.

### RESUMO

**Objetivo:** Avaliar as complicações apresentadas nos pacientes com epifisiolistese grave tratados por meio do procedimento de Dunn ou Dunn Modificado entre 2012 e 2018 no IOT-FMUSP. **Métodos:** Análise de prontuários, radiografias pré-operatórias e radiografias pós-operatórias com pelo menos 1 ano de seguimento radiográfico dos pacientes com epifisiolistese grave. **Resultados:** Analisou-se a presença de complicações em 19 casos operados de 2012 a 2018. Desses pacientes, 36,8% apresentaram osteonecrose da cabeça femoral, foi observada condrólise em 1 paciente e infecção pós-operatória em 1 paciente. **Conclusão:** A taxa de osteonecrose observada nesta série de casos está próxima à descrita em outros serviços. Alguns fatores que potencialmente influenciariam neste desfecho poderiam ter sido avaliados, como outras características do paciente (obesidade, doenças endócrinas e atividade esportiva) e do sistema de saúde. **Nível de Evidência III, Série Retrospectiva de Casos.**

**Descritores:** Epifisiolistese. Osteonecrose. Osteotomia. Procedimento de Dunn. Procedimento de Dunn Modificado. Ângulo de Southwick.

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### INTRODUCTION

Slipped capital femoral epiphysis (SCFE) is the displacement of the femoral head relative to the neck of the femur through the growth plate, commonly with superior anterior deviation of the femoral metaphysis relative to the epiphysis.<sup>1</sup> Despite its unknown etiology in most cases, this condition is associated with the following risk factors: morphology of the proximal femur (femoral anteversion or retroversion), obesity, sports practice, and endocrine disorders.<sup>2</sup> Different classifications can be used. One of them concerns the length of symptoms and displacement: acute (up to three weeks), chronic (after three weeks), acute-chronic (when a previous

displacement suffers an acute “slip”).<sup>3</sup> However, to define prognosis and conduct, two classifications are crucial: the first is radiographic, which refers to the degree of displacement and is obtained by measuring the Southwick angle in frog-leg or cross-table lateral radiographs. SCFE can be classified as: mild (up to 30° of epiphyseal displacement relative to the healthy side), moderate (30–50°), and severe (over 50°).<sup>4</sup> The second classification is clinical, proposed by Loder in 1993 and used to this day as a predictor of possible complications: stable (patient can walk using crutches or not, despite the pain) or unstable SCFE (patient cannot walk).<sup>5</sup>

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Among possible complications, osteonecrosis and its progression to osteoarthritis is probably the most feared.<sup>1</sup> Other unfavorable outcomes include postoperative infections, chondrolysis, femoroacetabular impingement, loosening of the synthesis material, and changes in limb growth.<sup>1,4</sup>

This study aims to assess complications, especially osteonecrosis of the femoral head, in patients with severe slipped capital femoral epiphysis of the proximal femur treated by a Dunn or modified Dunn surgical procedure from 2012 to 2018 at the Institute of Orthopedics and Traumatology of Hospital das Clínicas of the Universidade de São Paulo (HCFMUSP).

## MATERIALS AND METHODS

The medical records of patients with SCFE of the proximal femur submitted to a Dunn or modified Dunn procedure from 2012 to 2018 were collected.

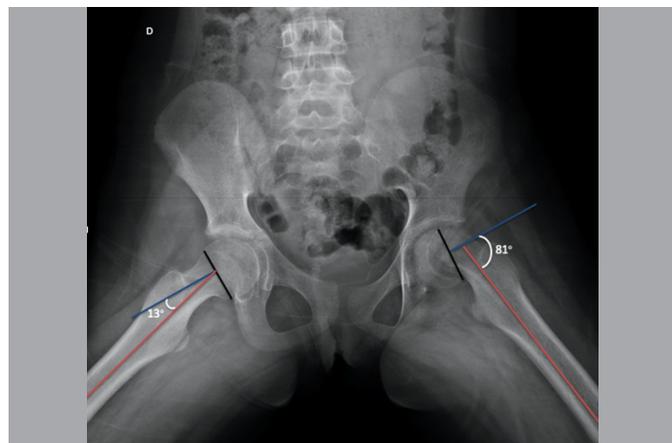
The Southwick angle (on AP and/or profile radiography) of each patient was calculated according to the method published by Southwick in July 1967 (Figure 1).<sup>6</sup>

After the epiphyseal line (black lines) is designed, a line is drawn perpendicular to it (blue lines); then, the angle between the blue line and a line drawn by the long axis of the diaphyseal femur (red lines) is calculated; finally, the value found on the affected side is subtracted from the unaffected side. Figure 1 shows the radiography of Patient 3, 11 years old, preoperative, Southwick angle: 81° (affected side, left) – 13° (unaffected side, right) = 68°.

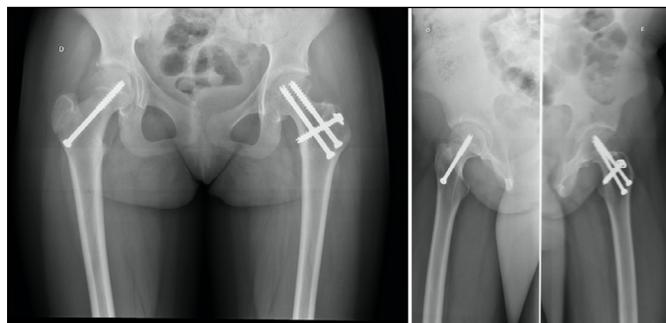
A period of one year was considered as the minimum radiographic follow-up time. Alterations that are compatible with the various stages of osteonecrosis of the proximal femur on control radiographs (anteroposterior and profile) were analyzed, including: presence of cysts or sclerosis in the femoral head, presence of the crescent sign (subchondral fracture), and flattening or collapse of the femoral head (Figure 2).<sup>7</sup>

Data were presented according to the types of variables. Absolute frequencies and percentages were used for qualitative variables. Quantitative variables were presented by the mean, median, standard deviation, and minimum and maximum values. The boxplot Graph shows the distribution of the Southwick angle according to osteonecrosis.

The association between the variables sex and laterality according to the presence of osteonecrosis was assessed by Fisher's exact test. Angle values were compared among patients with and without osteonecrosis by the Mann-Whitney nonparametric test. The significance level adopted for hypothesis tests was 5%. The analyses were performed by the IBM SPSS statistical software for Windows version 25©.



**Figure 1.** Calculation of the Southwick angle in the "frog leg" incidence.



**Figure 2.** Patient 3 of Figure 1, 12 years old, one year and two months after surgery.

## RESULTS

We identified 20 patients with severe slipped capital femoral epiphysis (Southwick angle > 50°)<sup>4</sup> submitted to Dunn or modified Dunn procedure from 2012 to 2018. After assessing the minimum radiographic follow-up of one year, 19 cases met our inclusion criteria.

The mean age of the patients was 11.9 years (standard deviation [SD] 1.8 years) and half of the participants were 12 years old (minimum-maximum: 9–17 years old). Most were women (11, 57.9%) and had the right side affected (12, 63.2%) (Table 1).

**Table 1.** Sociodemographic characteristics of patients with severe slipped capital femoral epiphysis treated by Dunn or modified Dunn procedure, IOT-FMUSP, 2012–2018.

Characteristic	n = 19	
	n (%)	
Age (years)	Mean (SD)	11.9 (1.8)
	Median (min-max)	12 (9-17)
Sex	Female	11 (57.9%)
	Male	8 (42.1%)
Laterality	Right	12 (63.2%)
	Left	7 (36.8%)

SD: standard deviation; min: minimum value; max: maximum value.

Out of all patients, seven (36.8%) had osteonecrosis at the end of the follow-up. Other complications were less frequent, including: chondrolysis, in one case; infection requiring removal of the synthesis material, in one patient (did not progress to femoral osteonecrosis); and a case with loosened fixation of the greater trochanter.

## DISCUSSION

The treatment of unstable severe SCFE is a major challenge for orthopedists, especially since its main complication is a frequent evolution of the femoral head to osteonecrosis. Several treatments have been used, including in situ fixation, which may show good clinical results in minor deviations but can lead to femoroacetabular impingement, chondrolysis, early osteoarthritis of the hip, and high rates of osteonecrosis in cases of severe deviations—up to about 33%.<sup>4,8</sup> The modified Dunn procedure is currently the main technique for moderate and severe deviations,<sup>1,8-11</sup> particularly in unstable cases,<sup>9</sup> aiming at lower complication rates.

Criteria for choosing cases was the classification (degree of deviation or stability) and incidence of osteonecrosis of the femoral head in cases of surgery for severe and/or unstable SCFE, which vary with the surgical method used. In 2013, Zaltz, Baca, and Clohisy<sup>12</sup> reviewed 15 articles (397 cases) on unstable

SCFE and found an overall mean osteonecrosis in 23.9% of patients. However, frequency ranged from 0% to 58%. Lerch et al.<sup>11</sup> described in their series that 5% of cases with severe SCFE submitted to the modified Dunn procedure evolved to osteonecrosis. However, this rate ranged from 0% to 29% in 14 of the articles reviewed by us. Regarding the possible complications of SCFE, Roaten and Spence<sup>1</sup> reported that the incidence of osteonecrosis in patients undergoing Dunn or modified Dunn procedure can range from 8% to over 30%.

In our retrospective analysis of severe cases of SCFE submitted to Dunn or modified Dunn procedure, we found a 36.8% rate (7 out of 19 hips) of osteonecrosis of the femoral head, similar to that observed in other series.

The prevalence of osteonecrosis was 62.5% in boys and 18.2% in girls, with no statistically significant association ( $p = 0.074$ ). Laterality was also not associated with the presence of osteonecrosis ( $p = 0.656$ ). The distribution of patients' ages was similar between those with osteonecrosis and those without ( $p = 0.793$ ). Table 2 describes the aforementioned data.

**Table 2.** Clinical characteristics of patients with severe slipped capital femoral epiphysis treated with the Dunn or modified Dunn procedure, IOT-FMUSP, 2012-2018.

Characteristic	n = 19	Osteonecrosis		p-value
		Yes	No	
		n = 7 (36.8%)	n = 12 (63.2%)	
Sex	Female	2 (18.2%)	9 (81.8%)	0.074 <sup>1</sup>
	Male	5 (62.5%)	3 (37.5%)	
Age	Mean (SD)	11.9 (1.8)	11.9 (1.9)	0.793 <sup>2</sup>
	Median (min-max)	12.0 (9-14)	11.5 (10-17)	
Laterality	Right	5 (41.7%)	7 (58.3%)	0.656 <sup>1</sup>
	Left	2 (28.6%)	5 (71.4%)	
Affected side	Mean (SD)	92.9 (22.1)	91.6 (31.7)	0.582 <sup>2</sup>
	Median (min-max)	81.0 (79-138)	81.5 (64-165)	
Normal side	Mean (SD)	21.3 (24.1)	28.2 (31.3)	0.703 <sup>2</sup>
	Median (min-max)	15.0 (1-72)	16.0 (2-99)	
Southwick angle	Mean (SD)	71.6 (15.9)	63.3 (10.7)	0.204 <sup>2</sup>
	Median (min-max)	66.0 (57-105)	61.5 (50-80)	

SD: standard deviation; min: minimum value; max: maximum value. <sup>1</sup>Fisher's exact test; <sup>2</sup>Mann-Whitney test for independent samples.

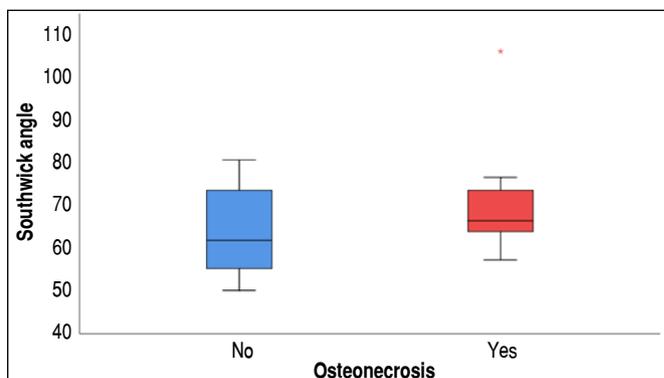
Because of the sample size, we could not statistically state that the increase in the Southwick angle is directly related to the increased incidence of osteonecrosis ( $p = 0.204$ ) (Table 3). However, Figure 3 shows the distribution of Southwick angle values in patients who developed the complication under analysis or not.

This study has some limitations. The case series was insufficient to statistically determine the relationship between the increase in the Southwick angle and the development of osteonecrosis. We did not arrange a control group to compare the different treatments currently used (in situ fixation and modified Dunn procedure). We also should have questioned the time for SCFE diagnosis considering the limitations of the Brazilian Unified Health System (SUS) to directly affect the degree of deviation and consequent complications. This information and other

**Table 3.** Southwick angles and osteonecrosis of the femoral head.

Patient	Age	Sex	Laterality	Affected Side	Normal Side	Southwick angle	Osteonecrosis
Patient 1	12	male	right	72	19	53	no
Patient 2	12	female	left	82	2	80	no
Patient 3	11	female	left	81	13	68	no
Patient 4	14	female	right	82	19	63	no
Patient 5	12	male	right	80	23	57	yes
Patient 6	12	male	left	80	15	65	yes
Patient 7	11	female	right	86	24	62	yes
Patient 8	14	male	right	138*	72*	66	yes
Patient 9	11	male	right	78	23	55	no
Patient 10	11	female	right	88	32	56	no
Patient 11	11	female	left	64	9	55	no
Patient 12	11	female	right	79	3	76	yes
Patient 13	12	female	left	70	10	60	no
Patient 14	12	male	left	149*	99*	50	no
Patient 15	10	female	right	92	13	79	no
Patient 16	17	female	right	165*	87*	78	no
Patient 17	10	female	right	76	13	63	no
Patient 18	9	male	right	81	11	70	yes
Patient 19	14	male	left	106	1	105	yes

\*Note: we had to assess the Southwick angle in the anteroposterior incidence in three patients.



**Figure 3.** Distribution of the Southwick angle values according to the presence of osteonecrosis (boxplot) in patients with severe slipped capital femoral epiphysis treated by the Dunn or Modified Dunn procedure, IOT-FMUSP, 2012-2018.

factors related to the worst outcome of SCFE could not be assessed because of inconsistencies in the data of some medical records, such as the presence of obesity, endocrinopathies, and sports practices.

## CONCLUSION

The analysis of the rate of osteonecrosis of the femoral head (36.8%) in patients operated for severe SCFE from 2012 to 2018 indicates that results obtained were satisfactory and consistent with those found in other services, but still far from ideal. Other variables that could negatively affect this outcome should also be questioned and minimized, including other clinical characteristics of patients and the health system.

**AUTHORS' CONTRIBUTIONS:** Each author contributed individually and significantly to the development of this article. EG: acquisition, analysis, and interpretation of data and writing of the study; BSMF: substantial contribution to the study design, interpretation of data for the study; CAML: substantial contribution to the study conception, interpretation of data for the study; PRR: substantial contribution to the study design, critical review of intellectual content; JSS: critical review of intellectual content, approval of the final version of the manuscript; KEK: critical review of intellectual content, approval of the final version of the manuscript.

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