

## Functional and Radiological Outcomes after Screw Fixation in Stable and Unstable Slipped Capital Femoral Epiphysis

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### ABSTRACT

**Background:** The hip condition known as slipped capital femoral epiphysis (SCFE), which affects adolescents between the ages of 9 and 15, is frequent. The exact cause is still mostly unclear, but a mix of hormonal and mechanical elements is most likely to be responsible.

**Objective:** The present study aimed to evaluate the functional and radiological outcomes of surgical treatment of stable and unstable slipped capital femoral epiphysis with screw fixation.

**Patients and methods:** A prospective clinical study that included 18 cases (21 hips) with slipped capital femoral epiphysis at Zagazig University Hospitals. Patients were classified as stable and unstable using the Loder criteria. All patients were followed up in the outpatient clinic as follow: after 2 weeks to follow up on the wound and removal of the sutures. After 3 and 6 months, patients were followed up clinically and radiologically.

**Results:** The SCFE was found on the left side in 50% of the cases, the right side in 33.3%, and bilateral in 16.7%. The average weight of the studied group was (54.2±8.9) ranging from 43 to 69 Kg. According to the stability classification, there were 15 patients are stable SCFE, and 3 patients are unstable SCFE. Regarding the severity 13 cases were mild and 8 cases were moderate. The follow-up time ranged from 5 to 7 months. Our findings' satisfactory outcome was the majority with 88.9%, 12 cases (66.7%) obtained excellent results 4 cases (22.2%) had good results, and unsatisfactory 11.1% (2 cases one of them obtained fair results).

**Conclusion:** Treatment with screw fixation in stable and unstable slipped capital femoral epiphysis gives good results. However, it highlights the fact that an unstable SCFE is more likely to generate a poorer outcome.

**Keywords:** Screw Fixation, Stable Slipped Capital Femoral Epiphysis, Radiological Outcomes.

### INTRODUCTION

Adolescent hip disorders like slipped capital femoral epiphysis (SCFE) are rather common. It is known as the sliding of the proximal femoral epiphysis through the growing cartilage concerning the femoral neck. It is posteroinferior to the neck because the epiphysis is still in the acetabulum at this point<sup>(1)</sup>. The SCFE is now present in 0.33 to 24.58 out of every 100,000 children. It typically affects children between the ages of 8 and 15, with a male-to-female ratio "between" 1.1:1 and 4.1:1, and is one of the most frequently overlooked diagnoses in children<sup>(2,3)</sup>.

The etiology seems to involve multiple factors. Obesity increased femoral retroversion, and increased physeal obliquity have all been identified as biomechanical factors that contribute to greater shear stresses in the capital physis. The endocrine illnesses hypothyroidism, hypogonadism, and hypopituitarism have all been linked to SCFE. SCFE is more likely to occur in children with renal failure, osteodystrophy, or a history of pelvic radiation<sup>(2)</sup>.

Clinical, radio-morphological, and chronological classifications are used for SCFE. Based on the patient's medical history, physical examination, and x-ray, the traditional chronological classification was preslip, acute, chronic, and acute on top of chronic. Southwick angle degree determines the radio morphological classification, which is divided into mild (0-30 degrees), moderate (30-60 degrees), and severe categories (more than 60 degrees). Newer classifications depend on

physeal stability, are more therapeutically applicable, and forecast the likelihood of avascular necrosis in the future. There are two categories: a clinical one and a radiological one. The child's capacity to walk will determine the clinical classification. A stable SCFE is one in which the child can walk, either with or without the aid of crutches. A youngster who is unable to walk, using crutches or not, is said to have an unstable SCFE. The hip effusion found on ultrasonography determines the radiographic categorization. An unstable SCFE is defined as having no metaphyseal remodeling and an effusion, while a stable SCFE has metaphyseal remodeling and no effusion. When opposed to stable SCFEs, which have a nearly 0% incidence of avascular necrosis, unstable SCFEs have an incidence of up to 50%<sup>(4,5)</sup>.

Patients with SCFE frequently limp and complain of hip, groin, thigh, or knee discomfort that is not well localized. Bilateral hip radiography, which should include anteroposterior and frog-leg lateral views, is used to confirm the diagnosis<sup>(4,6)</sup>.

The aims of treatment for this condition, which is debatable, are to stop additional slippage and keep consequences like chondrolysis, avascular necrosis, and femoroacetabular impingement at bay. Standard therapy for stable SCFE involves in situ screw fixation. In situ fixation, inadvertent reduction and screw fixation, with or without capsular decompression, and surgical dislocation with reduction and fixation of the epiphysis are other common treatments for unstable SCFE<sup>(7)</sup>.

Therefore, this study aimed to evaluate the functional and radiological outcomes of surgical treatment of stable and unstable slipped capital femoral epiphysis with screw fixation.

## PATIENTS AND METHODS

This study is a prospective clinical study that included 18 cases with slipped capital femoral epiphysis at Zagazig University Hospitals, Egypt from December 2021 to June 2022 with six months of follow-up.

The 18 SCFE patients were classified as stable and unstable using the Loder criteria, in which a slip was considered stable if the patient was able to ambulate, with or without the use of an assistive device, whereas it was considered unstable if the patient was unable to ambulate, even with the use of an assistive device.

**Inclusion criteria:** Patients with slipped capital femoral epiphysis confirmed clinically and radiologically. Unilateral or bilateral, stable or unstable SCFE treated by screw fixation.

**Exclusion criteria:** Patients who underwent prophylactic pinning or skeletal maturity.

### Ethical Consideration:

**Approval of the study was obtained from Zagazig University Academic and Ethical Committee. Written informed consent from all the participants was obtained. This work has been carried out following The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.**

### Preoperative management protocol:

On admission; History and General Examination:  
Careful history-taking and clinical examination were done for all patients as follows:

- **Personal data:** including name, age, sex, duration of symptoms, any management that has been done before, medical comorbidity, and medications.
- **Medical assessment:** weight, the side affected right or left, unilateral or bilateral, range of motion, ability to walk or not.

**Radiological evaluation:** Plain radiographs: (antero-posterior view / frog leg lateral views) of pelvis & both hips simultaneously.

**Laboratory investigations:** Routine preoperative investigations in the form of CBC, Viral screen, RBS, and Renal function test.

### Operative management:

- **Anesthesia:** General anesthesia was used and prophylactic broad-spectrum antibiotic (Third generation cephalosporin) was taken with the induction of anesthesia (intravenously 30–60 min before skin incision) after the hypersensitivity test.
- **Position of the patient:** The patient was put in the supine position on the fracture table in a neutral

position without force or traction. The other limb was positioned in abduction, to keep space for the image intensifier.

Placement of a guide wire over the anterior and lateral surfaces of the proximal thigh. We use the image intensifier to position the pin perpendicular to the physis and over the center of the femoral head in both planes. The point of entry will be at the intersection between two wire lines, the guide wire advanced on power drill through the neck to the center of the femoral head, perpendicular to the physis as seen on AP and lateral views of the hip

After reaming and taping a single cannulated screw 6.5 mm, partially threaded placed over the wire and advanced until five threads engage the epiphysis

### Postoperative management protocol:

**All patients were transferred to the ward. In the ward, the following protocol was followed:**

- Adequate analgesia and IV antibiotic were continued for 3 - 5 days then shifted to an oral broad-spectrum antibiotic for all patients for 1 week.
- Range-of-motion exercises are begun on the first postoperative day.
- Partial weight bearing with crutches on the affected extremity was recommended for the first 4 weeks postoperatively.

Patients were asked to avoid impact activities for an additional 4 weeks. Stich removal 2 weeks postoperative.

**All patients were followed up in the outpatient clinic as follows:**

- After 2 weeks, follow up on the wound and removal of the sutures.
- After 3 and 6 months, follow up the patient clinically and radiologically.

### Radiological evaluation:

Plain radiographs: (AP view/frog leg lateral views) of the pelvis & both hips.

Postoperative films were reviewed, assessing the positioning of the screw and how many threads crossed through the femoral physis. Southwick angle was reviewed for measurements of slip progression.

Radiological evidence of AVN was recorded if there was a collapse of the femoral head. Chondrolysis was diagnosed if there was a loss of 50% of joint space or where the joint space was less than 3 mm in patients with bilateral SCFE.

### Clinical evaluation:

The clinical evaluation included the assessment of the range of motion of the hip and observation of gait and the presence or absence of a limp and a positive or negative Trendelenburg test.

The patients were questioned about their physical activities, walking ability, and any discomfort. The results were classified and assessed according to the

criteria of Hey-man and Herndon and modified Harris hip score.

**Statistical analysis:**

Data were analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) software for analysis. According to the type of data, qualitative represents number and percentage, and quantitative continues group represented by mean ± SD. Differences between quantitative independent multiple by ANOVA or Kruskal Wallis. For all the above-mentioned statistical tests done, the threshold of significance was fixed at a 5% level (P-value). P-value of > 0.05 indicates non-significant results. P-value of < 0.05 indicates significant results.

**RESULTS**

The present study showed the average age of the studied group was (13.5±1.4), ranging from 10 to 16 years, and regarding sex, (61.1%) were males, and (38.9%) were females. half (50%) of the studied group were left-sided affected, the third (33.3%) were right-sided, and (16.7%) were bilaterally affected. Most of the studied group (83.3%) were stable and only (16.7%) were unstable. More than half of the studied group (61.9%) had mild severity and (38.1%) had moderate severity (Table 1).

**Table (1): Demographic characteristics and clinical presentation of the studied group:**

Demographic data	The studied group	
	No=(18) patients	%
<b>Age (years)</b>		
Mean ± SD	13.5±1.4	
Median	14	
(Range)	(10-16)	
<b>Sex</b>		
Male	11	61.1%
Female	7	38.9%
<b>The affected side</b>	33.3%	
Right	6	50%
Left	9	16.7%
Bilateral	3	
<b>Stability</b>	83.3%	
Stable	15	16.7%
Unstable	3	
<b>Severity</b>	83.3%	
Mild	15	16.7%
Moderate	3	

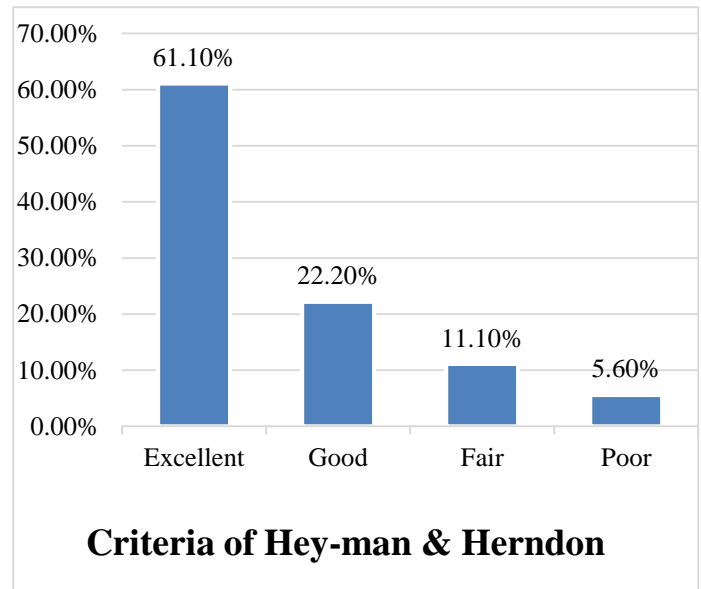
More than half of the studied group (66.7%) had excellent Harris hip scores followed by (22.2%) who had a good score and then a fair score (11.1%) (Table 2). More than half of the studied group (61.1%) had an excellent score in the criteria of Hey-man and Herndon

followed by (22.2%) who had a good score then fair (11.1%) and lastly poor score (5.6%) (Figure 1).

Most of the studied group (17 hips, 81.0%) didn't have any postoperative complications, two cases had impingement (9.5%), one case had AVN (4.8%) and another one had a Slip progression of 10 degrees (4.8%). Complications among stable SCFE were in 3 hips from 18 (16.7%), while in unstable SCFE was 1 hip from 3 (33.3%). AVN complicates 1 hip out of 3 unstable hips (33.3%), and no AVN was found in stable 18 hips (0%) (Table 3).

**Table (2): The postoperative modified Harris hip score evaluation among the studied group:**

Harris hip score	The studied group	
	No=(18) patients	%
<b>Excellent</b>	12	66.7%
<b>Good</b>	4	22.2%
<b>Fair</b>	2	11.1%



**Figure (1): Postoperative criteria of Hey-man & Herndon among the studied group.**

**Table (3): Postoperative complications among the studied group:**

Postoperative complications	The studied group			
	Total 21 hips	Total %	Stable 18 hips No / %	Unstable hips No / %
<b>Impingement</b>	2	9.5%	2 / 11.1%	0 / 0%
<b>AVN</b>	1	4.8%	0 / 0%	1 / 33.3%
<b>Slip progression 10 degrees</b>	1	4.8%	1 / 5.6%	0 / 0%
<b>Total Complications</b>	4	19%	3 / 16.7%	1 / 33.3%
<b>No</b>	17	81%	15 / 83.3%	2 / 66.7%

A 13-year-old female, presented with left hip moderate stable SCFE. The patient was treated with in situ cannulated screw fixation. At the end of the follow-up (6 months), the patient had no complications and was graded as good (Figure 2).



**Figure (2):** A 13-year-old female, presented with left hip moderate stable SCFE, (a): **Preoperative AP and Frog Lateral X-ray;** (b) **Post-operative AP and Frog Lateral X-ray;** (c) **6-months postoperative AP and Frog Lateral X-ray.**

## DISCUSSION

Screw fixation, now the most widely used method, has yielded favorable results. Although the percutaneous fixing technique often lowers the risk of necrosis and chondrolysis, it creates a persistent deformity at the level of the head-neck junction that could affect how the femoroacetabular impingement and subsequent arthrosis develop over the long run<sup>(1,8)</sup>.

The purpose of this study was to evaluate the functional and radiological outcomes of surgical treatment of stable and unstable slipped capital femoral epiphysis with screw fixation.

This was a prospective study conducted on a group of cases in the Orthopedic Department of Zagazig University Hospitals. The study had been conducted on 18 patients (11 males and 7 females) with slipped capital femoral epiphysis. 21 SCFE hips, 3 patients had bilateral SCFE. 18 stable and 3 unstable were treated with single in-situ screw fixation.

The patients' ages ranged from 10 to 16 years old, with the majority being male (61.1%) and female (38.9%). The SCFE was found on the left side in 9 cases (50%) of the cases, the right side in 6 cases (33.3%) bilateral involvement in 3 cases (16.7%), and **Loder et al.**<sup>(4)</sup> found that age ranged from 8 to 15 years old, and Bilaterality ranges from 18 to 50%.

**Lehmann et al.**<sup>(9)</sup> found that the male and female incidence rate produced an overall male-to-female ratio of 1.65, which is very similar to the rate in our study which was 1.57.

Regarding body weight, obesity, and BMI. **Loder et al.**<sup>(4)</sup> found that the majority of children are obese, >50% of children with SCFE are overweight for age, while in our study we found the overweight children for age are 39%.

Regarding fixation with one or multiple screws, we used in our study one screw fixation for all cases, **Kishan et al.**<sup>(10)</sup> supported the use of a 2 screws construct in acute/unstable SCFE fixation. The biomechanical benefit of 2 screws needs to be considered in the face of greater potential for inadvertent penetration into the joint with an increased number of screws.

**Macía Villa et al.**<sup>(11)</sup> reported that (91%-95%) success using the technique of in situ fixation with a single screw in mild and moderate SCFE.

**Abu-Amara et al.**<sup>(12)</sup> reported that the complication of using more than one screw can penetrate the joint cavity if the slip angle is more than 60 degrees.

**Senthi et al.**<sup>(13)</sup> reported that effectiveness in situ fixation using single/double screws both in stable or unstable SCFE found no difference, and slippage progression did not exceed 10 degrees.

Regarding the complication, the current study estimated the complication as overall with 4 hips (19%), and we found impingement in 2 hips (9.5%), slip progression of 10 degrees in only one case (4.8%), AVN

in 1 unstable hip (33.3%) of unstable hips. **Lang et al.**<sup>(7)</sup> studied 184 slips, stable SCFE in 166 (90.2%) cases, and unstable

SCFE in 18 (9.8%) cases, all of them were treated with in situ screw fixation, and capsular decompression, complications were reported as following, impingement was present in 29.3% of cases, AVN was 11.1% of unstable cases.

**Novais et al.**<sup>(14)</sup> compared 15 severe stable SCFE treated by modified Dunn procedure with a historical series of 15 severe stable SCFE treated by in situ fixation. They found a better radiographic correction after the modified Dunn procedure and no substantial differences in the rate of AVN between the two groups but an increased number of re-operations and worse clinical outcomes following in situ fixation. So **Novais et al.**<sup>(14)</sup> reported that the modified Dunn procedure results in better morphologic features of the femur, a higher rate of good and excellent clinical outcome, a lower reoperation rate, and a similar occurrence of complications when compared with in situ pinning for treatment of severe stable SCFE. Also suggested that the modified Dunn procedure is superior to in situ fixation in restoring the proximal femoral anatomy, without increasing the rate of revision surgery at short-term follow-up. This is because the technique has increased in popularity among orthopedic surgeons allowing them to limit the complications of the procedure.

Regarding the best options for treatment of both stable and unstable SCFE, with fewer complications rate **Loder et al.**<sup>(4)</sup> concluded that a systematic review of the literature recommends based on the level of evidence that the best treatment for a stable SCFE is a single screw in situ fixation and for unstable SCFEs urgent gentle reduction, decompression, and internal fixation.

**Souder et al.**<sup>(15)</sup> compared 64 stable SCFE treated by in situ fixation and 10 stable SCFE treated by modified Dunn procedure and reported 2 cases of AVN in the modified Dunn procedure group and no cases in situ fixation group. The authors concluded that stable SCFE should be better treated with in situ fixation to minimize the risk of AVN, postponing the correction of the deformity, if need be. So **Souder et al.**<sup>(15)</sup> concluded that In situ pinning remains a safe and predictable method for the treatment of stable SCFE with no AVN noted, even in severe slips. Attempts to anatomically reduce stable slips led to severe AVN in 20% of cases, thus this treatment approach should be considered with caution. Treatment of unstable slips remains problematic with high AVN rates noted whether treated by in situ fixation or capital realignment (Modified Dunn).

**Mulgrew et al.**<sup>(5)</sup> studied 38 slips, stable SCFE in 28 (73.7%) cases, and unstable SCFE in 10 (26.3%) cases, all of them were treated with single screw fixation, complications were reported as follows, slip progression rate of 28.5% in the stable group and 50%



in the unstable group, AVN was 20% of unstable cases. **Mulgrew *et al.*** <sup>(5)</sup> supported the evidence that an unstable slip is more likely to lead to a poor result. An adverse outcome in terms of AVN, chondrolysis, and revision surgery for slip progression was significantly higher in the unstable group (50%). In the stable group, there were only two adverse outcomes (7%) with no cases of chondrolysis or AVN.

Our study supports the evidence that treatment with screw fixation gives good results. However, it highlights the fact that an unstable SCFE is more likely to generate a poorer outcome as shown by an earlier study.

In our series, we had one patient who developed AVN. It was from the unstable group once again confirming the fact that unstable SCFE has a higher risk of AVN. In our study, 33% of the patients in the unstable group developed AVN, which is slightly lower than other series, and most likely due to the small number of unstable SCFE in this study.

**Iwinski**<sup>(1)</sup> summarized that Percutaneous fixation of the SCFE with a single screw guarantees good functional outcomes and high patient satisfaction without relevant complications. Thus, it can be considered a safe and effective procedure for the treatment of hip SCFE.

**Persinger *et al.*** <sup>(16)</sup> concluded that a series of unstable SCFE treated by a modified Dunn procedure showed a 6% incidence of avascular necrosis and low complication rates at the latest follow-up. Radiographs showed restoration of the slip angle,  $\alpha$  angle, femoral neck length, and greater trochanteric height. This series reveals the safety and effectiveness of the modified Dunn procedure for unstable SCFE.

## CONCLUSION

Treatment with screw fixation in stable and unstable slipped capital femoral epiphysis gives good results. However, it highlights the fact that an unstable SCFE is more likely to generate a poorer outcome. This study support previous findings that the risk of AVN is significantly higher in unstable SCFE as compared to stable SCFE.

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**Author contribution:** Authors contributed equally to the study.

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