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Efficacy of Single Screw Fixation for Slipped Capital Femoral Epiphysis

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ABSTRACT

Background: Several studies have failed to demonstrate a clinical or biomechanical advantage to multiple pins and advocate the using larger-diameter one screw inserted into the center-center position of epiphysis in managing of Slipped Capital Femoral Epiphysis (SCFE).

Objective: evaluation of functional outcome of using single screw in fixation of SCFE. **Methods:** The present study included 18 patients with slipped capital femoral epiphysis who enrolled for single screw fixation at Orthopedic Department, Zagazig University Hospitals.

Results: Southwick angle was significantly decreased from 32.38±12.33 to 23.0±10.74. Harris hip score was non-significantly increased from 51.05 ± 17.63 to 75.05 ± 12.57. About 5.6% of the studied patients had complication and 94.4% had no complication. There was significant relation between complication and renal failure co-morbidity**.**

Conclusion: single screw fixation has good results with low complication rate and considered as an effective method in managing slipped capital femoral epiphysis. Single-screw in situ fixation is the optimal treatment for a stable SCFE, while immediate mild reduction, decompression, and internal fixation are preferred for an unstable SCFE.

Keywords: Single Screw Fixation, Slipped Capital Femoral Epiphysis.

INTRODUCTION

This condition, known medically as slipped capital femoral epiphysis, occurs when the ligamentum teres persists in the acetabulum and causes the proximal femoral metaphysis to get out of alignment with the epiphysis. As a rule, the deformity manifests as a three-dimensional deformity with the distal component rotated outward in the axial direction and the coronal plane[(1)]. The proximal femoral physis is assumed to be mechanically inadequate, which leads to SCFE. An abnormally high load across a normal physis or an exceptionally weak physis, or some combination of the two, is what causes the slip. Obesity, femoral retroversion, and increased physeal obliquity are mechanical causes of an excessive load[(2)].

Hypothyroidism, growth hormone insufficiency, and hypogonadal abnormalities are all conditions that impair the physis. Chondrocyte dysregulation and extracellular matrix turnover abnormalities may be contributing factors to the formation of the physis aberrant weakening, and these may have their source in cells[(3)]. Adolescents who are obese and between the ages of 10 and 15 are most likely to suffer from a slipped capital femoral epiphysis. Males are more likely than females to be affected [(4)].

In order to determine the severity of the slipped capital femoral epiphysis, the stability, duration, and Southwick slip angle are all taken into consideration[(4)].

Osteonecrosis of the femoral head can be predicted by the classification of loader based on their ability to bear weight; unstable and unable to walk, with a high risk of osteonecrosis, whereas stable and able to bear weight with less risk[(5)]. Based on the length of time symptoms have been present (temporal); there are several types of symptoms that can be classified as either acute or chronic, depending on how long they have persisted. Acute symptoms can also be classified as those that last more than three weeks[(6)]. Based on the severity of the slip; slippage in grades I and II ranges from zero to 33%, whereas grades III and IV range from 50% to 100%[(7)].

One screw in situ fixation is the usual treatment for stable SCFE, and most patients with mild to moderate SCFE treated with in situ fixation have good to outstanding long-term outcomes. In comparison to stable SCFE, an injury from unstable SCFE is far more serious. Stable SCFE with in situ fixation has comparable treatment aims, although the specifics of treatment are up for debate[(8)].

According to a number of studies, several pins do not offer a clinical or biomechanical advantage over one large screw placed in the epiphysis' center-center location. Occasionally, a second screw can be used if a high-grade slip is present, and a single screw does not achieve adequate stability in the unstable SCFE [(9)].

It was the goal of this study; evaluation of functional outcomes of using single screw in fixation of SCFE.

SUBJECTS AND METHODS

At Orthopedic Departments of Zagazig University Hospital, we conducted this clinical trial on 18 hips with slipped capital femoral epiphysis.

Ethical consent:

Research Ethics Council at Zagazig University approved the study (ZU-IRB #9862) as long as all participants' guardians provided informed consent forms. Ethics guidelines for human experimentation were adhered to by the World Medical Association's Helsinki Declaration.

Inclusion criteria: Male and female patients were included and both stable and unstable types of SCFE were incorporated in this study

Exclusion criteria: Children less than 10 years, patients with severe degrees of SCFE, who were medically unfit for anesthesia and those who refused to participate were

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excluded also.

All patients were subjected to:

1. A thorough history of the patient's medical history and an orthopedic examination.
2. Radiological examination by anteroposterior (AP) and frog–leg lateral views to detect proximal femoral slippage; a pelvic radiograph (Anteroposterior and frog-leg views), lateral epiphyseal shaft angle measurements, if available at the time of diagnosis, were used to categorize the degree of slip into mild, moderate, or severe[10]**.** If the angle difference was between 30° and 50°, the slip was regarded light; between 30° and 50°, the slip was considered moderate; and over 50°, the slide was considered severe.
3. All patients had full preoperative lab investigation before surgery including:
   Complete blood picture, Random blood sugar, Viral screen, Coagulation studies (PT/PTT) as well as Kidney and liver function tests.
4. **Surgical technique:**

All of the study participants were administered general anesthesia. Before inducing anesthesia, a prophylactic broad-spectrum antibiotic was given. Patients lied on their backs with their knees facing forward and their limbs neutral or slightly abducted on the fracture table to prevent the risk of further injury.

In case with chronic stable mild degree of slippage, traction in ordinary table in supine position with free draping of the limb was done. In case of unstable slips, the epiphysis was noted to have reduced to some extend in this position. No further efforts at reduction was made.

The opposite limb was placed in traction and maximum abduction or flexed and abducted to clear it from the lateral fluoroscopic projection. Proper functioning of the fluoroscope with adequate anterior-posterior and lateral visualization of the femoral epiphysis were confirmed at this time the C arm fluoroscope was then draped out of the surgical field internal rotation and in the AP view (Fig. 1). To achieve the full length of the neck, gently an internal rotation of the hip was done. Subchondral bone and physeal plate were made surely visible.

Figure (1): C arm in lateral view.

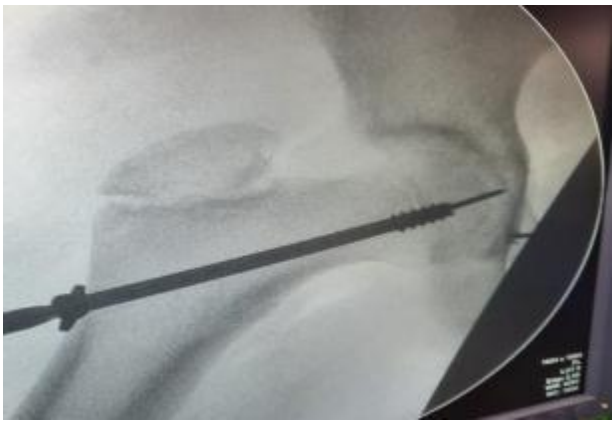
A free guide wire was placed against the patient's skin while fluoroscopy was used to evaluate the position of the guide wire on both the AP and LAT views (Fig. 2). These two lines indicated the proper point of insertion of guide wire into the patient limb. A stab incision in the skin was made; at this point we made either a 1- or 2-cm incision.

Under fluoroscopic guidance and following the trajectories marked on the patient's skin, the guide wire was pushed onto the base of femoral neck, then was advanced into the neck across the physis (Fig. 3). If the location of the guide wire was not ideal, it was repositioned, or temporarily left in place as a guide for the insertion second guide wire in proper position.

Great care was exercised that the guide wire and subsequently the drill tap, and screw were not advanced into the hip joint. The pin was positioned perpendicular to the physis and over the middle of the femoral head using an image intensifier.

Figure (2): Placement of guide wire over the lateral aspect of the thigh.

A



B

Figure (3): Insertion of a single 6.5 mm cannulated, partially-threaded screw over the guide pin to level

within 5 mm of the subchondral bone; Anteroposterior (A) and lateral (B) views

Clinical examination and hip radiographs were used in the follow-up evaluation and the Modified Harris Score was used to measure it. The radiographic results were based on the development of the signs and symptoms of avascular necrosis and chondrolysis as well as Southwick-style angle.

Statistical analysis

In order to analyze the data acquired, Statistical Package for the Social Sciences version 20 was used to execute it on a computer (SPSS). In order to convey the findings, tables and graphs were employed. The quantitative data were presented in the form of the mean, median, standard deviation, and range. The information was presented using qualitative statistics such as frequency and percentage. The paired student's t test (T) was used to assess the data while dealing with quantitative paired variables. Pearson Chi-Square was used to assess qualitatively independent data. The significance of a P value of 0.05 or less was determined.

RESULTS

Mean age was 12.8, males were majority (77.8%) and 38.9% had co-morbidities (Table 1).

Table (1): Demographics among studied group

		Age	
Mean± SD		**12.8 ± 1.23**	
Median (Range)		**13 (11-15)**	
		N	**%**
Sex	**Male**	**14**	**77.8**
	Female	**4**	**22.2**
Co-morbidities	**No**	**11**	**61.1**
	Down	**2**	**11.1**
	Hypothyroidism	**4**	**22.2**
	Renal failure	**1**	**5.6**
	Total	**18**	**100.0**

Regarding hips characters among the studied groups, right and left sides were affected equally (50% each), history of trauma was in 88.9%, acute were 44.4%, regarding grades 22.2% were Grade I and 77.8% were II, and regarding severity the majority were moderate (77.8%) (Table 2).

Table (2): Hips characters among studied group

		N	%
Side	**Left**	**9**	**50.0**
	Right	**9**	**50.0**
History of trauma	**Yes**	**16**	**88.9**
	No	**2**	**11.1**
Types	**Acute**	**8**	**44.4**
	Acute on chronic	**6**	**33.3**
	Chronic	**4**	**22.2**
Stability	**Stable**	**10**	**55.6**
	Unstable	**8**	**44.4**
Grade	**I**	**4**	**22.2**
	II	**14**	**77.8**
Severity	**Mild**	**4**	**22.2**
	Moderate	**14**	**77.8**
	Total	**18**	**100.0**

Southwick angle significantly decreased postoperatively. Harris hip score non-significantly increased postoperatively (Table 4).

Table (3): Pre and postoperative Southwick angle and Harris hip score among the studied group

	Preoperative	**Postoperative**	**Paired t**	**P**
Southwick angle	**32.38 ± 12.33**	**23.0 ± 10.74**	**2.43**	**0.02***
Harris hip score	**51.05 ± 17.63**	**75.05 ± 12.57**	**6.80**	**<0.01**

5.6% of the studied patients had complication and 94.4% had no complication (Table 4).

Table (4): Postoperative complications among the studied group

		N	%
Infection	**No**	**17**	**94.4**
	Yes	**1**	**5.6**
Replacement	**No**	**18**	**100**
	Yes	**0**	**0**
Deformities	**No**	**18**	**100**
	Yes	**0**	**0**
Overall complication	**No**	**17**	**94.4**
	Yes	**1**	**5.6**
	Total	**18**	**100.0**

There was significant relation between complication and renal failure co-morbidity (Table 5).

Table (5): Relation between complication and other parameters

			Non-complicated 17	Complicated 1	X^2	P
Sex	**Male**	**N**	**13**	**1**		
		%	**76.5%**	**100.0%**		
	Female	**N**	**4**	**0**	**0.30**	**0.58**
		%	**23.5%**	**0.0%**		
Side	**Left**	**N**	**8**	**1**		
		%	**47.1%**	**100.0%**		
	Right	**N**	**9**	**0**	**1.05**	**0.30**
		%	**52.9%**	**0.0%**		
Type	**Acute**	**N**	**7**	**1**		
		%	**41.2%**	**100.0%**		
	Acute on chronic	**N**	**6**	**0**	**1.32**	**0.51**
		%	**35.3%**	**00.0%**		
	chronic	**N**	**4**	**0**		
		%	**23.5%**	**00.0%**		
Co morbidity	**No**	**N**	**11**	**0**		
		%	**64.7%**	**00.0%**		
	Down	**N**	**2**	**0**		
		%	**11.8%**	**0.0%**		
	Hypothyroidism	**N**	**4**	**0**		
		%	**23.5%**	**00.0%**	**18**	**<0.001**
	Renal failure	**N**	**0**	**1**		
		%	**0.0%**	**100.0%**		
Grade	**I**	**N**	**4**	**0**		
		%	**23.5%**	**00.0%**		
	II	**N**	**13**	**1**	**0.30**	**0.58**
		%	**76.4%**	**100.0%**		
Stability	**stable**	**N**	**10**	**0**		
		%	**58.8%**	**00.0%**		
	Un stable	**N**	**7**	**1**	**1.32**	**0.25**
		%	**41.2%**	**100.0%**		
Severity	**Mild**	**N**	**4**	**0**		
		%	**23.5%**	**00.0%**		
	Moderate	**N**	**13**	**1**	**0.30**	**0.58**
		%	**76.5%**	**100.0%**		

Figure 4 shows a stable case that was followed up till 6 months postoperatively.

A-Preoperative X-Ray

B-Postoperative X-Ray

C- 3months postoperative

D-6 months postoperative

E-6 months follow up of range of motion

Figure (4): 13-year old male with Lt SCFE and minimal history of trauma, stable case with follow up till 6 months postoperative.

DISCUSSION

With different ethnicity and ages among adolescent between nine and sixteen years, one of the most common hip injuries is slipped capital femoral epiphysis. One in 10,000 to 20,000 children are affected by SCFE [11]. Moving the epiphysis in metaphysis posteriorly through the physis in the distal femur is SCFE[12]. The epiphysis moves posteriorly and medially in relation to the metaphysis as a result of a weak proximal femoral physis [13]. Increased physeal obliquity, post-radiation pelvic treatment and endocrinopathy such as hypothyroidism, hypogonadism and hypopituitarism,
obesity as well as increased femoral retroversion, are all implicated in the SCFE[14].

Treatment options for SCFE have been described in various ways. Surgical intervention is necessary, however there are major disagreements over the optimal course of action [15]. Osteonecrosis and chondrolysis can be avoided by correcting the deformity and preventing additional slippage [12]. Except for children with metabolic or endocrine abnormalities and the very young, the reason for a programme in which prophylactic fixation is usually conducted is debatable [16-18].

The natural history of SCFE and the reported outcomes of in situ pinning should be taken into account as treatment options for SCFE evolve [15]. However, in the case of severe, unstable slips, osteotomies, open reduction, and capsular decompression have all been used in addition to in situ pinning as therapeutic options for SCFE [19,20]. A variety of techniques have been described, ranging from the use of a single cannulated screw to the use of three or four Kirschner wires. As a result of their simplicity and less invasive nature, these procedures are in high demand [21]. The best location for the single screw is in the middle of the neck, perpendicular to the growth plate [22]. Chondrolysis, SCFE-induced impingement with accompanying damage to articular cartilage and labral injury, fixation failure and advancement of deformity, growth arrest and development of bilateral disease are among the more commonly described consequences [23].

The present study included 18 patients with slipped capital femoral epiphysis who were enrolled for single screw fixation at Orthopedic Department, Zagazig University Hospitals. The current study aimed to evaluate the functional outcome of using single screw in fixation of SCFE and to assess the complication rate after using single screw in SCFE.

The present study showed that mean age was 12.8 ±1.23 with minimum 11 and maximum 15, males were majority with 77.8% and 38.9% have co-morbidities. This agrees with **Nectoux *et al.*** [24] who reported mean age at diagnosis of 12.8 years, there were 131 boys (59%) and 91 girls. Similarly, **Herngren *et al.*** [13] who found a median age of 11.7 (from 7.2 to 15.4) years and male-to-female ratio was 1.3:1. Age at diagnosis was comparable to that previously reported from other study by **Hagglund *et al.*** [25] **and Jerre *et al.*** [26]. While SCFE incidence decreased steadily throughout the course of the twentieth century, this downward trend has come to an end [27]. According to prior studies, we found that the ratio ranged from 1.1:1 to 4.1:1 [26-29].

Our study revealed that right and left sides were affected equally (50% each), patients having history of trauma were 88.9% and 11.1% were without history of trauma, acute were 44.4%, acute on chronic were 33.3% and chronic 22.2%. As regard grade, 22.3% were Grade I and 77.8% were II and as regard severity the majority were moderate (77.8%).

The severity of the slide and the length of time that the symptoms persisted were found to be associated [30-31]. **Herngren *et al.*** [13] indicated that neuropsychiatric diseases were the most common diagnosis in their study (15 of 379). It's possible that the risk behavior of these kids in their recreational time contributes to their condition. In our study, there were 10 patients classified as stable SCFE and other 8 patients classified as unstable SCFE. The capital physis stability was assessed using the **Loder *et al.*** [31] clinical classification, which did not necessitate the implementation of any novel preoperative diagnostic procedures. This classification was widely accepted according to other study [30]. Another study have demonstrated that the stability of the physis can vary, arguing against this categorization [32].

The present study showed that Southwick angle was significantly decreased from 32.38±12.33 to 23.0±10.74. Harris hip score was non-significantly increased from 51.05 ± 17.63 to 75.05 ± 12.57. A second study suggests that only single screw fixation should be used in SCFE if the Southwick angle is less than 35° [20].

The current study revealed that 5.6% of the studied patients had complication and 94.4% had no complication. There was significant relation between complication and renal failure co-morbidity. This agree with **Goodman *et al.*** [33] who found no evidence of avascular necrosis or chondrolysis. Seventeen of the twenty-one hips tested were found to be fully functioning. Three hips had a positive outcome, whereas one hip had a negative one. There was a propensity to link improper pin placement with poor performance.

Loder [31] reported an overall incidence of 21% (88 of 417) of osteonecrosis in unstable slips. In addition, some studies recorded the complications on long term follow up. **Monin *et al.*** [34] the average follow-up was 19 years, and the rate of osteoarthritis was 60%; in cases of > 40° slip, the rate was really 100% after just 10 years. Additionally, after 37 years of follow-up, it was discovered that patients who had isolated single fixation had a significantly higher incidence of radiological signs of femoroacetabular impingement (convexity, flattening, osteophytes, and a herniation pit) than patients in a control group who had no hip pathology.

CONCLUSION

Single screw fixation has good results with low complication rate and is considered as an effective method in treatment of slipped capital femoral epiphysis. To avoid difficulties, just one screw should be used in slipping epiphyses, as the additional rigidity does not outweigh the increased risk of complications. Single-screw in situ fixation is the optimal treatment for a stable SCFE, while immediate mild reduction, decompression, and internal fixation are suggested for an unstable SCFE.

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