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CASE REPORT

Diagnostic and Therapeutic Challenges of a Slipped Capital Femoral Epiphysis in a Low and Middle Income Country: A Case Report and Literature Review

Aimé Mbonda^{1,2,*}, Landry W Tchuenkam^{2,3}, Joel Noutakdie Tochie^{2,3}, Serges Abogo⁴ and René Essomba^{1,5}

¹Department of Surgery, National social Insurance Fond hospital, Yaounde, Cameroon

²Faculty of Medicine and Biomedical Sciences, University of Yaounde I, Cameroon

³Department of Surgery and Specialties, Faculty of Medicine and Biomedical Sciences, University of Yaounde I, Cameroon

⁴Department of Radiology, National social Insurance Fond hospital, Yaounde, Cameroon

⁵Higher Institute of Medical Technology, Yaounde, Cameroon

Abstract:

Background:

Slipped Capital Femoral Epiphysis (SCFE) is an incapacitating orthopedic disease, particularly affecting older children and adolescents and caused by the sliding of the proximal femoral epiphysis on the metaphysis. SCFE has a clinical polymorphism, compounded with a certain diagnostic variability among health practitioners and the relatively high cost of its surgical management contribute to the diagnostic delay observed in most developed countries as well as developing ones. Herein, we report the case of SCFE in an adolescent Cameroonian, with emphasis on its diagnostic and therapeutic challenges in Low and Middle-Income Countries (LMICs), in a bit to improve on timely recognition and management by clinicians in these settings.

Case Presentation:

A 10-year-old girl has presented with unilateral right thigh pain of more than one year duration associated with a limping gait and no fever. Before the referral to our health facility, she consulted several general practitioners in rural areas and pediatricians in the city with no definite diagnosis. On the basis of the clinical and the imaging studies, the diagnosis of stable right SCFE with moderate displacement was made. Under general anesthesia, the patient underwent open reduction and internal fixation with three pins under c-arm fluoroscopy. Clinical and radiological follow-up till one year after surgical intervention were satisfactory. The pins were removed after one year of fixation confirming a good bone fusion in plain x-ray. Her clinical examination and radiological follow-up three years after removal of the pins were satisfactory.

Conclusion:

The case report illustrates that SCFE often a missed diagnosis in LMICs. This is worrisome because delayed diagnosis may lead to long-term complications such as avascular necrosis and early degenerative joint disease. Although the above case was missed by several clinicians and finally diagnose late, the present case highlights the need for a high index of clinical suspicion in order to timely diagnose and timely manage SCFE to avert potential long-term physical disabilities and psychological trauma in children.

Keywords: Slipped capital femoral epiphysis, Pin fixation, Low income Country, Clinical polymorphism, Proximal femoral epiphysis, C-arm fluoroscopy.

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1. BACKGROUND

Slipped Upper Femoral Epiphysis (SCFE) is an orthopedic pathology caused by sliding of the superior femoral epiphysis on femoral neck through the physal plate [1]. It is a common

pathology of the hip in school aged children and adolescents occurring often during sport, accidental fall and after a trivial trauma. Anatomically, there is a shift of the femoral neck in the anterolateral direction, while the head remains fixed in the acetabulum. It is only later that the femoral head will be pushed by the neck of the femur towards the back and the bottom. Therefore, we talk about SCFE in varus [2]. Occasionally, a valgus is observed when the proximal femoral epiphysis slips laterally and posteriorly [3]. The incidence of the pathology

* Address correspondence to this author at the Faculty of Medicine and Biomedical Sciences, University of Yaounde I, Cameroon; Tel: +237697760387; E-mail: aimembonda450@gmail.com

varies from one region to another [2]. A systematic review published in 2011 gives an incidence of 0.33 / 100,000 to 24.58 / 100,000 adolescents aged 8 to 15 years [2]. There is a racial disparity with relatively high prevalence rates observed among Polynesians (5.6%) and black Americans (3.9%); Hispanics (2.5%) and Caucasians (1.0%). Few data has been found in the literature about an estimate of prevalence or incidence in sub-Saharan Africa (SSA) [2].

Classically, SCFE affects an obese adolescent who most often consults for hip pain or sometimes knee pain associated with a walking disorder occurring in a non-traumatic context [4]. Generally, isolated knee pain as the presenting initial complaint has been observed to be a significantly missed diagnosis with consequent diagnostic delay [4]. There is variability in diagnostic accuracy between health practitioners [5]; the highest diagnostic accuracy found in radiologists (84% to 92%); orthopedic surgeons (80% to 88%) and pediatricians (48% to 78%). A study published in Denmark showed a diagnostic delay in 67% of patients when the initial consultation was made by a general practitioner or a resident physician [6]. All these elements mentioned above are factors that contribute to explain the diagnostic delay observed in the developed as well as developing countries. Delayed management leads to long-term complications such as avascular necrosis and early degenerative joint disease [7]. In these countries, the financial cost is also a factor to consider. Once diagnosed, management should be instituted in an orthopedic unit.

We report here a case of a 10-year-old girl with a chronic non-traumatic pain of the right thigh. This case highlights the difficulty in the diagnosis and management of SCFE in Low and Middle-Income Countries (LMICs).

2. CASE PRESENTATION

A 10-year-old girl, black African was referred to the orthopedic department of the National Social Insurance Fond hospital in Yaounde, Cameroon by a pediatrician for investi-

gation of a persistent non-traumatic thigh pain of sudden onset for which she had been followed-up for 12 six months.

She complained for a year of a spontaneous pain of the right mid-thigh of insidious onset associated with a limping gait. The pain was permanent, rated at 5/10 on the visual analogue scale without any radiation. No notion of neither fever nor night sweats was associated with this pain, which was temporarily relieved by Non-Steroidal Anti-Inflammatory Drugs (NSAIDs). After consulting several general practitioners and two pediatricians, a total of four plain x-rays of the thigh and an ultrasound were requested and showed no abnormal finding. Lastly, a pelvic and thigh MRI carried out revealed a SCFE before her referral. Her past history was remarkable for no chronic pathology, no sickle cell disease, and she was premen-arche.

At the initial physical examination, she was fully conscious, oriented in time, place and person. Her anthropometric parameters were: a height of 130 cm, a BMI of 20 kg /m². There was no fever. The right lower limb was in abduction with slight external rotation spontaneously on inspection. A right amyotrophic was noted with a difference of one cm diameter compared to the contralateral thigh. She had no shortening. On palpation, there was no tenderness of the thigh, but tenderness on palpation of the right groin. During mobilization of the right hip, there was a limitation of the internal rotation and an increase in external rotation. There was also a limited painful flexion of the hip. Examination of the underlying and contralateral joints was normal. Also, she had a limping gait in external rotation of the lower right limb. The rest of the general examination was normal.

An MRI requested in our health centre revealed a shift of the right femoral head, equalled to the upper third of the metaphysis with a tilt angle of 40°, there was oedema of the femoral metaphysis, and a liquid effusion of the right hip joint (Fig. 1). Hence, we made the diagnosis of a stage 2 right SCFE.

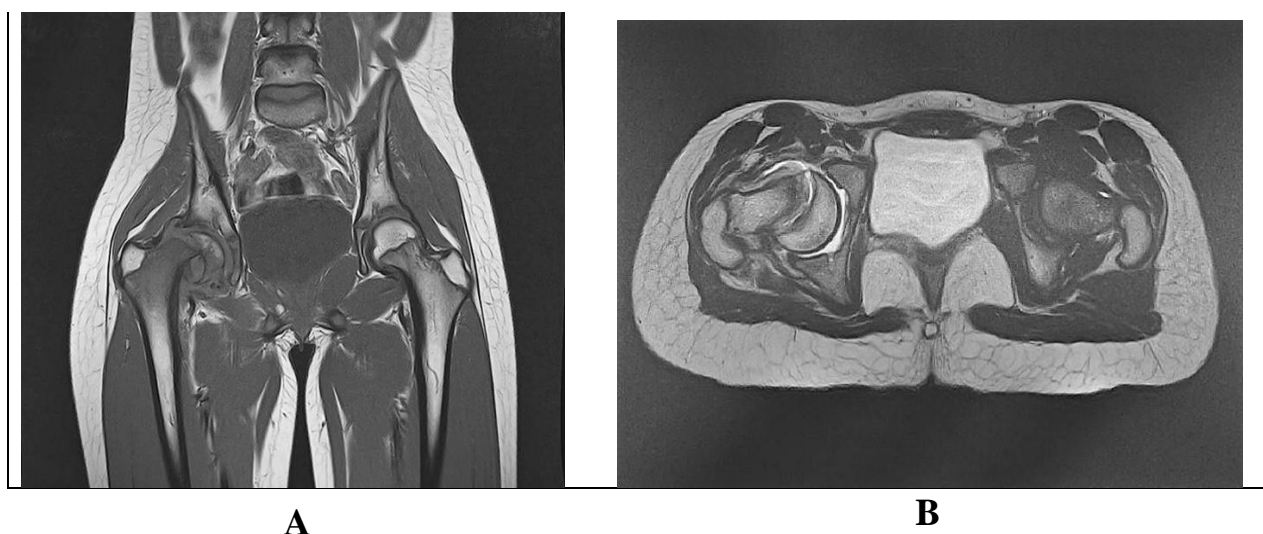


Fig. (1). MRI findings: A: Coronal view; B: Axial view.

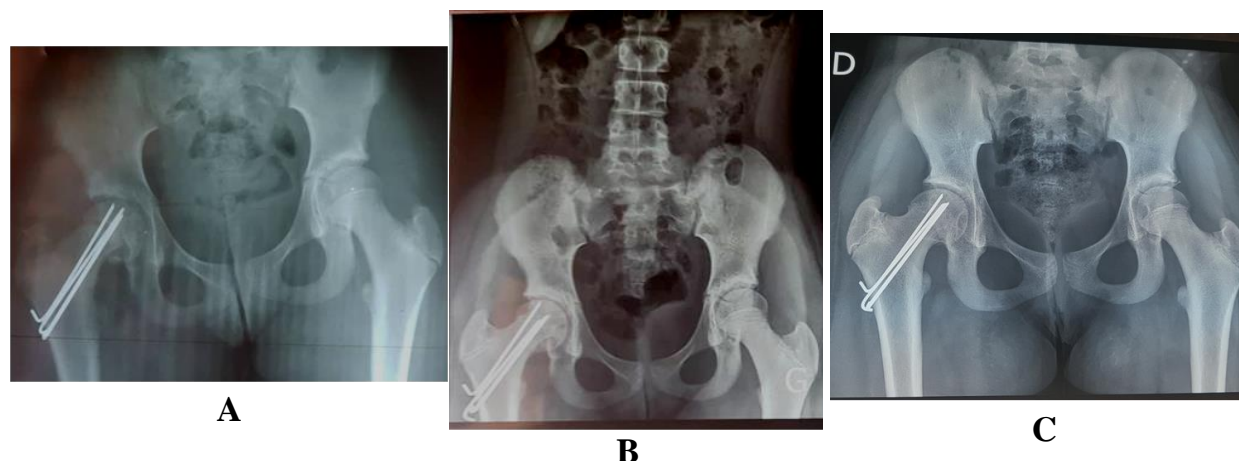


Fig. (2). Post operative radiographs: **A:** Day 1; **B:** 6th Month; **C:** 12th month.

After obtaining the consent of the parents, the child underwent surgery under general anesthesia. The surgical technique chosen was open reduction and internal fixation using three pins. The postoperative course was uneventful. At Day 2 post-operation, we started the isometric mobilization of the limb. On Day 4, we started the weight bearing with axillary crutches. We discharged the patient on the day 6 post operation without any sign of surgical site infection. Full weight bearing was allowed after 6 weeks period. Clinical and radiological check-ups were one at one month, six months and one year postoperatively showed good outcome with a satisfactory bone fusion (Fig. 2). Hence, the pins were removed after one year of fixation. Her clinical examination and radiological follow-up three years after removal of the pins were satisfactory with no particular signs of complications (avascular necrosis, chondrolysis, and femoral acetabular impingement) or signs of contralateral involvement.

3. DISCUSSION

Hip disorders in children are frequent reasons for pediatric consultations. The causes are multiple, benign most often. But they can be severe, or functional disabling [8]. SCFE, also called upper femoral epiphysis (SUFE), is a common cause of pediatric hip disorders characterized by a displacement of the femoral head (epiphysis) on the femoral neck due to weakness in the hypertrophic zone of the growth plate. The etiology of the pathology responsible for the slip is unknown to date. However, some predisposing factors reported include obesity [10], male gender, history of radiation, renal insufficiency, endocrine disorder [9], especially hypothyroidism [10] or growth hormone deficiency [10]. In the present case, her diagnosis was missed and overlooked by several clinicians due to the rarity of SCFE, lack of prevalence studies in SSA, occurring in a female gender, whereas, the literature reports a prediction for the male gender. This cumulated to her delay in diagnosis and management. Early diagnosis of SCFE is often challenging, particularly if the patient presents initially with unspecific symptoms such as mild weakness, easy fatigability, or a limping gait with groin pain [11]. On the other hand, the

onset of illness may be abrupt due to large amount of epiphyseal displacement, where the patient is often in severe pain and is unable to walk. If the pain is mild and chronic, it is common for families to first resort to automedication with analgesics, hence, delaying seeking medical consultation and consequently late diagnosis and treatment [11]. A similar scenario was observed in the present case, where the patient presented with long standing moderate hip pain of one year duration temporarily relieved by NSAIDs. Our findings corroborate with those of Green *et al.* [12], who found a 52% incidence of missed diagnosis for SCFE by primary care physicians, despite 60% having a hip and/or groin for close to 1 year after consultation

The outcome and prognosis of SCFE depends on early recognition, hence, preventing progression to a severe slip, avascular necrosis, and chondrolysis [13]. This is quite challenging because about 20% of children present with benign musculoskeletal pain at some time in their lives. Consequently, the diagnosis of SCFE can be missed or delayed especially when there is a lack of a leading history and specific physical findings [14].

Several clinical classifications of SCFE are found in the literature. In the current practice, Fahey O'Brien has established a classification based on the duration of symptoms [15]. Therefore, we distinguish the acute form that have symptoms of less than three weeks duration; acute-on-chronic form and the chronic form if the symptoms last for more than three weeks. The clinical findings on limp inspection are shortening, and amyotrophy whose form varies according to the chronicity of the symptoms (Table 1). SCFE can also be classified according to the degree of stability of epiphysiolysis [16]. A stable SCFE if the patient can still walk and bear weight with or without crutches and unstable if the patient is immobilized, unable to walk. According to this description, it was in our case a girl who had chronic symptoms of more than 6 months duration. Her radiologic classification, was a stable epiphysiolysis. Indeed, the unstable form increases the risk of avascular necrosis by 9.4 times compared to the stable form [17].

Table 1. Clinical presentation according to the duration of the symptoms.

Chronological Type	Duration	Symptoms	Physical Finding	Frequency*
Acute	< 3 Weeks	Rapid onset of pain	Functional impotence / Charge impossible most often. Vicious attitude of the hip in abduction, flexion, external rotation. Painful mobilization Shortening of the limb	25%
Acute on Chronic	> 3 Weeks	Exacerbation of symptoms on a chronic setting	Variable functional impotence Painful mobilization Hip in abduction, internal rotation	17%
Chronic	> 3 Weeks	Chronic pain	Gait Hip in abduction, internal rotation, limited flexion Shortening possibly	58%

* Rebich et al(17)

Table 2. Sensibility and specificity of imaging diagnostic test.

Tests	Pelvic Incidence on Radio	Year	Description of a Positive Test	Se*	Sp*
Klein's line	AP	1952	Klein's line fails to intersect the lateral part of the proximal epiphysis (femoral head)	68.3%	89.0%
Modified Klein's line	AP	2009	The epiphyseal width lateral to Klein's Line ≥ 2 mm between hips	79% [†]	NR
Southwick Head Shaft Angle (SHSA)	Frog -leg (lateral)	1967	head shaft angle $\geq 13^\circ$	NR	NR
The Wilson Percent Epiphyseal Displacement	Frog -leg (lateral)	1960	displacement of the epiphysis $< 1/3$ of the diameter of the femoral neck	NR	NR
The Metaphyseal Blanch Sign of Steel	AP	1986	semicircular area of increased density on the proximal part of the femoral neck	NR	NR
The S-sign	Frog -leg (lateral)	2017	Broken continuity of the S, asymmetry, or sharp turns of the S-sign	89.0%	95.2%
Combination of S-sign and Klein's Line	Lateral and AP	2017	Combination of the positive results of the two parameters	96.5%	85.0

Se= sensitivity; Sp= Specificity.; * Green DW *et al.* [16]; [†] Tosounidis T *et al.* [15].

The diagnosis is confirmed by imaging studies, with x-ray as the first intention. Bilateral hip radiographs on anterior-posterior and Frog-leg views are generally sufficient to establish the diagnosis and to look for complications (avascular necrosis and chondrolysis). The profile view (Frog-leg) is useful at the early stage in search of a mild slip that may go unnoticed at the frontal view. It is therefore the first examination to be performed in case of hip pain or limp in the child [8]. Several signs were described on the radiographs to establish the diagnosis (Table 2). We quote the Klein's line, the modified Klein's line, the white metaphyseal sign, and the S-sign. The Klein line is a line tangent to the upper edge of the femoral neck. Indeed, in the case of SCFE, this line fails to intersect the lateral part of the proximal epiphysis. This classic definition using the Klein line showed a low sensitivity (40.3%) in diagnosing SCFE [18]. According to Rebish *et al.* [19], in a more recent study published in 2018, diagnostic accuracy is best when combining the Klein's line and S-sign. Despite the need of a plain x-ray to confirm the diagnosis of SCFE, the radiographic diagnostic findings can be misread by inexperienced health personnel [14], as seen in our patient in whom a total of four x-rays of the hip were requested and the radiographic diagnosis missed each time.

CT and MRI scans be used when radiographs are inconclusive and SCFE is still suspected [20]. MRI may be

used to assess blood supply of the femoral epiphysis; therefore, it can reveal head avascular necrosis and chondrolabral damage. However, the high cost of these examinations is often a deplored obstacle to timely diagnosis of this condition in our resource-poor settings. Imaging, including radiography, can also be used to classify the patient according to the stage of severity of SCFE (Table 3). These classifications have an impact on the choice of the therapeutic modality and the prognosis (Table 3). Chronic evolution, unstable form, severe displacement are independent factors of poor prognosis in terms of Avascular necrosis (AVN) [21], chondrolysis, osteoarthritis or FAI.

The treatment of this pathology is essentially surgical. It aims to stabilize the proximal epiphysis in order to stop the progression of sliding and avoid complications [22]. It depends on the stability and the degree of severity of the slip [23]. In stable forms [24], in situ pinning with a single crew is the surgical fixation technique mostly used by orthopedic surgeons according to a survey conducted by Wight [23]; especially when it is a mild to moderate stable form. In unstable forms, there is no consensus in the management regarding delay and therapeutic options [24].The treatment differs according to the specialized hospitals, or even within the same structure. Therefore, the therapeutic options vary according to the stage of severity, the approach, the possibility of reduction, the type

of implants, the duration of evolution of symptoms before management. Regarding the timing of the treatment, a systematic review and meta analysis [25] showed an avascular necrosis rates of 6%, 52% and 7% when the interventions were performed within 24 hours, between 24 and 72 hours, and after 72 hours after the onset of symptoms respectively. Table 4 presents the different therapeutic options with prognosis in patients with a stable or unstable form.

In our clinical case, the treatment option chosen was in situ fixation with 3 pins. Post operative radiographs performed did not reveal any signs in favor of complications. Osteonecrosis or avascular necrosis was suspected in case of collapse of the

femoral head, sclerosis, and cyst formation. Chondrolysis when there is narrowing of the femoroacetabular space; and Femoroacetabular Impingement (FAI) when we see an abnormal contact between the proximal femoral metaphysis and the acetabular rim [26]. Prophylactic treatment of the contralateral side is also a therapeutic option although it can lead to complications. The elements to be taken into account are [27]: an atypical presentation, the severity of slippage on the sick side, the risk of losing sight of the patient during the follow up. All these elements must be weighed with the risks of complications inherent to the treatment: chromolysis, avascular necrosis, postoperative infections and the risk of fracture.

Table 3. Stage of severity and prognosis.

Severity's grade		Frequency *	Prognostic†
According to Southwick head shaft angle (SHSA) ‡ (ref...)			
Mild	displacement <30 degrees compared with the unaffected side	40	3%
Moderate	displacement between 30 and 50 degrees compared with the unaffected side	51	15.5%
Severe	displacement > 50 degrees compared with the unaffected side	9	14.2%
According to Wilson (ref)§			
Mild	displacement of the epiphysis < 1/3 of the diameter of the femoral neck		
Moderate	displacement of the epiphysis is > 1/3 but < 1/2 of the diameter of the femoral neck		
Severe	displacement of the epiphysis > 1/2 of the diameter of the femoral neck		

* Rebach et al. [17]; ‡xxxx; §xxx

Table 4. Therapeutic options for stable and unstable SCFE.

Stable*						
Treatment Method	AVN %	CL %	FAI %	Patient Satisfaction	Indication*	Comments*
Pinning Using Single Screw	1.4	2.1	29.8	47% excellent 36% good	First option for mild –moderate. Can be used in severe stable	Screws that allow continued growth should be chosen in relation to standard screws
Pinning Using Multiple Pins	2.2	4	NR	67% excellent 17% good	Good alternative to mild-moderate	Is often chosen in 2nd option with Pinning using single screw
Physal Osteotomy	11.1	9.8	1.5	28% excellent 45% good	Good option for severe stable	intracapsular cuneiform osteotomies of Dunn and Fish
Bone Graft Epiphysiodesis	3	1.3	NR	67% excellent 06% good	Alternative for severe	Less used by orthopedists: blood loss, donor site morbidity, length of surgical time and length of stay
Hip Spica	9.5	20.5	NR	NR	Obsolete option in developed countries	A relative option for mild to moderate SCFE in LCIs
Ganz Surgical Dislocation	3.1	2.1	6	87% excellent 03% good	Alternative for severe stable	Very high patient satisfaction after intervention, but high risk of AVN
Unstable†						
Pinning in situ	33	NR	NR	NR	Mild to moderate	Highest rate of AVN
Closed Reduction and Pinning	26	NR	NR		Moderate to severe	Lire 101
Open Reduction and Internal Fixation	5	NR	NR	NR	severe	Is associated with the lowest rate of AVN
Open Reduction and Physal Osteotomy	17	NR	NR	NR	severe	restore the proximal femoral anatomy Lire 101
Ganz Surgical Dislocation	18	NR	NR	NR	severe	Lire 101
Epiphysiodesis	9	NR	NR		Severe	Chronic symptoms

AVN: Avascular necrosis; CL: FAI; * Gutman IM et al. [19]

* Comments come from an analysis of the authors

† Naseem et al. [20]

CONCLUSION

SCFE is a pathology of the adolescent occurring during his pubertal growth spurt. It is most often a child with chronic pain, partial or complete functional impotence of the affected limb and with a diagnostic delay. This delay in diagnosis coupled with the high cost of surgical treatment in low-income countries are obstacles to the management of this pathology.

AUTHORS 'CONTRIBUTIONS

AMN and LWT contributed in the design of the study and writing of the manuscript

AMN and RE managed the case

LWT and JNT contributed in manuscript writing and critical revision

SA carried out the imaging studies investigation and their interpretation

AMN and RE collected the pictures, and obtained the guardian's consent.

All authors have read and approved the final version of the manuscript.

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AVAILABILITY OF DATA AND MATERIAL

'Not applicable' in this section

LIST OF ABBREVIATIONS

AVN	=	Avascular Necrosis
BMI	=	Body Mass Index
FAI	=	Femoro-Acetabular Impingement
LMICs	=	Lower and Middle Income Countries
SCFE	=	Slipped Capital Femoral Epiphysis
WHO	=	World Health Organization
NSAIDs	=	Nonsteroidal Anti-Inflammatory Drugs
SSA	=	Sub-Saharan Africa

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

No applicable.

HUMAN AND ANIMAL RIGHTS

No animals/humans were used for studies that are the basis of this research.

CONSENT FOR PUBLICATION

Written informed consent was obtained from the patient's guardian for publication of this case report and any accompanying images.

CONFLICTS OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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