Valgus slipped capital femoral epiphysis: presentation, treatment, and clinical outcomes using patient-reported measurements

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Valgus slipped capital femoral epiphysis (SCFE), is rare. This study describes the diagnosis, treatment and outcome of valgus SCFE in Uruguay. The medical records and radiographs were reviewed in eight consecutive children [mean age 11.9 years (range 9–13; six female)] with valgus SCFE between 1997–2017. In 2018–2019, all patients were reexamined clinically, new radiographs obtained, and patient-reported outcomes completed using the international tool of hip results (iHOT-12). The prevalence of clinical femoroacetabular impingement (FAI), avascular necrosis, and surgical complications were also studied. There were 11 valgus SCFEs in eight patients; two had primary bilateral SCFEs, and one child later developed a valgus SCFE in the contralateral hip. Seven out of eight patients were overweight. All were stable idiopathic SCFEs. The mean femoral head shaft angle on the anteroposterior radiographs for the 11 SCFEs was 145° (range 140–168) and 141° (range 139–145) for the six healthy contralateral hips. Slip severity measured on the Lauenstein projection was mild (<30°) in eight hips and moderate (30°–60°) in three hips. At a mean follow-up of 87 months (range 24–252), there were no cases of avascular necrosis. The mean iHOT12 was 74 (range 13–97). Significant remodeling was detected in both head shaft angle (8°) and alpha angle (10°) in the affected hips. Nine hips (81%) demonstrated clinical signs of FAI. Our study is the first to describe long-term results using both clinical and patient outcome measures (iHOT-12). A majority of patients have residual symptoms, likely associated with FAI. *J Pediatr Orthop B* XXX: 000–000

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Introduction

Slipped capital femoral epiphysis (SCFE) is characterized by a change in the position of the proximal femoral epiphysis relative to the metaphysis. In most cases of SCFE, the epiphysis moves posteromedial relative to the metaphysis [1–3]. However, a small fraction of patients with SCFE have a valgus deformity with posterolateral displacement of the epiphysis relative to the metaphysis [2–4]. There have been approximately 147 valgus SCFEs in 113 patients reported in the literature [1–33]. Only seven series with more than four patients have been previously published [3,4,22,27,30,32,33]. Although the cause of a valgus SCFE in idiopathic cases is unclear, an increased neck-shaft angle, horizontal physis, and increased femoral anteversion are postulated as predisposing factors [2–4,19,22,24].

Varus SCFE is more common in boys [34] while the majority of reported valgus SCFEs have been in girls [1–4,7–11,14,15,17–20,22–33]. Mostoufi-Moab *et al.* [27] and Chung *et al.* [32] demonstrated an increased risk for the development of an atypical valgus SCFE in children under treatment with recombinant human growth hormone, and after chemotherapy or radiation in childhood cancer. To our knowledge, there is no previous study that has evaluated patient-reported clinical outcomes after percutaneous fixation of valgus SCFE. Using a nation-based cohort, the aims of the present study were to describe the clinical and radiographic outcome of valgus SCFE, with a focus on patient-reported outcome data using a validated outcome instrument.

Material and methods

We found 11 stable idiopathic valgus SCFEs in eight patients treated in Uruguay between 1997 and 2017. The average follow-up was 87 months (range 24–252) after percutaneous fixation. Institutional Human Subjects approval was obtained for this study from our local Board. All participants (either the adult, or the parent of a minor patient) consented to participate and were brought back for a final follow-up history, physical examination,

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radiographs, and completion of an outcome instrument. This review was performed at a minimum of 2 years after the index SCFE surgery and performed by one of the authors (A.G.) not involved in the patient's care.

Demographics

Demographic data are presented in Table 1. A BMI equal to or greater than the 85th percentile in children and teens [35] and a BMI equal to or greater than 25.0 in adults [36], was classified as being overweight.

Radiographic data

All pre- and immediate postoperative radiographs were reviewed to confirm the presence of a valgus SCFE. Head-shaft angle (HSA) was measured on the anteroposterior radiographs while the alpha angle and slip angle were measured on the lateral Lauenstein radiograph. Presence of a cam deformity was defined as an alpha angle >55° [37], and coxa valga as a femoral head shaft angle ≥140° [38]; slip severity based on the slip angle was classified as mild (<30°), moderate (30°–60°), and severe (>60°) [39]. All measurements were done by one researcher (A.G.).

Clinical and radiological variables at follow-up

All patients underwent a physical examination including a test of femoroacetabular impingement (FAI) performed by one of the authors (A.G.). The hip was passively flexed to 90° with the patient in supine, followed by forced adduction and internal rotation. A positive FAI test was recorded if these movements produced sharp pain in the groin [40]. The International Hip Outcome Tool (iHOT-12), a validated functional patient-reported outcome measure, was completed. This instrument is recommended for the assessment of young- to middle-aged adults with hip pain and dysfunction [41–43]. The iHOT-12 in Spanish includes 12 questions (range 0–100, with 100 representing the best quality of life) [41]. The total score is calculated as the mean of these responses [42]. Radiographs of the pelvic (anteroposterior and Lauenstein projection) were obtained at follow-up and evaluated for physeal closure, signs of avascular necrosis [44] and radiographic measurements of HSA and alpha angles [45,46].

Statistical analysis

Descriptive statistics were used to characterize the demographic data and subjective and objective hip function. Wilcoxon signed-rank test was used to assess changes in HSA and alpha angles. A *P*-value of <0.05 was considered to be statistically significant. Statistical analysis was performed with SPSS Mac 24.0 (SPSS Inc., Chicago, Illinois, USA).

Results

The average age at diagnosis was 11.9 years (range 9–13) (Table 1). Six of the eight patients were girls. Two children (cases 4 and 8) had primary bilateral valgus SCFE at initial presentation, and one child (case 3) developed a contralateral valgus SCFE later. All SCFEs were stable. In one patient (case 8), bilateral stable valgus SCFE was diagnosed. However, before treatment, the patient sustained a fall while playing and developed an unstable varus SCFE on the right. Seven of the children were overweight while one was underweight (BMI of 12) at

Table 1 Demographics, injury description, and iHOT12 at follow-up of eight patients (11 hips) with valgus slipped capital femoral epiphysis

	Patient no											
Variables	1	2	3		4		5	6	7	8[a]		Mean (range)
Age at surgery (years)	12.2	12.3	10.3	11.5	12.1	12.1	11.8	11.5	12.9	12.4	12.4	11.9 (10.3–12.9)
Age at follow-up (years)	32.8	24.1	16.9		18.5		15.4	14.0	15.2	14.4		18.9 (14.0–32.8)
Sex [b]	F	F	F		M		F	F	F	M		
Side [c]	L	R	R	L	R	L	L	R	L	R	L	
Bilateral SCFE [d]	N	N	Y	Y	Y	Y	N	N	N	Y	Y	
Later valgus slip in the contralateral hip [d]	N	N	N	Y	N	N	N	N	N	N	N	
Pre-operative slip angle, degrees	2	29	27	28	13	10	56	36	26	52	28	28 (2–56)
Slip severity [e]	Mi	Mi	Mi	Mi	Mi	Mi	Mo	Mo	Mi	Mo	Mi	
BMI at Surgery (kg/m^2)	26	27	29	29	26	26	12	32	26	33	33	26 (12–33)
Overweight or obese at surgery [f]	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	
Time from surgery to last radiograph (months)	252	144	79	65	77	77	30	30	27	24	24	75 (13–252)
Femoral shaft angle, at post-op degrees, affected hip	168	147	142	140	140	140	145	145	140	148	145	145 (140–168)
Alpha angle at post-op, degrees, affected hip	68	57	67	62	60	52	77	60	65	76	64	64 (52–77)
Alpha angle at follow-up, degrees, affected hip	57	45	47	42	54	46	70	51	58	70	63	55 (42–70)
Positive impingement test[d]	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	
IHOT-12[g]	13	93	91		97		84	45	90	83		74 (13–97)

SCFE, slipped capital femoral epiphysis.
[a]The patient had initially an untreated stable valgus SCFE on the right side and after a fall developed an unstable varus SCFE.
[b]M, male; F, female.
[c]L, left; R, right.
[d]Y, yes; N, no.
[e]Mi, mild (<30°); Mo, moderate (30°–60°); S, severe (>60°).
[f]BMI equal to or greater than the 85th percentile in children and teens and in adults as BMI equal to or greater than 25.0.
[g]International Hip Outcome Tool (range, 0–100, with 100 representing the best quality of life).

the time of surgery. All SCFEs were idiopathic without any associated diseases.

Coxa valga was noted in all patients and the mean femoral head shaft angle for the 11 SCFEs was 145° (range 140–168) and 141° (range 139–145) for the six non-SCFE hips. Six patients had the diagnosis confirmed preoperatively with a computed tomography (CT) scan of the hip (Fig. 1).

The case (no. 8) that displaced from valgus into varus underwent closed reduction and fixation with percutaneous Kirschner wires. In all other cases, the SCFE was stabilized with a partially threaded screw. The threads were equally distributed across the physis with the intention to create physeal closure and prevent further slippage (Fig. 2). None underwent prophylactic treatment of the contralateral hip. None of the patients in our study had any complication related to the initial surgical treatment. However, in one patient (case 1) the femoral vein was injured during secondary hardware removal and required immediate repair by a vascular surgeon.

Radiographic follow-up demonstrated significant remodeling in both the HSA and alpha angle. The HSA in the SCFE hip decreased an average of 8° (range 3–23) (P = 0.005) and 2° (range 0–5) in the normal hip (P = 0.066) (Fig. 3). The alpha angle improved an average of 10° (range 1–22) in the SCFE hip (P = 0.005) compared to 3° (range 1–5) in the normal hip (P = 0.042) (Fig. 4).

Fig. 1

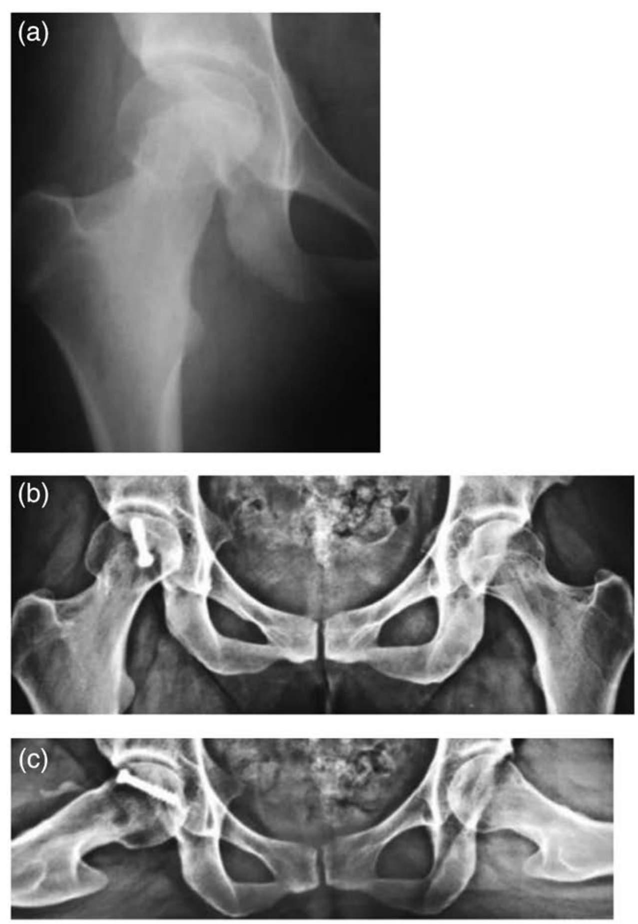
Preoperative 3-D CT reconstruction of valgus SCFE (case 6). CT, computed tomography.

At follow-up, the mean iHOT-12 was 74 (range 13–97), iHOT-12 score for each patient is presented in Table 1. The patient with the longest follow-up (21 years) and worst iHOT-12 score (case 1), had secondary osteoarthritis that affected hip function. Nine of the eleven hips had a positive impingement test, of which five had an alpha angle >55°. Only patient number 4 (bilateral case) had a negative impingement test. None of the eight patients had a positive Trendelenburg sign at follow-up. Six out of seven patients who were overweight at the time of surgery were also overweight at follow-up. There was no case of avascular necrosis.

Discussion

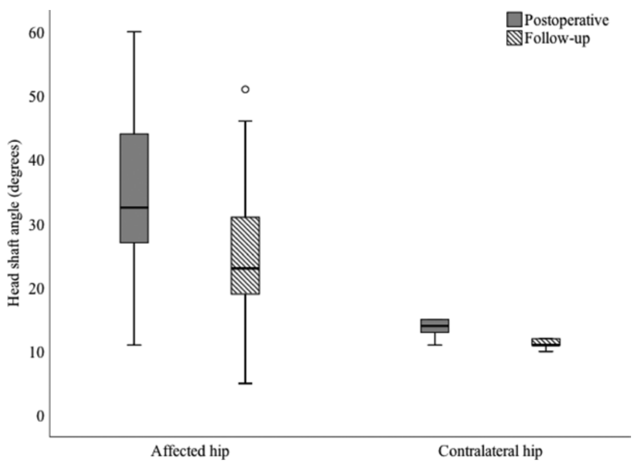
This study evaluated subjective and objective hip outcomes in eight patients with idiopathic valgus SCFE. The patient-reported outcome in our group of patients varied considerably with iHOT-12 scores from 13 (bad) to 97 (excellent). Our results are in agreement with previous studies regarding the predominance of female sex [2–4]

Fig. 2



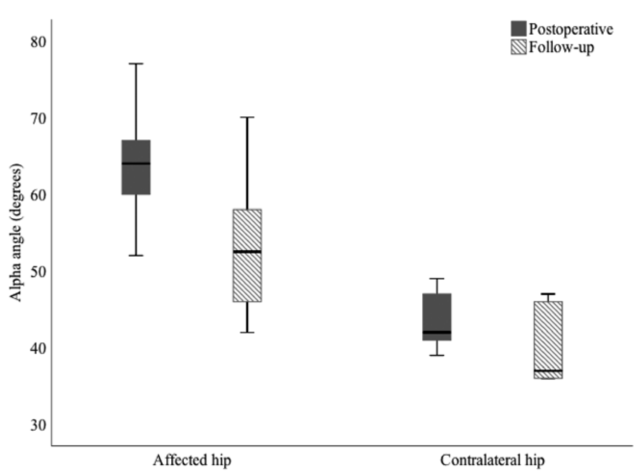
Preoperative (a) and final follow-up (b and c) radiographs 12 years after surgery (case 2). Alpha angle and iHOT12 score at follow-up (45° respective 93 points).

Fig. 3



Radiographic head shaft angle in both the immediate postoperative radiograph and at follow-up in the slipped SCFEs (n = 10) and the contralateral (n = 5) hips. Results are presented as the median (heavy transverse black line) with interquartile range (gray box) and total range (longitudinal line with hashmarks). The circle represents an outlier. The right hip of patient no. 8 has been excluded since the patient developed an unstable varus SCFE after falling in-between the initial surgery and follow-up.

Fig. 4



Radiographic alpha angle in both the immediate postoperative radiograph and at follow-up in the slipped SCFEs (n = 10) and the contralateral (n = 5) hips. Results are presented as the median (heavy transverse black line) with interquartile range (gray box) and total range (longitudinal line with hashmarks). The right hip of patient no. 8 has been excluded since the patient developed an unstable varus SCFE after falling in-between the initial surgery and follow-up.

in valgus SCFE. All valgus SCFEs were stable in our study, similar to other studies [2,7,14,17–20,23,24,28,29]. In our study, all slips were idiopathic. Although one of our patients was underweight at the time of the SCFE, no endocrine disorder could be established. All the other patients in our study were overweight, both at the time of surgery and at follow-up.

The mean age at diagnosis in patients with valgus SCFE is lower than in children with varus SCFE [2–4]. This likely reflects the sex composition.

In children with suspected SCFE, it is necessary to perform a lateral radiograph to evaluate the posterior epiphyseal displacement. This is especially true in a valgus SCFE since the Klein's line on the frontal radiograph is always normal [47]. In our study, six patients also had CT scans performed. We found CT useful for pre-operative planning including a more medial starting point on the skin for the screw placement compared to varus SCFE. Several authors have discussed the potential risks with percutaneous in-situ fixation of valgus SCFE due to the immediate proximity to the femoral neurovascular bundle [2,3,24,31]. Scher *et al.* [18] recommended a limited open technique to minimize the risk of neurovascular complications.

Even though not all hip symptoms may be explained by FAI, a positive clinical test for anterior impingement was found in nine of 11 hips. Radiographically the femoral head was abnormal with five hips having an alpha angle >55°. The one patient (two hips) without clinical FAI had an alpha angle <55° in both hips (Table 1). The high rate of FAI among our patients indicates a need for potential further treatment, either non-surgical or surgical [37]. Kalhor *et al.* [30] suggest an initial approach with intracapsular realignment osteotomy combined with periacetabular osteotomy to avoid impingement and future osteoarthritis. However, such extensive surgery may not be necessary because the proximal femur has the potential to remodel after in situ fixation. In support, a recently published series of varus SCFE treated with the Hansson hook-pin, a nail that permits longitudinal growth, showed that the alpha angle reduced proportionally to the amount of remaining growth [48]. Also in our patients, we noted significant radiographic remodeling between the time of primary surgery and follow-up (Figs. 3 and 4).

We recognize that our study has several limitations, two of which are the retrospective nature of the study and the small number of patients. Another weakness is that even if the patients had a minimum of 24 months after surgery, the large range of follow-up time may confound results. The strength of this study is that we used both traditional data for follow-up as well as a patient-reported outcome (iHOT-12), which has not been previously used in a series of valgus SCFEs.

In conclusion, this study highlights valgus SCFE as a rare type of SCFE. In contrast to varus SCFE, valgus SCFE seems to be more common in girls. Our study is the first to describe long term results using both clinical and patient outcome measures (iHOT-12). A majority of patients have residual symptoms as young adults, likely associated with FAI.

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Conflicts of interest

There are no conflicts of interest.

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