The Fate of Hips That Are Not Prophylactically Pinned After Unilateral Slipped Capital Femoral Epiphysis

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Published online: 3 January 2013
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Abstract

Background The indications for prophylactic pinning of the contralateral hip after unilateral slipped capital femoral epiphysis (SCFE) remain controversial in part because the natural history of the contralateral hip is unclear.

Questions/purposes We therefore determined (1) the incidence of contralateral slips in patients with unilateral SCFE, (2) the rate of subsequent corrective surgery, and (3) the Harris hip score (HHS) and VAS pain score for hips that sustained a contralateral slip after unilateral pinning.

Methods We retrospectively reviewed 226 patients with unilateral SCFE at initial presentation between 1965 and 2005; of these, 133 met our inclusion criteria and were followed at least 2 years. Latest followup included examination and radiographs for 52 patients and HHS (without

radiographs) and VAS pain score for 81 hips. Minimum followup was 2 years (median, 13 years; range, 2–43 years). **Results** Of the 133 patients at risk for a subsequent slip, 20 patients developed a contralateral slip (15%). One patient developed avascular necrosis requiring arthroplasty, and another patient had a mild contralateral slip with disabling pain. For the 15 patients with contralateral slips and scores available, the mean HHS was 90 (range, 49–100) and the mean VAS pain score was 20 of 100. Six found the contralateral hip painful.

Conclusions The contralateral slip sustained by the majority of patients was for the most part mild. However, nearly 1/3 of the contralateral slipped hips were painful. One patient has severe pain, and a second required THA for avascular necrosis after an unstable slip. These may have been preventable by prophylactic pinning.

Level of Evidence Level III, therapeutic study. See Instructions for Authors for a complete description of levels of evidence.

The institution of the authors has received, during the study period, funding from the Mid-America Orthopaedic Association (Rochester, MN, USA).

Each author certifies that he or she, or a member of his or her immediate family, has no funding or commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

All ICMJE Conflict of Interest Forms for authors and *Clinical Orthopaedics and Related Research* editors and board members are on file with the publication and can be viewed on request.

Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

Several studies have addressed the question of whether the contralateral hip in a patient presenting with unilateral slipped capital femoral epiphysis (SCFE) should be pinned prophylactically [6, 16, 36]. Proposed parameters to determine which patients should undergo prophylactic pinning include age [6, 25, 33], sex [9], weight [25], modified Oxford bone age score [31], presence of an endocrine disorder [23, 26], and surgeon's assessment regarding the families' ability to return for regular followup [16].

Prophylactic pinning of the normal, contralateral hip in patients with unilateral SCFE may be undertaken to avoid a subsequent acute unstable slip, which may result in

avascular necrosis and severe hip deformity [2]. For the most part, a low rate of severe slips (0%–3%) has been reported for the contralateral hip [13, 17, 24], perhaps since children and parents are aware of the condition and able to report for treatment as soon as symptoms develop. Thus, since severe slips are rare, expectant management of a contralateral hip at risk for slipping has been well accepted, particularly for older children and those without associated risk factors of an endocrinopathy.

Recent literature, however, suggests mild slips result in femoroacetabular impingement and eventual early degenerative arthritis of the hip [8, 19]. Prophylactic pinning may prevent a mild slip and subsequent degenerative changes to the hip in future years [8]. Limited data [13, 15], however, exist regarding the long-term natural history of the contralateral hip that was not pinned to determine whether substantial disability arises that may have been prevented by prophylactic pinning. Previous authors suggest the majority of these slips are asymptomatic, and only one in eight patients with a contralateral slip will require additional treatment [13, 15].

A recent publication from our center showed a similar population-based incidence of SCFE compared to previous epidemiologic studies, with 8.3 unilateral cases and 0.5 bilateral cases per 100,000 children per year, which has been stable in our region for many years [19]. Thus, we undertook this study to determine (1) the rate of contralateral slips, (2) whether any contralateral slips subsequently required a THA or other corrective procedure compared to patients who had only a unilateral slip, and (3) the patient-reported outcome measures of individuals with a subsequent contralateral slip compared to patients with only a unilateral slip.

Patients and Methods

We searched a diagnostic and surgical procedure database to identify 226 patients who underwent treatment for a new diagnosis of SCFE between 1965 and 2005. Primary outcome measures were additional surgery and Harris hip score (HHS). Only patients with a new radiographic diagnosis of SCFE treated at our center using in situ pinning and intraoperative fluoroscopy were included in the current study. Forty-five patients had less than 2 years of followup and could not be located for this study, despite exhaustive search efforts. There was no difference in age at presentation or slip severity between those lost to followup and those with greater than 2 years of followup. Sixteen patients had nonoperative treatment or acute treatment with osteotomies and were excluded because nonoperative management is no longer a standard of care for the treatment of SCFE and because primary osteotomies (typically

valgus derotational) are rarely performed today for initial treatment of SCFE. One patient refused to participate in research, and six patients were deceased. Twenty-two patients presented with bilateral disease and underwent treatment of both hips at initial presentation. Three patients underwent prophylactic pinning of the contralateral normal hip. Thus, 133 patients with unilateral disease had adequate followup and were judged at risk for sustaining a second slip. Of the 133 patients, 35 were from the immediate county, 50 from the region, and 48 from outside the region. No demographic differences were found among local, regional, and referral patients. Of those 133 patients, 20 went on to have a radiographically documented childhood slip treated at our facility. Institutional review board approval was obtained for all aspects of this study.

Minimum radiographic followup for the 133 patients was 2 years (median, 13 years; mean, 16 years; range, 2–43 years). This should be sufficient to detect contralateral slips, which typically occur within 18 months of the first slip [6, 13, 22, 24, 31, 42]. We reviewed medical records to determine the rate of a subsequent contralateral slip. Merely the radiographic finding of a gunstock deformity after skeletal maturity was not considered a slip because the etiology of these radiographic findings is unclear [32, 38]. Since patients were seen over a 40-year period, followup protocols varied considerably by individual surgeon. A variety of implants were used as well, although all included hips were treated by in situ pinning with intraoperative radiography.

In addition to existing medical records, we obtained study data from telephone interviews and mailed surveys. Patients were specifically asked whether symptoms had developed in the contralateral hip and whether additional surgery had been undertaken, either as a child or an adult. On survey results, no patients reported additional childhood treatment of a contralateral slip performed at another center. Patient-reported outcome scores, both general and disease-specific, were collected to determine hip function and long-term clinical results. Hip and functional scores in the contralateral hip were compared to those in patients with a unilateral slip. We used the following outcome measures to assess general and disease-specific health status: Hip Disability and Osteoarthritis Outcome Score (HOOS) [29], HHS [12], SF-12 [40], UCLA activity score [1], activity score of Marx et al. [27], and VAS scores for pain and stiffness [14]. The HOOS is a validated disease-specific patient-reported outcomes tool, with a maximum score of 500, representing perfect hip health. The HHS is a physician-reported score commonly used to assess hip function. An excellent score is defined as 90 points or more. The SF-12 is a multipurpose survey that is validated and reliable. Patient functional level was measured by the UCLA activity score (10 reflecting a high level of activity,

i.e., regularly participates in impact sports) and the validated Marx activity score (maximum score of 16, i.e., running/pivoting sports four times weekly). Pain and stiffness were scored by the patients on a VAS of 0 to 100, with 100 representing maximum pain or stiffness.

For the 133 patients, latest followup included a physical examination and radiographs for 52 patients and survey results for only 81 patients (15 from those who had a contralateral slip and 66 from those who did not). All patients had radiographic imaging and examination at a minimum of 2 years of followup. For the 20 patients who sustained a childhood contralateral slip, nine had both recent survey and radiographic results available, six had survey results only, one had recent radiographs only, and four had neither recent radiographs nor recent survey results (Table 1).

The rate of revision surgery and function in these 20 patients were compared to those of the 113 patients who did not sustain a second slip. For the 20 patients who developed a contralateral slip, the median followup (survey or radiograph) was 21 years (mean, 19 years; range, 3–41 years) and the median age at followup was 31 years (mean, 31 years; range, 14–53 years). For the 113 patients who did not have a contralateral slip, the median followup

was 13 years (mean, 16 years; range, 2–43 years) and the median age at followup was 26 years (mean, 29 years; range, 12–56 years). The mean age was less ($p = 0.0034$) in patients who developed a contralateral slip than in patients who had only a unilateral slip (Table 2). More ($p = 0.059$) males than females sustained a contralateral slip. Otherwise, demographics between the two groups were quite similar.

We used Pearson's chi-square test to compare discrete variables (sex, endocrinopathy, unstable slip, complication, reconstructive surgery) and Student's t-test to evaluate differences in continuous variables (age, BMI, followup, age at followup, UCLA activity score, Marx activity score, SF-12, VAS, HOOS, HHS) between patients with a unilateral slip who did not develop contralateral disease and patients who did develop contralateral disease. No Bonferroni correction was utilized, though this may increase the risk of a false-positive result when reporting significance [34]. JMP® was utilized for statistical analysis (Version 9.0.1; SAS Institute Inc, Cary, NC, USA).

Results

Of the 133 patients, 20 patients (15%) developed a contralateral slip and underwent treatment of the second hip (Table 2). For these 20 patients, the mean time between first and contralateral slip was 368 days (range, 6–943 days).

At last followup, 19 patients had required no further surgery (Fig. 1). One patient underwent hip arthroplasty due to avascular necrosis from an unstable contralateral slip (Fig. 2). A second patient developed painful degenerative arthritis and is considering arthroplasty (Fig. 3). One additional patient developed an infection at the screw site

Table 1. Followup for patients with a contralateral slip

Patient	Time from initial pinning to contralateral slip (years)	Time from contralateral pinning to latest radiograph (years)	Time from contralateral pinning to survey (years)
1	1.8	40	40
2	1.6	2	NA
3	0.8	7	NA
4	1.1	36	36
5	1.2	34	32
6	1.8	2	34
7	0.4	18	26
8	0.3	2	23
9	0.8	4	27
10	2.6	2	13
11	0.3	22	21
12	0.7	2	26
13	0.7	3	NA
14	0.9	4	23
15	0.6	3	11
16	1.8	3	20
17	0.6	2	NA
18	0.1	6	NA
19	1.9	2	9
20	0.3	6	5

NA = not available; survey not returned.

Table 2. Demographics and slip characteristics

Variable	Patients with unilateral slip	Patients with a delayed contralateral slip	p value
Number of patients	113	20	
Age at slip (years)*	13 ± 2	12 ± 1	0.0034
BMI (kg/m ²) at presentation*	24 ± 5	25 ± 5	0.42
Sex (females/males)	36 (32%)/77 (68%)	2 (10%)/18 (90%)	0.059
Endocrinopathy (number of patients)	6 (5%)	0	0.59
Unstable slip (number of hips)	7 (6%)	1 (5%)	0.4
Followup (years)*	16 ± 12 (2–43)	19 ± 13 (3–41)	0.13
Age at followup (years)*	29 ± 12 (12–56)	31 ± 13 (14–53)	0.74

* Values are expressed as mean ± SD, with range in parentheses.

Fig. 1 An AP pelvis radiograph is shown of a 52-year-old man who presented with a right moderate SCFE at age 10.5 years. Twenty-two months later, he developed mild stable left SCFE. At 40 years after the slips, both joint spaces are well preserved, and he has minimal symptoms (HHS: right, 81; left, 92).

on the contralateral slip and underwent uneventful implant revision 3 months after the index surgery and implant removal 4 years after the initial slip. This likely could not have been prevented by prophylactic pinning.

Of the 113 patients who sustained a unilateral slip, 13 patients (11%) had a subsequent reconstructive surgery on the affected hip, including THA (five), offset procedure/surgical hip dislocation (two), and femoral osteotomy (seven) (Table 3). One hip was treated with an osteotomy and subsequently an offset procedure. There were three cases of avascular necrosis, two of which were treated with femoral osteotomy. The first slip more frequently ($p = 0.21$) required reconstructive surgery (13 of 113 hips) at a mean 16 years of followup compared to the contralateral slip (one of 20 hips) at a mean 20 years of followup.

We found no differences in clinical and patient-reported outcomes between patients with a unilateral slip and patients with a subsequent contralateral slip (Table 4). Six of the 15 patients with contralateral slips and outcome scores available reported pain in the contralateral hip, with a mean VAS pain score of 20 of 100. Mean HHS for the 15 patients was 90.

Fig. 2A–D (A) A male patient presented with a left mild chronic SCFE at 12 years of age and underwent pinning. Four months later, he developed an acute unstable right SCFE treated with pinning. (B)

This resulted in avascular necrosis. (C) He developed pain in his right hip (HHS 49) and (D) underwent THA at 42 years of age. He self-reports an HHS of 99 on the left.

Fig. 3 A 49-year-old man initially presented with a left chronic SCFE at age 10.4 years. Fourteen months later, he developed a mild stable right SCFE. He now has considerable symptoms on both sides and is considering THA.

Table 3. Complications after SCFE treatment

Complication	Number of patients		p value
	Patients with unilateral slip (n = 113)	Patient with delayed second slip (n = 20)	
Avascular necrosis	3 (2%)	1 (5%)	0.69
Any complication	12 (11%)	1 (infection, implant removal) (5%)	
Any reconstructive surgery	13 (11%)	1 (5%)	0.93
Osteotomy	7 (6%)	0 (0%)	0.56
THA	5 (4%)	1 (5%)	
Offset procedure/surgical hip dislocation	2 (1.8%)	0 (0%)	

SCFE = slipped capital femoral epiphysis.

Patients in both groups had a low activity level with a mean Marx activity score of 4 to 5 of 16 and UCLA activity score of 7 to 8 of 10. This may be due to the medical comorbidities and high BMI common in patients with SCFE.

Discussion

SCFE is a common condition in children and can result in distorted anatomy of the proximal femur and subsequent degenerative arthritis. Patients may complain of limited motion in the hip and an external foot progression angle. Excluding patients presenting with bilateral disease, reported rates of documented, symptomatic childhood

Table 4. Outcome scores after SCFE treatment

Scoring system	Score (points)		p value
	Patients with unilateral slip (n = 66)	Patients with delayed second slip (n = 15)	
UCLA activity score (points)	8.1 (3–10)	7.6 (5–10)	0.59
Marx activity score (points)	4.5 (0–16)	4.4 (0–14)	0.89
SF-12 physical component (points)	48.7 (25–63)	51.2 (40–56)	0.19
SF-12 mental component (points)	51.8 (26–67)	52.0 (37–61)	0.92
VAS pain (points)	26 (0–100)	20 (0–70)	0.35
VAS stiffness (points)	25 (0–100)	18 (0–55)	0.25
Hip Disability and Osteoarthritis Outcome Score (points)	401 (85–500)	409 (250–500)	0.79
Harris hip score (points)	88.5 (33.5–100)	90 (49–100)	0.1

Values are expressed as mean, with range in parentheses; SCFE = slipped capital femoral epiphysis.

progression to bilateral disease in children range from 9% to 36% [3, 6, 10, 17, 22, 33]. Considering asymptomatic disease, other series report a much higher rate of bilateral disease at up to 36% to 79% of patients with unilateral slips developing bilateral disease evident by deformity on radiograph at skeletal maturity [4, 11, 13]. Prophylactic pinning is offered at some centers to children with unilateral disease to prevent a contralateral slip. Prophylactic pinning is thought to have low morbidity [6, 16, 41]. However, Woelfle et al. [41] reported a 10% revision rate (seven of 65 patients) for hips prophylactically pinned with K-wires. Further, avascular necrosis and subtrochanteric fracture after prophylactic screw fixation of the contralateral hip have been reported [20]. In contrast, the long-term outcomes of the contralateral side are not well reported in the literature. We therefore undertook this study to determine (1) the rate of contralateral slips, (2) whether any contralateral slips subsequently required a THA or other corrective procedure compared to patients who had only a unilateral slip, and (3) the patient-reported outcome measures of individuals with a subsequent contralateral slip compared to patients with only a unilateral slip.

Limitations to this work include the following. First, this was a retrospective study performed over many years using different operative techniques for in situ pinning. From the original cohort of 226 patients with SCFE treated at our center, 45 patients (19%) were entirely lost to followup. Of the selected cohort of 133 patients, we did have minimum 2-year followup and mean 16-year followup, which were similar between patients with unilateral and delayed bilateral slips. Median 21-year followup was available in

Table 5. Reported bilateral incidence of SCFE

Study	Time to followup (years)	Rate of bilateral SCFE		
		At presentation	Subsequently (diagnosed in childhood)	Subsequently (SCFE based at skeletal maturity, radiographic findings)
Current study	Median, 13 (range, 2–43)	22 of 226 (10%)	20 of 133 (15%) (52 lost to followup/deceased)	NA
Larson et al. [18] (2010) (population-based data from our center, including some of the same patients)	Mean, 2.6	3 of 51 (6%)	9 of 47 (19%)	NA
Loder et al. [24] (1993)	Mean, 4 ($\pm$ 1.7)	41 of 224 (18%)	41 of 183 (22%)	NA
Loder [22] (1996)	NA	221 of 1630 (13.5%)	146 of 1409 (10%)	NA
Barrios et al. [3] (2005)	Mean, 5 (range, 3–7)	NA	8 of 47 (17%)	NA
Hagglund et al. [11] (1988)	Mean, 33 years (range, 16–66)	23 of 260 (9%)	32 of 237 (13%)	104 of 205 late diagnosis based on radiographic measures; thus, a total of 159 of 260 slips (61%)
Billing and Severin [4] (1959)	NA	NA	NA	80% rate of slip in skeletally mature patients based on radiographic measures
Koenig et al. [17] (2007)	Minimum, 2	8 of 93 (9%)	12 of 71 (17%)	NA
Klein et al. [15] (1953)	Minimum, 2	8 of 61 (13%)	17 of 61 (28%)	NA
Popejoy et al. [31] (2012)	Minimum skeletal maturity	NA	64 of 260 (24%)	NA
Yildirim et al. [42] (2008)	Mean, 2.2 (minimum, 2)	189 of 520 (36%)	82 of 227 (36%) (104 lost to followup)	NA
Hurley et al. [13] (1996)	Casted: mean, 3.6 (range, 0.5–9.5) Surgery: mean, 2.8 (range, 1.0–8.3)	NA	61 of 160 (38%) (but of those, 49% of these slips were asymptomatic?, were they treated?)	NA

SCFE = slipped capital femoral epiphysis, NA = not available/not applicable.

20 patients who had a documented childhood contralateral slip. Second, our findings apply to a mostly suburban/rural white population. Other centers have documented a higher rate of bilateral disease and complications, perhaps due to racial differences and/or limited access to health care [31, 42]. Third, we lacked radiographic followup in some patients. Although much focus has been placed on the high rate of the radiographic appearance of SCFE found in the contralateral hip in adult patients (reported at up to 79% of patients with SCFE [4]), there is little evidence to suggest such an asymptomatic slip actually occurs [38]. The gunstock deformity commonly attributed to SCFE may simply be due to age-related changes in the hip or acetabular retroversion that is a common in patients with SCFE and perhaps a risk factor for SCFE [35] rather than a silent slip as previous authors have theorized [32, 38]. Thus, rather than radiographic measures, validated, patient-reported

outcomes and rates of additional revision surgery were the primary outcome measures for this study. Fourth, statistical analysis is limited by the incomplete followup. It is possible patients who have no hip symptoms were less likely to return for followup and/or return the survey. Alternatively, patients with hip problems may have been less likely to return for followup or may have sought care at other centers.

The rate of subsequent slip in our series was 15%, which is comparable to the rates of other reports of predominantly white patients, similar to our patient population (Table 5). Excluding patients presenting with bilateral disease, reported rates of documented, symptomatic childhood progression to bilateral disease in children range from 9% to 36% [3, 6, 10, 17, 22, 33, 42]. Thus, our 15% rate of subsequent slip is similar to the reported literature. In our patient population, more than six children would have to

undergo prophylactic pinning to prevent a single contralateral slip.

We found the rate of reconstructive surgery in patients developing a contralateral slip similar to that of patients with a unilateral slipped hip. Previous series have reported the subsequent slip is typically mild and stable. With the exception of one patient who subsequently required arthroplasty for a moderate, unstable slip, our study confirmed these findings. This rate of one of 20 hips (5%) is similar to the reported rates of arthroplasty for patients with unilateral SCFE [19]. In contrast, Yildirim et al. [42] did have a high rate of moderate and severe subsequent slips.

Mild slips are believed to be well tolerated, although a recent case series reported radiographic evidence of impingement in 10 of 16 hips with mild slips at 11 to 21 years of followup [8]. In addition, a case series of three hips with mild slips undergoing surgical hip dislocation for treatment of a recent diagnosis of SCFE showed degenerative changes to the labrum in two hips and acetabular cartilage damage in all three hips [21]. An MRI study of 35 hips evaluated 12 years after treatment for mild or moderate SCFE also noted 24 hips had superior acetabular cartilage damage [28]. Some centers are aggressively treating even stable slips with early corrective osteotomies using a surgical hip dislocation approach with the aim of preventing future degenerative changes [37, 43]. It is clear that some patients with a history of SCFE may eventually require THA, but it is unknown which hips become symptomatic over time [19]. Some studies report a low rate of THA, with 5% to 10% of hips requiring THA at 20 to 40 years [19, 30]. Hip arthroplasty for SCFE appears to be durable and have a similar rate of revision surgery as that of degenerative conditions [18, 39]. Slip severity does not necessarily predict symptoms [7, 8]. Thus, it is difficult to know which patients to target with early treatment such as prophylactic pinning, surgical hip dislocation, or osteotomy. One of our patients had a subsequent THA on the contralateral hip secondary to avascular necrosis from an unstable SCFE. Of the 19 mild contralateral slips, only one patient was severely symptomatic, although four others reported mild or moderate pain. We further assessed activity level and hip symptoms in patients with a contralateral slip. These were similar to rates of pain and stiffness reported by patients with a unilateral slip, with approximately 1/3 of patients finding the hip mildly painful. This is similar to other reports discussing the short- and intermediate-term outcomes of in situ pinning for SCFE [5].

In conclusion, this series provides additional data regarding the outcome of the contralateral hip. One patient required THA due to avascular necrosis, and a second patient has severe pain and is likely to require arthroplasty in the future. These symptoms may have been prevented by prophylactic pinning. Given these new data, a formal decision analysis should be undertaken to weigh the

expected risks and benefits of prophylactic pinning versus expectant management of the contralateral hip. In some practice settings, closer followup and better patient and parent education may help prevent mild slips, as well as high-grade, unstable slips and subsequent avascular necrosis. Although complications with prophylactic pinning are rare, the ethical burden of potentially causing harm to the contralateral hip demands careful consideration, particularly in contrast to the relatively benign intermediate-term results we determined for the contralateral slipped hip. Further, a substantial number of hips (greater than six) must be pinned to prevent one subsequent slip. For these reasons, except in cases of endocrinopathy or substantial skeletal immaturity, we continue to observe the contralateral hip in patients with unilateral SCFE in our patient population. Followup recommendations and indications for prophylactic pinning, however, should be tailored to the individual practice setting, patient demographics, and family's ability to return for medical care.

Acknowledgments The authors thank the patients for participation in these study efforts.

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