

Original article

Prophylactic pinning should be considered in patients at risk for slipped capital femoral epiphysis

Yohei Tomaru¹, Hiroshi Kamada^{1,2}, Yuta Tsukagoshi¹, Shogo Nakagawa¹, Mio Onishi¹, Kenta Tanaka¹, Ryoko Takeuchi¹, Yuki Mataki¹, Shumpei Miyakawa¹, and Masashi Yamazaki¹

¹Department of Orthopaedic Surgery, Faculty of Medicine, University of Tsukuba, Japan

²Tsukuba Sports Medicine & Health Science Center, University of Tsukuba, Japan

Abstract

Background: The use of prophylactic contralateral pinning for slipped capital femoral epiphysis (SCFE) remains controversial. This study evaluated the outcome of SCFE treatment and examined the use of prophylactic pinning.

Methods: The study included 44 patients (33 men, 11 women; 54 hips [right, 31; left, 23]), with mean age of 12.9 (7.3–29) years, who underwent treatment between 1986 and 2017, with follow-up for more than 6 months. Patients were divided into 3 groups: group 1 had bilateral SCFE at first presentation, group 2 developed contralateral side SCFE during follow-up, and group 3 had unilateral SCFE until final follow-up. Three patients who received prophylactic pinning were excluded. Univariate and multivariate logistic analyses were performed.

Results: Overall, 93% (50/54) of hips underwent positional reduction and in situ fixation and 7.4% (4/54) underwent open reduction. Mean follow-up period was 4.8 (0.5–25) years. Groups 1, 2, and 3 had 7, 3, and 31 cases, respectively. Sex, age, and follow-up period showed no significant differences among the groups. The Rohrer index was significantly higher in group 1, the affected side posterior sloping angle (PSA) was significantly higher in group 3, and the contralateral side PSA and percentage with endocrinopathy were significantly higher in group 2. In multivariate logistic analysis, age, sex, Rohrer index, affected side PSA, and endocrinopathy were significantly correlated with bilateral SCFE.

Conclusion: We recommend prophylactic contralateral side pinning in patients with risk factors of obesity, high PSA before slipping, and endocrinopathy. Careful observation until growth plate closure is required in patients without risk factors.

Key words: slipped capital femoral epiphysis, prophylactic pinning, posterior sloping angle

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Background

During 1997–1999, the annual incidence of slipped capital femoral epiphysis (SCFE) in Japan was estimated at 2.98 per 100,000 10–14-year-olds¹⁾. This was 5 times higher than that reported in 1976²⁾. A close association between an increase in obesity and SCFE incidence has been reported¹⁾.

With lifestyle changes and increased obesity, SCFE is becoming more common in Japan.

Patients with unilateral SCFE are 2,335 times more likely to develop contralateral SCFE³⁾. The rate of bilateral SCFE is reported to be approximately 14–40%^{1, 4–7)}. Therefore, prophylactic pinning of the contralateral side has been performed in some cases. Prophylactic pinning is effective for prevention of late-onset contralateral side SCFE. Citing the absence of serious complications and the benefit of contralateral SCFE prevention, several reports recommended routine prophylactic pinning in patients with unilateral SCFE^{8, 9)}. However, other reports did not recommend routine prophylactic pinning because of potential serious complications, such as osteonecrosis and fracture¹⁰⁾. As the use of prophylactic pinning of the contralateral side remains controversial, it is necessary to evaluate surgical complications in the context of outcomes. This study evaluated the outcome of treatment for SCFE and examined the use of prophylactic pinning.

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Correspondence: Yohei Tomaru, Department of Orthopaedic Surgery, Faculty of Medicine, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8575, Japan

E-mail: maruto222@tsukuba-seikei.jp

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Table 1 Patient characteristics

	Group 1	Group 2	Group 3	p-value
n	7 patients, 14 hips	3 patients, 6 hips	31 patients, 31 hips	–
Male/Female	6/1	3/0	10/21	n.s.
Age (year)	13.9 (9.3–29)	12.1 (9.5–14.3)	11.7 (7.3–15.2)	n.s.
Rohrer index (kg/(cm) ²)	180* (132–237)	151 (131–174)	152 (96–220)	<0.05
Follow-up period (year)	5.3 (0.5–11.1)	5.1 (0.5–8.5)	5.3 (0.8–25)	n.s.
PSA (affected side)	38°(14–82)	20° (8–40)	44°* (6–90)	<0.05
PSA (contralateral side)	–	13.3°* (10–18)	4.7° (–14–23)	<0.05
Endocrinopathy rate	14% (1/7)	33%* (1/3)	0% (0/31)	<0.05

Sex and endocrinopathy rate were analyzed using Fisher's exact test. Age, Rohrer index, follow-up period, and affected side posterior sloping angle (PSA) were analyzed using the Tukey HSD test. Contralateral side PSA was analyzed using Student's t-test. Group 1, bilateral from presentation; Group 2, contralateral slip during follow-up; Group 3, unilateral until final follow-up; * significantly high; n.s.: not significant.

Materials and Methods

Approval for the study design was obtained from the Institutional Ethics Review Committee of the University of Tsukuba. Each patient provided informed consent.

Between 1986 and 2017, 49 patients (60 hips) with SCFE underwent surgery in our institution. Selection of in situ pinning or open reduction was left to the operator.

Among these cases, 5 (6 hips) were excluded because of lack of preoperative X-ray imaging. The study included 44 patients (33 men, 11 women; 54 hips [right, 31; left, 23]), with follow-up for more than 6 months. The mean age was 12.9 (7.3–29) years. All hips were classified into acute, acute-on-chronic, and chronic type groups according to Aaldalen *et al.* and Fahey *et al.*^{11, 12}. In addition, all hips were classified into stable type and unstable type groups according to Loder *et al.*¹³. Obesity was evaluated using the Rohrer index, and the posterior sloping angle (PSA) was used to evaluate the slip angle. An abnormal somatomedin C, testosterone, estradiol, follicle stimulating hormone (FSH), or luteinizing hormone (LH) level, but with normal intact parathyroid hormone level, was defined as endocrinopathy. Radiological outcome was evaluated using the Jones classification and the rate of avascular necrosis (AVN)¹⁴.

Statistical analysis

Based on the use of contralateral prophylactic pinning, patients were divided into 3 groups: group 1 had bilateral SCFE at first presentation, group 2 developed contralateral side SCFE during follow-up, and group 3 had unilateral SCFE until final follow-up. Patient characteristics were compared using univariate analysis (Fisher's exact test, Student's t-test, and the Tukey HSD test). A p-value <0.05 was considered significant. Three patients who received prophylactic pinning were excluded.

Multivariate logistic analysis was first performed in groups 1–3, with bilateral SCFE as the objective variable

and age, sex, Rohrer index, affected side PSA, and endocrinopathy as explanatory variables. Analysis was then performed in groups 1–2, with late-onset contralateral SCFE as the objective variable and age, sex, Rohrer index, affected side PSA, contralateral side PSA, and endocrinopathy as explanatory variables. All statistical analyses were performed using JMP version 13.0.0 (SAS Institute Inc., USA).

Results

Among the examined cases, 20% (11/54) were acute type, 19% (10/54) were acute-on-chronic type, and 61% (33/54) were chronic type; 5.8% (3/52) were unstable type and 94% (49/52) were stable type. The mean Rohrer index was 160 kg/cm³ (96–237). The mean PSA on the affected and contralateral sides at presentation was 36.8° (8–90) and 5.6° (–14–23), respectively. Positional reduction and in situ fixation were used to treat 93% (50/54) of hips, and 7.4% (4/54) were treated with open reduction. The mean follow-up period was 4.8 (0.5–25) years.

Furthermore, 89% (48/54) of hips were followed up until epiphyseal closure, and 40% (19/48), 29% (14/48), and 31% (15/48) were classified as Jones type A, B, and C, respectively. AVN developed in 7.4% (4/54) of hips.

Three patients had endocrinopathy: 2 had hypogonadism and 1 had panhypopituitarism. Seven cases were bilateral at presentation (group 1), 3 developed contralateral side slip during follow-up (group 2), and 31 were unilateral until the final follow-up (group 3). Patient background details are shown in Table 1.

Sex, age, and follow-up period showed no significant differences among the 3 groups. The Rohrer index was significantly higher in group 1, the affected side PSA was significantly higher in group 3, and the contralateral side PSA and percentage with endocrinopathy were significantly higher in group 2 (Table 1).

In multivariate logistic analysis, age, sex, Rohrer index,

Table 2 Multivariate logistic analysis with the objective variable of bilateral slipped capital femoral epiphysis (SCFE)

Explanatory variables	p value
Sex	<0.05
Age	<0.05
Rohrer index	<0.05
Affected side PSA	<0.01
Endocrinopathy	<0.01

Sex, age, Rohrer index, affected side posterior sloping angle (PSA), and endocrinopathy were significantly correlated with bilateral SCFE.

Table 3 Multivariate logistic analysis with the objective variable of late-onset contralateral side slipped capital femoral epiphysis (SCFE)

Explanatory variables	p value
Sex	<0.01
Age	<0.01
Rohrer index	n.s.
Affected side PSA	n.s.
Contralateral side PSA	<0.01
Endocrinopathy	n.s.

Sex, age, Rohrer index, contralateral side PSA, and endocrinopathy were significantly correlated with late-onset contralateral side SCFE. n.s.: not significant; PSA: posterior sloping angle.

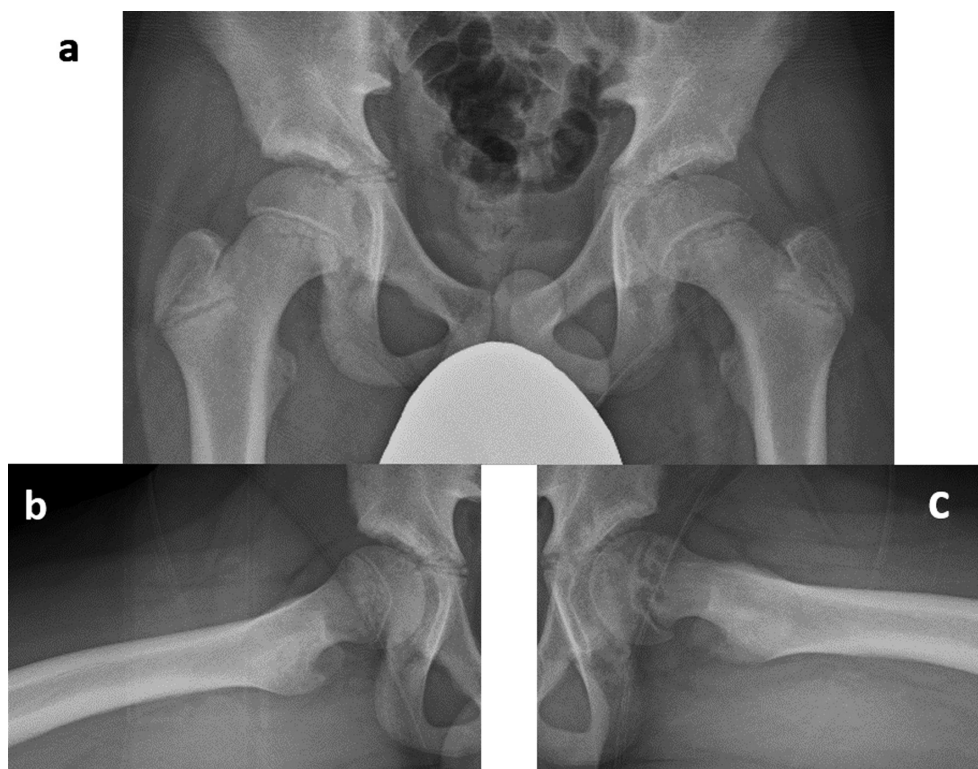


Figure 1 Radiographs of the patient at the time of presentation with left slipped capital femoral epiphysis. a: Anteroposterior view, b: right lateral view (PSA: 11°), c: Left lateral view (PSA: 15°). PSA: posterior sloping angle.

affected side PSA, and endocrinopathy were significantly correlated with bilateral SCFE (Table 2), and age, sex, and contralateral side PSA were significantly correlated with contralateral side slip (Table 3).

Case presentation

An 11-year-old boy developed left SCFE during soccer (Figure 1). Initial presentation to our institution was approx-

imately 3 months after the onset of symptoms. Positional reduction and in situ fixation were performed 87 days after symptom onset. SCFE was classified as chronic, stable type. The Rohrer index was 145, and the PSA of the contralateral hip (right) was 11°. Four months after surgery, right SCFE developed and was treated with positional reduction and in situ fixation (Figure 2). High PSA in the contralateral side hip and mild obesity were risk factors in this patient.

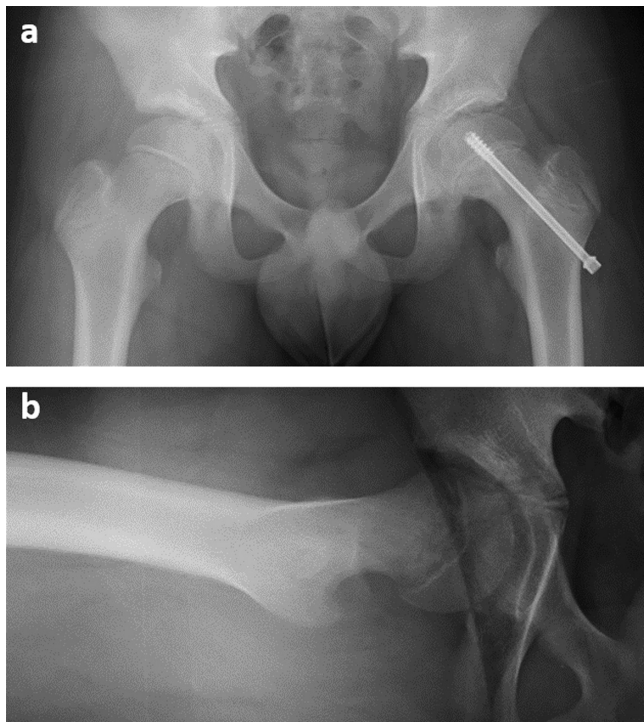


Figure 2 Four months after the in-situ fixation of left hip, right slipped capita femoral epiphysis (SCFE) developed.

Discussion

As prophylactic contralateral side pinning remains controversial, this study evaluated the outcome of SCFE treatment and the use of pinning.

Jones *et al.* reported that 43% (21/49) of SCFE cases did not show remodeling at final follow-up¹⁴. In the present study, 31% (15/48) were classified as Jones type C at final follow-up, and no significant difference was found (χ^2 test, $p=0.236$). Several studies reported AVN prevalence of approximately 4–15%^{15–17}. The present study reported AVN prevalence of 7.4% (4/54), with no significant difference from reported prevalence in previous reports (Fisher's exact test, $p \geq 0.05$). The prevalence of AVN of the hip treated with positional reduction and in situ fixation or open reduction was 2.0% (1/51) and 75% (3/4), respectively. The AVN rate was higher in hips treated with open reduction than in hips treated with in situ fixation (Fisher's exact test, $p < 0.001$). The mean PSA in SCFE treated with open reduction was 64.8°; this was significantly higher than in cases treated with in situ fixation (Student's t-test, $p < 0.01$). This finding implies that not only open reduction but also slip severity contributed to the high rate of AVN in the open reduction group.

The Rohrer index was significantly higher in group 1 than in groups 2 and 3. This is compatible with the report that obesity is a risk factor for SCFE¹⁸. Prophylactic contra-

lateral side pinning should be considered in obese patients.

The affected side PSA was significantly higher in group 3 than in groups 1 and 2; however, the reason is unknown. Patients who had severe slip tended to have prolonged and greater physical activity limitations after surgery. Most contralateral side slip occurs within 15 months after initial presentation¹⁹. Activity limitation during this high-risk period may lead to lower incidence of contralateral side slip.

The contralateral side PSA was significantly higher in group 2 than in group 3. In previous reports, high PSA was a risk factor for late-onset SCFE^{20,21}, partly because the shear force on the growth plate increases if PSA is high. If contralateral side PSA is high, prophylactic pinning should be considered. The cut-off values for PSA were 19° and 15° in studies by Phillips *et al.* and Bellemore *et al.*, respectively, and 10° in the present study^{20,21}.

The prevalence of endocrinopathy was significantly higher in group 2. Sikora *et al.* reported an association between bilateral SCFE and endocrinopathy²². Given that endocrinopathy is a risk factor for bilateral SCFE, prophylactic contralateral side pinning should be considered.

Riad *et al.* reported that contralateral prophylactic pinning should be considered in girls aged <10 years and boys <12 years who present with unilateral SCFE²³. Popejoy *et al.* reported that patients with a modified Oxford score ≤ 19 are at high risk for late-onset SCFE²⁴. In contrast to these reports, group 1 (bilateral SCFE) patients were older than those in groups 2 and 3 in the present study. If a 29-year-old patient included in group 1 is excluded, the mean age will be 11.6 years. This is comparable to that in the other 2 groups. However, in this study, younger age was not a risk factor for late-onset SCFE. The small number of patients in groups 1 and 2 might have affected this result. Accumulation of additional cases for analysis is expected to clarify this issue in future.

The use of routine prophylactic contralateral side pinning remains controversial. Although the rate is low, some serious complications have been reported¹⁰. Implant removal is usually performed in Japan, but a high complication rate with SCFE screw removal has been reported²⁵. Therefore, complications associated with both insertion and removal should be considered. The possibility of serious complication in healthy hips that did not require treatment should be considered.

There are some limitations. First, this was a retrospective study. Second, the number of patients was small.

We recommend prophylactic contralateral side pinning in patients with risk factors such as obesity, high PSA before slipping, and endocrinopathy. In patients without these risk factors, careful observation until growth plate closure is recommended.

Conflicts of interest and source of funding: None.

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