

# Review of the Management Outcome of Slipped Capital Femoral Epiphysis and the Role of Prophylactic Contra-lateral Pinning Re-examined

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## Abstract

**Introduction:** Slipped capital femoral epiphysis is the most common hip problem in the adolescent age group. It can involve both hips, presenting itself bilaterally at first presentation or sequentially. The overall incidence of bilateral disease is variable, but the risk of occurrence is higher when there is underlying endocrinopathy, renal disease and obesity. **Materials and Methods:** Amongst the 36 cases (44 hips) of slipped capital femoral epiphysis that we had, there were 8 cases of bilateral disease, of which 3 were bilateral sequential slips. A retrospective review of all case records and X-rays was done. **Results:** According to Aadalén's criteria, the results were excellent or good in 37 hips, fair in 3 hips, and poor in 2 hips. Two patients were considered as treatment failure because of avascular necrosis. The incidence of bilateral slipped capital femoral epiphysis was 22.2%. The overall average age was 11.4 years. All cases of sequential involvement presented within 15 months of the initial slip. One patient had hypothyroidism (who also had a positive family history for slipped capital femoral epiphysis), while 91.6% were above the 75<sup>th</sup> percentile for weight. There was no statistically significant difference in age, sex, race, body mass index (BMI) and weight percentile distribution between patients with unilateral and bilateral disease. **Conclusion:** Satisfactory outcomes can be expected in most patients treated for slipped capital femoral epiphysis. The risk of avascular necrosis is higher in unstable slips. The role of prophylactic contra-lateral pinning should be restricted to patients with hypothalamic-pituitary-ovarian axis disease, especially hypothyroidism.

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**Key words:** Asian, Bilateral, Hypothyroidism

## Introduction

Slipped capital femoral epiphysis is the commonest hip problem in the adolescent age group.<sup>1,2</sup> The goals of treatment are aimed at avoiding the complications of osteonecrosis and chondrolysis, preventing further slips, and promoting physeal closure. The incidence of bilateral slipped capital femoral epiphysis is variable. The average incidence of bilaterality has been reported to be 46% (range 23% to 65%) overall.<sup>3</sup> This being the case, one of the controversial issues involving the management of slipped capital femoral epiphysis is that of prophylactic pinning of the contra-lateral hip in patients who have unilateral involvement on first presentation.

In this retrospective study, we examined the cases of bilateral slipped capital femoral epiphysis treated at our institutions, with a view to examining the role of prophylactic pinning of the contra-lateral hip in our local population.

## Materials and Methods

Forty patients with 48 involved hips were treated in KK Women's and Children's Hospital and Changi General

Hospital from 1997 till early 2006 for slipped capital femoral epiphysis. Four patients were lost to follow-up. There remained 36 patients with 44 hips who were suitable for our study. Twenty-seven were boys, while 9 were girls. Average follow-up duration was 37 months (range, 18 to 72). The average age of the patients was 11.4 years (range, 6 to 15). The average age of boys was 11.7 years (range, 6 to 15), while the average age of the girls was 10.4 years (range, 9 to 12). Twelve patients were Chinese, 7 were Malay, 16 were Indian, and 1 patient was Eurasian. Eleven hips were classified as acute (less than 3 weeks of symptoms), 17 hips were considered acute-on-chronic, while 16 hips were classified as chronic. Sixteen hips were unstable, while 28 hips were stable.<sup>4</sup> Thirty-two patients presented with hip pain, 2 patients with thigh pain, 7 patients with knee pain, 2 patients were asymptomatic, while 1 patient presented with gait abnormality. Prior history of trauma was present in 32 patients. Two patients had a positive family history of the disease. Overall, 1 patient had sub-clinical hypothyroidism, 11 patients were found to have impaired glucose tolerance, while 1 patient had idiopathic

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delayed puberty. Of the 36 patients, there were 8 cases of bilateral slips, comprising 22.2% of the patients. Treatment comprised a short duration of traction, followed by pinning in situ, or gentle manipulation followed by pinning in all but 1 patient. The implants used included cannulated screws, or Moore's pins. One patient presented with coxa vara after a previous slip, and required a subtrochanteric valgus derotational osteotomy. All case notes and radiological records of all our patients were examined.

Analysis for statistical significance was done using SPSS for Windows version 11.5. Comparison of categorical data was analysed using Fisher's exact test, given the small patient population. Likewise, for our data with continuous variables, the Mann-Whitney U test was used because of the small numbers in our series. Statistical significance was taken as a  $P$  value of  $\leq 0.05$ .

## Results

According to Aadalen's criteria,<sup>5</sup> the results were excellent or good in 37 hips, fair in 3 hips, and poor in 2 hips. Two patients were considered as treatment failure because of avascular necrosis (Table 1). Though these 2 patients presented with unstable slipped capital femoral epiphysis, there was no statistically significant difference in outcome on comparing the stable and unstable slips ( $P = 0.41$ ). This is most likely due to our small numbers. However, we note in the literature that unstable slips are at greater risk of avascular necrosis.<sup>4</sup> The first patient was an 11-year-old Indian boy, who sustained an acute, unstable, severe slipped right capital femoral epiphysis after a fall. This was treated with gentle reduction and pinning. Unfortunately, he presented with avascular necrosis of the right hip at 6 months of follow-up. His implants were removed as intra-articular penetration had resulted from the collapsed head. No further procedures were done. The last review at 52 months of follow-up showed that he had persistent hip pain with limitation of range of motion in the right hip. The second patient was an 11-year-old Chinese boy, who presented with a left-sided acute, unstable, mild slipped capital femoral epiphysis after a fall. He was treated with in-situ pinning of the left hip. He presented with left hip pain, and avascular necrosis 7 months after treatment. He first underwent screw exchange to a shorter screw in view of the joint penetration resulting from the collapsed head. He subsequently underwent a subtrochanteric osteotomy a

year later. His last review at 20 months of follow-up showed that he still had mild left hip pain, with limitation of left hip range of motion.

Five patients were found to have bilateral involvement at first presentation, while 3 patients presented with bilateral sequential slipped capital femoral epiphysis at the 7th, 13th and 15th months of follow-up respectively. These patients included 2 Chinese, 1 Malay and 5 Indians. There were 5 boys and 3 girls. The average age of patients was 10.9 years (range, 9 to 12). The average age of the girls was 10.7 years (range, 9 to 12), while the average age of the boys was 11 years (range, 10 to 12). One of the patients who suffered from bilateral sequential slipped capital femoral epiphysis was found to have subclinical hypothyroidism on endocrine screening. He also had a positive family history; his brother was also treated for unilateral slipped capital femoral epiphysis 4 months earlier. All the other patients had no significant thyroid problems, or abnormalities of the hypothalamic-pituitary-ovarian axis. The average body mass index (BMI) for this group of patients was 28.1 kg/m<sup>2</sup> (range, 20.5 to 33). All patients had body weights above the 75<sup>th</sup> percentile for their age, while 87.5% had body weights above the 90<sup>th</sup> percentile. The specific details of these patients are outlined in Table 2.

Of the 28 patients with unilateral involvement, there were 8 Chinese, 9 Malays, 11 Indians and 1 Eurasian. There were 19 boys and 6 girls. The average age was 11.6 years (range, 6 to 15). The average age of the girls was 10.3 years (range, 9 to 12), while the average age of the boys was 11.9 years (range, 6 to 15). The average BMI of the patients with unilateral involvement was 25.3 kg/m<sup>2</sup> (range, 19 to 33). Eight-nine per cent of these patients were above the 75<sup>th</sup> percentile for body weight, while 64.3% were above the 90<sup>th</sup> percentile.

On comparing the patient group with unilateral involvement against that with bilateral involvement, we could not find any statistically significant difference with regard to age, race, sex, BMI and weight percentiles. This may be due to the small numbers in our series. Our group of patients with bilateral disease was too small for statistical analysis. However, we note that there was a trend for patients with bilateral involvement to be Indian, and a larger percentage of patients to be above the 90<sup>th</sup> percentile for body weight.

Table 1. Management Outcome of Stable and Unstable Slipped Capital Femoral Epiphysis

|          | Outcome according to Aadalen's criteria <sup>5</sup> |      |      |      |         | Total |
|----------|------------------------------------------------------|------|------|------|---------|-------|
|          | Excellent                                            | Good | Fair | Poor | Failure |       |
| Unstable | 8                                                    | 4    | 1    | 1    | 2       | 16    |
| Stable   | 16                                                   | 9    | 2    | 1    | 0       | 28    |
| Total    | 24                                                   | 13   | 3    | 2    | 2       | 44    |

Table 2. Patients with Bilateral Slipped Capital Femoral Epiphysis

|   | Race | Sex | Time of 2nd slip | 1 <sup>st</sup> slip |          | 2 <sup>nd</sup> slip |          | Obesity/Endocrine Problems | Family history | Complications | Outcome   |
|---|------|-----|------------------|----------------------|----------|----------------------|----------|----------------------------|----------------|---------------|-----------|
|   |      |     |                  | Age                  | Severity | Age                  | Severity |                            |                |               |           |
| 1 | Ch   | M   | Sim              | 11                   | Mild     | 11                   | Mild     | Obese                      | Nil            | Nil           | Fair      |
| 2 | Ch   | M   | Seq              | 12                   | Mild     | 13                   | Mild     | Obese/IGT                  | Nil            | Nil           | Excellent |
| 3 | Ind  | M   | Sim              | 10                   | Moderate | 10                   | Mild     | Obese                      | Nil            | Nil           | Excellent |
| 4 | Ind  | M   | Sim              | 10                   | Mild     | 10                   | Mild     | Obese/IGT                  | Nil            | Nil           | Excellent |
| 5 | Mal  | F   | Sim              | 12                   | Mild     | 12                   | Mild     | Obese                      | Nil            | Nil           | Excellent |
| 6 | Ind  | F   | Sim              | 11                   | Mild     | 11                   | Mild     | Obese/IGT                  | Nil            | Nil           | Excellent |
| 7 | Mal  | F   | Seq              | 9                    | Mild     | 10                   | Mild     | Obese                      | Nil            | Nil           | Good      |
| 8 | Ind  | M   | Seq              | 12                   | Mild     | 13                   | Moderate | Obese/hypothyroidism       | Nil            | Nil           | Good      |

Ch: Chinese; IGT: impaired glucose tolerance; Ind: Indian; Mal: Malay; Sim: simultaneous slip; Seq: sequential slip

## Discussion

We achieved 84.1% of excellent or good outcomes in our patients. Both cases of avascular necrosis occurred in patients who had unstable slips, and this finding is consistent with the literature.<sup>4</sup> Interestingly, there was no case of chondrolysis in our series. Though we had only 8 patients with bilateral disease, this comprised 22.2% of all our patients. Five had presented with bilateral involvement at first presentation, while 3 presented sequentially. Jerre et al<sup>3</sup> noted in their review of 11 series, including a total of 1474 patients, the incidence of bilateral involvement on primary admission to be about 15% (range, 8% to 27%), with an average of 37% (range, 12% to 40%) of patients developing sequential bilateral disease. There was an average incidence of bilaterality of 46% (range, 23% to 65%) in total. Loder<sup>6</sup> reported a lower overall incidence of 22.3% of bilaterality across all races involved in a multicentre study. However, he noted the lowest incidence of bilaterality in Indonesian Malay children, where only 4% of the cases had bilateral involvement.<sup>6</sup> Our proportion of multiracial patients with bilateral involvement is comparable to previous studies, but it appears to be much higher than the subpopulation of Indonesian Malay children in our neighbouring country. In addition, there appears to be a trend towards more of the children with bilateral involvement being Indian, though there was no statistical difference in the number of slipped capital femoral epiphysis patients between the races.

All sequential slips presented within 18 months of the first slip. This is consistent with Loder's study, which shows that 88% of sequential slips presented within 18 months,<sup>6</sup> and Castro et al's<sup>7</sup> review of 18 studies including 395 patients who were found to have a 13-month average interval between index and contralateral slips.

Our findings in the group of patients with bilateral involvement are consistent with the literature, where the significant risk factors include the presence of endocrinopathies, renal disease and obesity.<sup>8-12</sup> The highest risk

is associated with hypothyroidism, where up to a 100% risk has been reported.<sup>9</sup> More recently, chronological age has also been shown to be a significant risk factor for contra-lateral involvement.<sup>13</sup> However, we have noted no significant difference in the age of presentation of both groups of patients, and this may again be attributable to our small numbers. Interestingly, our single patient with hypothyroidism who had bilateral slipped capital femoral epiphysis also had a younger brother, who presented to us 4 months earlier with a unilateral slip as well, but he had a normal endocrine work-up. This pair of brothers were the only patients we had who had any significant family history of note. Rennie<sup>14</sup> reported that familial slipped capital femoral epiphysis could occur with mainly autosomal dominant mode of inheritance with variable penetrance.

## Role of Prophylactic Pinning in our Population

Proponents of contra-lateral prophylactic pinning have included Hagglund,<sup>15</sup> who suggested the fixation of all contra-lateral hips, the reason being a total incidence of 61% of bilaterality in his series (sequential slip in 12% during adolescence and sequential slips in 40% detected during 16 to 66 years later), with 25% of patients in his series having osteoarthritis from untreated contra-lateral slips. MacLean and Reddy<sup>16</sup> also supported routine prophylactic pinning. In analysing 9 of 36 patients who presented with sequential slips, they concluded that the subsequent slip was unpredictable in timing and chronological age, and was often unstable.

Other authors who have proposed contra-lateral prophylactic pinning have been more selective. Rostoucher et al<sup>17</sup> advocated similar treatment for patients who were at risk, namely patients who had not yet reached puberty, the presence of an open physis and severe initial slips, and for everyone with bone age less than or equal to 12 for girls and 13 for boys. Barrios et al<sup>18</sup> suggested prophylactic pinning if an axial posterior sloping angle of the physis exceeded 12 degrees. Finally, both Loder et al<sup>8</sup> and Wells et al<sup>9</sup> advocated

prophylactic pinning only in patients with known endocrine disorders.

In contrast, other authors have completely opposed prophylactic contralateral pinning, particularly in view of the risks.<sup>19-21</sup> Castro et al<sup>7</sup> after reviewing 18 studies involving 395 patients, recommended against prophylactic pinning for the following reasons: firstly, about 80% of patients with unilateral slipped capital femoral epiphysis would eventually do well; secondly, the duration of close follow-up to detect the sequential contra-lateral slip was generally short (12 to 14 months); and finally, their ability to detect a contra-lateral slip was superior to their ability to predict which of the remaining patients would develop a further slip in view of physician follow-up and improved patient awareness. In our small series, we note a low incidence of endocrine disorders involving the hypothalamic-pituitary-ovarian axis in our patients (3.4%), although there was a high incidence of obesity, which is itself a risk factor. Given the heightened awareness of patients and the ease of follow-up in our country, we would generally advise close observation of these patients with unilateral slipped capital femoral epiphysis rather than prophylactically pinning the contra-lateral hip, in view of the risks of pinning a normal hip. However, we agree that should the patient be diagnosed with abnormalities of the hypothalamus-pituitary-ovarian axis, in particular hypothyroidism, prophylactic contra-lateral pinning should be seriously considered, given the extremely high incidence of bilateral involvement.

## Conclusion

Given our review of the current literature and the review of our experience in the treatment of bilateral slipped capital femoral epiphysis in the local setting, we would like to summarise our findings as such:

1. In both groups of patients with unilateral or bilateral involvement, female patients tend to present at an earlier age.
2. Excellent or good outcomes can be expected in most patients treated for slipped capital femoral epiphysis. However, the complication of avascular necrosis is more likely to occur in unstable slips.
3. Approximately 1 in 5 of our patients developed bilateral hip involvement, with the majority having bilateral involvement at first presentation.
4. Our overall incidence of bilaterality is more than 5 times higher than our Indonesian Malay neighbours.
5. We observed a trend towards a larger number of our patients being Indian. However, this was not statistically significant.
6. Our findings suggest that obese patients may be predisposed to bilateral involvement.
7. Sequential bilateral involvement occurred within 15 months of the first slip.
8. The role of prophylactic contra-lateral pinning should be restricted to patients with hypothalamic-pituitary-ovarian axis disease, especially hypothyroidism, in view of the extremely high risk of bilateral sequential involvement.
9. All other patients should be followed-up closely after treatment of the first slip, with careful education of the patient and family regarding the possibility of a contra-lateral sequential slip at a later date, prior to physeal closure.
10. The main limitation of our study was the small numbers in our series. A future study with a larger group of patients may yield greater understanding in the epidemiology, and the incidence of bilateral slipped capital femoral epiphysis in our population.

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