Increased time between diagnosis and surgery in slipped capital femoral epiphysis results in increased radiographic deformity

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Abstract

Purpose Previous work has examined the impact of delay of diagnosis in slipped capital femoral epiphysis (SCFE) but not the impact of delay in treatment after radiographic diagnosis. Due to requirements for long distance transportation from less developed regions for many of our patients, our hospital was able to study variation in time between diagnosis and surgery for SCFE, as related to slip severity.

Methods This is a retrospective review of patients treated for SCFE between 2005 and 2014 at a tertiary care paediatric hospital. Demographics, time between diagnosis and surgery, radiographic deformity (Southwick angle), postoperative complications and need for further surgery were variables of interest. Statistical analysis included Pearson and Spearman rank correlations and chi-squared tests.

Results The study sample included 147 hips (119 patients). Mean time between radiographic diagnosis and surgery was 20.9 days (SD 46, 0 to 321). The mean Southwick angle (SA) at the time of surgery was 31.9˚ (SD 19.6˚, 1˚ to 83˚). There was a significant relationship between increased delay and increased SA (0.34, p < 0.001). Increased SA was correlated with need for future significant surgery (0.27, p < 0.01).

Patients from less-developed regions, with barriers to timely care, had moderate and severe deformity (SA) (p < 0.001), and required significant further surgery more often than SCFE patients from the local population (p < 0.01

Conclusion The unique referral environment of our hospital provided an opportunity to examine traditional recommendations for treating SCFE promptly after radiographic diagnosis. Delay in treatment is correlated with increased radiographic deformity.

Level of Evidence III

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Keywords: Slipped upper femoral epiphysis; slipped capital femoral epiphysis; delay in treatment; hip deformity; Polynesia

Introduction

Slipped capital femoral epiphysis (SCFE) is a paediatric hip disorder characterized by displacement through the proximal femoral physis leading to variable degrees of deformity, pain and dysfunction.¹ The incidence of SCFE varies based on race and geography, between two to 13 per 100 000.¹,² Initial management of SCFE follows the recommendations of the major paediatric orthopaedic textbooks, namely that patients with suspected stable SCFE should be escorted to the radiology suite, preferably in a wheelchair, or, on a stretcher and, if the diagnosis is confirmed, admitted to hospital on bed rest until prompt surgical stabilization.¹ The rationale for prompt treatment is to prevent an increase in deformity and the progression from a stable to an unstable slip.

While this is a rational, common-sense approach, documentation in the literature of deformity progression or conversion to an unstable slip due to delay is limited.³,⁴ A delay in making the diagnosis has been shown to correlate with increased radiographic deformity (once the SCFE is diagnosed). However, such studies involved a retrospective review of often imprecise and incomplete medical records, and relied on patient and parent recollection of when groin, thigh, or knee pain began.³,⁶ No previous study looks at time to surgery after radiographic diagnosis of SCFE.

Our hospital serves two distinct populations – local patients from Hawaii and patients from the Pacific Basin, for
whom there is frequently a delay in surgical stabilization of SCFE after a firm radiographic diagnosis has been made. This delay is due to the requirement for long distance travel between Hawaii and Pacific Basin island nations, given access to care challenges for treating SCFE in their locales.

With a firm radiographic diagnosis of SCFE as a start point, this unique patient population provided an opportunity to assess the impact of increased time to surgical stabilization on proximal femoral deformity. Our hypothesis was what most paediatric orthopaedists believe, but what the literature has not yet shown well – that children with greater time intervals between diagnosis and treatment would have greater radiographic deformity at the time of surgery.

Materials and methods

Following institutional review board approval, the medical records of 125 patients (156 hips) surgically treated for SCFE between 2005 and 2014 were reviewed. All patient charts were reviewed one year after the last patient had been included in the sample. Bilateral cases were counted separately.

Inclusion criteria were: primary diagnosis of SCFE, age < 18 years at the time of surgery, sufficient documentation to determine the precise date of radiographic diagnosis and both preoperative and postoperative biplanar radiographs of the affected hip. Exclusion criteria included known endocrine disease, prophylactically pinned contralateral hips and patients with greater than one year between radiographic diagnosis of SCFE and surgery. Patients were stratified by residential location as either ‘local’ or from the Pacific Basin, a distinction based on differences in ease of access to surgical care.

Once patients were identified, demographic covariates, time between radiographic diagnosis and surgery, radiographic deformity or Southwick angle (SA), postoperative complications and need for both any future surgery and ‘significant’ further surgery, were defined. Time between radiographic diagnosis and surgery deserves further explanation as this truly represents the interval between a radiograph from which a diagnosis of SCFE is made, and surgical treatment. This is reflective of access to care issues for many patients in the Pacific Basin, for whom the diagnosis of SCFE can be made locally, but surgical treatment requires transportation often several thousand miles over sea to our hospital. Travel is by air and takes between four and twelve hours, however, for many patients is delayed for weeks or more due to the need for visas, obtaining a chaperone for children and various economic reasons.

‘Significant’ further surgery included procedures that could conceivably be more likely to be due to more severe deformity including intertrochanteric osteotomies (Southwick, Imhäuser), surgical hip dislocation with osteochondroplasty, with or without concomitant intertrochanteric osteotomy, hip arthroscopy, total hip arthroplasty and hip fusion. Procedures not included in this ‘significant’ category, but captured as ‘any future surgery’ included irrigation and debridement, hip arthrograms, screw removal and screw replacement. SA was assessed as a continuous variable, but also examined as an ordinal variable by defining slip severity as mild (SA < 30°), moderate (SA = 30° to 50°) and severe (SA > 50°).

Patient demographics, medical history and physical examination data were summarized using descriptive statistics. Student’s t-tests and chi-squared analysis examined the differences in the number of hips affected, age, laterality, weight and body mass index (BMI) between patients from Hawaii versus those from the Pacific Basin. Pearson correlational analysis assessed associations among the study variables of time from diagnosis to surgery, SA, BMI, weight, height and age at diagnosis. Spearman rank correlational analysis was used to assess time from diagnosis to surgery, SA, intraoperative complications, further surgery and significant further surgery.

Results

Nine hips were excluded due to greater than one year between diagnosis and surgical treatment. The study sample consisted of 147 hips (119 patients, 28 bilateral). Patient demographic information, stratified by geographic region, is presented in Table 1. For the sample, mean weight was 74.4 kg (sd 19.0) and mean BMI was 29.5 (sd 5.4). The majority of patients were of Hawaiian, or, other Polynesian heritage, as presented in Table 2. Five patients presented with unstable SCFE, as defined by Loder.3

Initial surgery included: 132 (89.8%) single cannulated screw, in situ fixation; five (3.4%) two cannulated screws, in situ fixation; seven (4.7%) single cannulated screw, in situ fixation and intertrochanteric osteotomy; two (1.4%) intertrochanteric osteotomy (physis fused); and one (0.7%) modified Dunn capital realignment.

The mean time between radiographic diagnosis and surgery was 20.9 days (sd 46, 0 to 321). The mean SA at time of in situ fixation was 31.9° (sd 19.6°, 1° to 83°). Slip severity was classified as mild, moderate or severe and

| Table 1 Demographic information of patients treated for slipped capital femoral epiphysis between 2005 and 2014 by location |
|--------------------------------------------------|
| Hawaii | Pacific Basin (non-Hawaii) | p-value* |
|---|---|---|
| Hips (n) | 76 | 71 |
| Mean age (yrs) | 11.7 (sp 1.7) | 12.2 (sp 2.1) | 0.07 |
| Laterality (L/R) | L:42 / R: 34 | L: 35 / R: 36 | 0.47 |
| Mean weight (kg) | 72.4 (sp 19.5) | 76.4 (sp 18.4) | 0.21 |
| Mean height (cm) | 155.2 (sp 11.1) | 160.1 (sp 10.2) | 0.007 |
| Mean body mass index | 29.5 (sp 5.5) | 29.3 (sp 5.4) | 0.83 |

*Student’s t-test: age, weight, height and body mass index; chi-squared: laterality
The impact of time from diagnosis to surgical stabilization was assessed. As severity of deformity increased, so too did time between diagnosis and stabilization. In 77 mild hips (SA < 30°) time to surgery was a mean of four days, in 44 moderate hips (SA = 30° to 50°) time to surgery was 13.5 days and in the 26 hips classified as severe (SA > 50°), time to surgery was a mean of 18 days.

There was a statistically significant relationship between SA and time between diagnosis and surgery (r = 0.34, p < 0.001). Time between diagnosis and surgery was not correlated with an increased need for either any future surgery, or, significant further surgery (as defined above). However, when patients who underwent initial intertrochanteric osteotomy were included in the significant future surgery group, there was a significant correlation between time and significant future surgery (r = 0.34, p < 0.001). SA was significantly related to need for significant further surgery (r = 0.27, p = 0.001), weight (r = 0.20, p = 0.04), height (r = 0.36, p < 0.001) and age at diagnosis (r = 0.37, p < 0.0001).

Patients from Hawaii were pooled and compared with those from the Pacific Basin. There was a significant difference in SA, with Hawaii patients presenting with a mean SA of 25.9° (SD 17.8°) as compared with 38.3° (SD 19.5°) in Pacific Basin patients (p < 0.0001). A significantly greater number of Pacific Basin patients presented with moderate and severe SA (p < 0.01) and required significant further surgery more frequently (p < 0.01). Time to surgery differed significantly as patients from Hawaii had a mean 7.3-day delay (SD 14.5) as compared with 35.5 days (SD 61.4) from the Pacific Basin (p = 0.0003).

Of the five unstable SCFE treated, one was a previously stable slip that progressed. This was a local patient diagnosed at an outside facility who presented to our hospital 45 days after initial diagnosis when he became unable to weight-bear.

Discussion

The unique outreach and referral environment of our hospital provided an opportunity to further examine present recommendations for treating SCFE. Our hospital is a referral centre for children throughout the Pacific Basin, as well as serving primarily the more socio-economically disadvantaged portions of Hawaii’s population. The majority of patients treated and examined in this study are of Polynesian descent, which is a group that has been identified to have the highest incidence of SCFE of any racial group and which also grew at four times the rate of the general population in the United States between 2000 and 2010. Nearly 50% of the hips treated in this study represent patients radiographically diagnosed with SCFE in an environment in the Pacific Basin, in which the standard of prompt surgical treatment cannot currently be met in all locales. Due to transportation and logistical challenges such as acquiring visas, there is often a significant delay between diagnosis and arrival at our hospital for surgical stabilization.

The strongest motivator in recommending hospital admission and prompt surgical stabilization of SCFE is to prevent the progression of a stable SCFE to one which is unstable, with the consequent increased risk of a poor outcome accompanying loss of stability. Loder et al reported avascular necrosis developing in 14 of 30 (47%) hips that were reclassified as unstable SCFE, but none among the stable hips. However, the literature contains few cases of progression to loss of stability after diagnosis has been made, with the first from more than 50 years ago and the second being a case report of two patients. In the latter study, both patients did well despite slip progression.

The current study, in a group of patients with substantial mean delay, adds one more such case, although we cannot comment on the long-term outcome of the patient, who was lost to follow-up.

The risk of a SCFE maintaining stability, but progressing in terms of deformity, is difficult to determine. Ordeberg et al reported that there is always a risk of progression as long as the physis remains open. In a report on the natural history of SCFE patients, Carney et al reviewed 36 hips that received symptomatic nonoperative treatment consisting of bed rest, crutch ambulation or no treatment. Displacement progressed in six hips (17%), five of which were severe, while 11 developed an ‘acute-on-chronic’ SCFE progressing to severe displacement requiring surgical stabilization.

More recently, two studies have revealed a significant correlation between delay in diagnosis and increased slip severity. Kocher et al studied 196 patients with a median delay in diagnosis of eight weeks, and determined that increasing delay in diagnosis was associated with increased slip severity. In another study, Rahme et al defined delayed diagnosis as those patients with greater than two weeks delay after the first presentation to a healthcare professional. A higher proportion of SCFE with greater severity were found in the ‘delayed diagnosis’ group.

Kocher’s study excluded 90 patients during the study period for whom the duration of antecedent symptoms prior to diagnosis was not identified, which highlights the challenges of performing a retrospective study that has to rely on varying degrees of accuracy regarding medical charting and patients’ recall of when symptoms began. In
Delay in stabilization increases deformity in SCFE

Epidemiology of slipped capital femoral epiphysis in a population's particular susceptibility to this disorder. Our geographic region contains a population particularly vulnerable to SCFE, with a large Polynesian contingent. This population’s susceptibility to SCFE is highlighted by the mean weight (74.4 kg) and BMI (29.5) of our cohort, which is easily the heaviest thus far presented in the literature. Interestingly, we found that weight was predictive of increased deformity but BMI was not.

There are several weaknesses to this study including its retrospective nature, incomplete follow-up and inability to review the radiographs that were obtained at the time of initial diagnosis. Subjects primarily came from many resource-limited Pacific Basin islands and obtaining original diagnosis radiographs was not possible. The lack of follow-up does not impact the finding that the Southwick angle preoperatively was statistically significantly correlated with increased time between diagnosis and surgery. However, it certainly detracts from the validity of our finding that increased time to surgery was not correlated with the need for future significant surgery. This is particularly true given that other studies have identified that degree of long-term disability is generally correlated with severity of deformity, and that long-term follow-up studies have shown one-quarter of SCFE patients requiring total hip arthroplasties at 30 to 40 years of age. When we included patients who underwent initial intertrochanteric osteotomy in the significant future surgery, as is logical, there was a statistically significant correlation between time to surgery and need for significant future surgery.

Our study provides support that traditional orthopaedic recommendations are correct, that is, delay in treatment of SCFE is associated with increased radiographic deformity. Most paediatric orthopaedists have assumed this to be true, but supporting data is surprisingly sparse. While previous studies rely on patient recall of length of symptoms, determination of ‘delay’ in this study begins from the time of radiographic diagnosis of SCFE. In addition, this work highlights the continued challenges in accessing timely care for patients in less-developed regions, the majority of which, in this study, were American Territories. Ongoing work has begun to improve outcomes for SCFE in these regions and define the natural history of potentially undiagnosed, untreated (as well as treated) SCFE, given the population’s particular susceptibility to this disorder.

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REFERENCES
1. Herring JA. SCFE. Tachdjian’s pediatric orthopaedics. Vol 1. 4th ed. Philadelphia: Elsevier, 2008: chapter 18.
2. Weinstein SL, Flynn JM. SCFE. Lovell and Winter’s Pediatric Orthopaedics. Vol 2. 7th ed. Philadelphia: Lippincott, Williams & Wilkins, 2014: chapter 25.
3. Birch JG. Slipped capital femoral epiphysis: still an emergency. J Pediatr Orthop 1987;7:334-337.
4. Hall JE. The results of treatment of slipped femoral epiphysis. J Bone Joint Surg (Br) 1957;39-B:659-673.
5. Kocher MS, Bishop JA, Weed B, et al. Delay in diagnosis of slipped capital femoral epiphysis. Pediatrics 2004;113:622-625.
6. Rahme D, Comley A, Foster B, Cundy P. Consequences of diagnostic delays in slipped capital femoral epiphysis. J Pediatr Orthop B 2006;15:93-97.
7. Loder RT, Richards BS, Shapiro PS, Reznick LR, Aronson DD. Acute slipped capital femoral epiphysis: the importance of physeal stability. J Bone Joint Surg [Am] 1993;75-A:1134-1140.
8. Phadnis J, Phillips P, Willoughby R. The epidemiologic characteristics of slipped capital femoral epiphysis in Maori children. J Pediatr Orthop 2012;32:510-514.
9. Stott S, Bidwell W. Epidemiology of slipped capital femoral epiphysis in a population with a high proportion of New Zealand Maori and Pacific children. N Z Med J 2003;116.U647.
10. US Census Bureau. The Native Hawaiian and Other Pacific Islander Population: 2010. (Report No. C2010B2-12). www.Census.gov/prod/cen2010/briefs/c2010br-12.pdf (date last accessed 06 April 2018).
11. Ordeberg G, Hansson LI, Sandström S. Slipped capital femoral epiphysis in southern Sweden. Long-term result with no treatment or symptomatic primary treatment. Clin Orthop Relat Res 1984;191:95-104.
12. Carney BT, Weinstein SL, Noble J. Long-term follow-up of slipped capital femoral epiphysis. J Bone Joint Surg [Am] 1991;73-A:662-674.
13. Wensaaas A, Svenningsen S, Terjesen T. Long-term outcome of slipped capital femoral epiphysis: a 38-year follow-up of 66 patients. J Child Orthop 2011;5:75-82.

COMPLIANCE WITH ETHICAL STANDARDS

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ETHICAL STATEMENT
Ethical approval: Institutional review board approval was obtained for this study. Informed consent: Because of its retrospective nature, the need for informed consent was waived.

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