

Delay in Diagnosis of Slipped Capital Femoral Epiphysis

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ABSTRACT. *Objective.* Delay in diagnosis of slipped capital femoral epiphysis (SCFE) has important implications in terms of slip severity and long-term hip outcome. The purpose of this study was to identify predictors of delay in the diagnosis of SCFE.

Methods. A review of 196 patients with SCFE was performed. The primary outcome measure was delay from onset of symptoms to diagnosis. Covariates included age, gender, side, weight, pain location, insurance status, family income, slip severity, and slip stability. Delay in diagnosis was not normal in distribution; therefore, nonparametric univariate and multivariate analyses were performed.

Results. The median delay in diagnosis was 8.0 weeks. There was a significant relationship between delay in diagnosis and slip severity (<30°: 10.0 weeks; 30° to 50°: 14.4 weeks; >50°: 20.6 weeks). There were no significant associations between delay in diagnosis and covariates of age, gender, side, and weight. There were significant associations between longer delay in diagnosis and covariates of knee/distal-thigh pain versus hip/proximal-thigh pain (6.0 vs 15.0 weeks), Medicaid coverage versus private insurance (12.0 vs 7.5 weeks), lower family income, and stable slips versus unstable slips (8.0 vs 6.5 weeks). Controlling for the other covariates, knee/distal-thigh pain, Medicaid insurance, and stable slips remained significant independent multivariate predictors of delay in diagnosis.

Conclusions. Patients who present with primarily knee or distal-thigh pain, patients with Medicaid coverage, and patients with stable slips have longer delays in diagnosis of SCFE. Focused intervention programs to reduce the delay in diagnosis of SCFE should emphasize patients with knee/thigh pain and patients with Medicaid coverage. *Pediatrics* 2004;113:e322–e325. URL: <http://www.pediatrics.org/cgi/content/full/113/4/e322>; *slipped capital femoral epiphysis, hip disorders, diagnosis, Medicaid.*

ABBREVIATION. SCFE, slipped capital femoral epiphysis.

Delay in diagnosis of slipped capital femoral epiphysis (SCFE) in the pediatric and adolescent hip has important implications in terms of long-term hip outcome. Delayed diagnosis is associated with increased slip severity.¹ Increased slip

severity is associated with a higher risk of short-term complications from treatment such as avascular necrosis and chondrolysis.^{2–7} Increased slip severity is also associated with poorer long-term outcome including pain, limitation of motion, and degenerative joint disease.^{6–10} The burden of disease from SCFE may be substantial, because it is estimated that a relatively large percentage of adult hip osteoarthritis stems from sequelae of pediatric hip disease.¹¹

The purpose of this study was to identify predictors of delay in diagnosis of SCFE. Our hypotheses were that delay in diagnosis was associated with increased slip severity and that specific covariates were associated with delay in diagnosis.

MATERIALS AND METHODS

Patients treated at a tertiary-care children's hospital for SCFE from 1988 to 2002 were identified from a computerized database. Institutional review board approval for medical record review was obtained. A retrospective review of medical records was performed. Patients with known risk factors for SCFE, such as endocrinopathy, renal disease, or previous radiation therapy, were excluded ($n = 23$). Patients without a time interval of symptoms documented in the medical record were excluded ($n = 90$). Cases of stable (able to bear weight or limp) SCFE and acute on chronic (>3 week) unstable (unable to bear any weight) SCFE were included. For cases of bilateral, nonsimultaneous SCFE, only the presentation of the first slip was studied. The study population comprised 196 slips in 196 patients.

The primary outcome measure was delay from onset of symptoms to diagnosis, measured in weeks. Symptoms included pain, limp, or gait disturbance.

Covariates included age, gender, side, weight, pain location, insurance status, family income, slip stability, and slip severity. Pain location was categorized as primarily hip/proximal thigh or primarily knee/distal thigh. Insurance status was categorized as Medicaid coverage or private insurance. The types of private insurance were not differentiated. Family income was extrapolated from 2002 US Census Bureau data for per capita family income based on street-level data. Slip stability was defined per Loder et al¹² based on ability to bear weight (stable) versus inability to bear weight (unstable). Slip severity was determined based on the difference of the head-shaft angle between the 2 sides from the anteroposterior radiograph as described by Southwick¹³ and was categorized as <30°, 30° to 50°, and >50°.

The delay in diagnosis of SCFE (in weeks) was nonparametrically distributed (Fig 1) (skewness: 3.09; kurtosis: 11.36; Kolmogorov-Smirnov test: $P < .001$). Therefore, nonparametric univariate and multivariate analyses were performed. Descriptive data were summarized by using median and interquartile distance. Differences in delay in diagnosis for continuous covariates was determined by using Spearman's rho, for dichotomous covariates by using the Mann-Whitney U test, and for ≥ 3 categorical covariates by using the Kruskal-Wallis test. Multivariate analysis was performed to identify independent determinants of delay in diagnosis by using a stepwise, multiple linear regression model with backward selection. Collinearity and residual diagnostics were performed. The coefficient of multiple determination (adjusted R^2) was used to indicate how much of the variability in patient satisfaction was accounted for by the determinants in the final multiple

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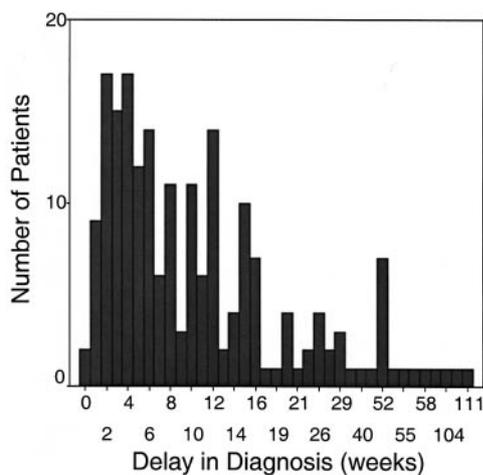


Fig 1. Nonparametric distribution of delay in diagnosis of SCFE.

linear regression model. Statistical analysis was performed by using SPSS 10.0 (SPSS Inc, Chicago, IL) and SAS 6.12 (SAS Institute Inc, Cary, NC) software packages. All reported *P* values are 2-tailed, with an α level of .05, indicating statistical significance. Institutional review board approval was obtained before commencing this study.

RESULTS

The median delay in diagnosis was 8.0 weeks (range: 0–111; interquartile distance: 4.0–8.0).

Descriptive covariate data (mean or percentage) of the study population were: age (12.5 years), gender (54.8% male), side (59.5% left), weight (67.6 kg), pain location (hip/proximal thigh: 74.2%; knee/distal thigh: 25.8%), insurance status (private: 80.0%; Medicaid: 20.0%), family income (\$35 646), slip stability (stable: 84.7%; unstable: 15.3%), and slip severity (<30°: 53.8%; 30°–50°: 28.0%; >50°: 18.1%).

Patients with stable SCFE had a median delay in diagnosis of 8.0 weeks. Patients with acute on chronic unstable SCFE had a median delay in diagnosis of 6.5 weeks, with a median duration of unstable status of 0.6 weeks.

There was a significant relationship between longer delay in diagnosis and greater slip severity (Fig 2) (<30°: 10.0-week median; 30°–50°: 14.4-week median; >50°: 20.6-week median; *P* = .013).

There were no significant associations between delay in diagnosis and covariates of age (Spearman's ρ = .126; *P* = .078), gender (male: 8.0-week me-

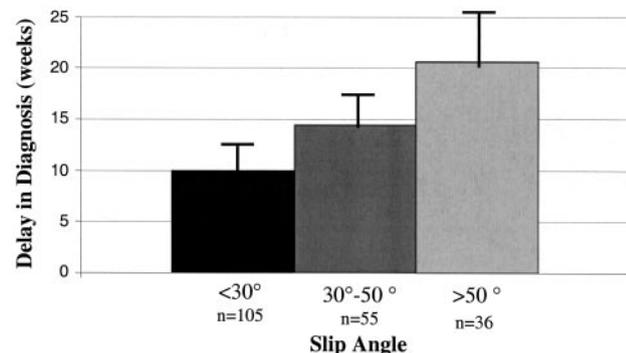


Fig 2. Delay in diagnosis for slip severity (the histogram represents median values, and bars represent the 95% confidence intervals).

dian; female: 8.0-week median; *P* = .999), side (right: 8.0-week median; left: 8.0-week median; *P* = .969), and weight (Spearman's ρ = .137; *P* = .061).

There were significant associations between longer delay in diagnosis and covariates of knee/distal-thigh pain (hip/proximal-thigh pain: 6.0-week median; knee/distal-thigh pain: 15.0-week median; *P* < .001) (Fig 3), Medicaid coverage (Medicaid insurance: 12.0-week median; private insurance: 7.5-week median) (Fig 4), family income (Spearman's ρ = -.200; *P* = .007) (Fig 5), and stable slips (stable slip: 8.0-week median; unstable slip: 6.5-week median; *P* = .010).

Controlling for the other covariates in the multivariate analysis, knee/distal-thigh pain (*B* = 0.185; *P* = .013), Medicaid coverage (*B* = 1.72; *P* = .024), and stable slips (*B* = 0.239; *P* = .001) remained significant independent predictors of delay in diagnosis (model-adjusted R^2 = 0.274).

CONCLUSIONS

In this study of 196 SCFE treated at a tertiary-care children's hospital, the median delay in diagnosis was 8.0 weeks. Longer delay in diagnosis was associated with greater slip severity. Longer delays in diagnosis were identified in patients with primarily knee/distal-thigh pain (compared with those with primarily hip/proximal-thigh pain), in patients with Medicaid coverage (compared with those with private insurance), and in patients with stable slips (compared with those with unstable slips).

Limitations of this study include potential selection bias and the operational definition of some covariates. Because of the tertiary-care nature of the study setting, cases with greater delays in diagnosis and greater slip severity may have been preferentially selected. Because of the retrospective nature of this study, the primary outcome measure and covariate definitions were limited by the quality of available data in the medical record. Patients without a documented delay in diagnosis in terms of days or weeks were excluded. Delay in diagnosis was determined from patient and family recall of the onset of symptoms, as recorded in the medical record. The onset of symptoms in SCFE can be vague and subtle. Therefore, recall of the onset of symptoms by the patient and family may be imprecise. Pain location

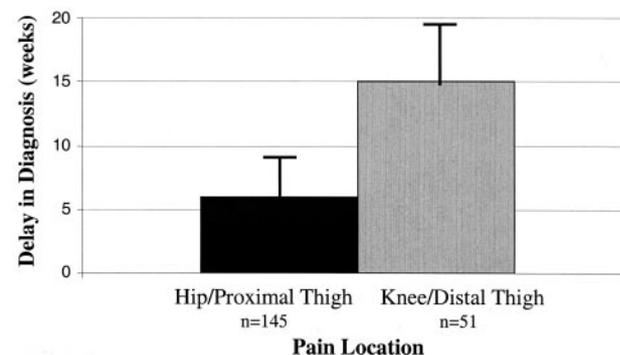


Fig 3. Delay in diagnosis for pain location (the histogram represents median values, and bars represent the 95% confidence intervals).

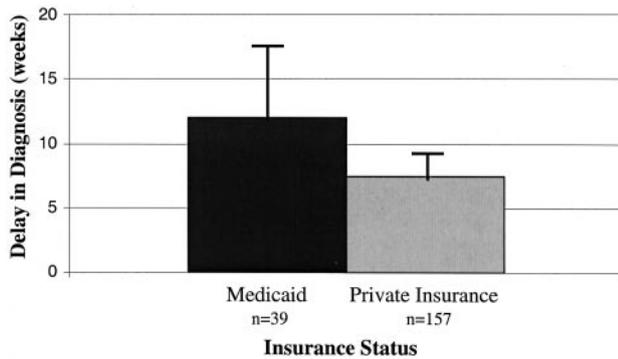


Fig 4. Delay in diagnosis for insurance status (the histogram represents median values, and bars represent the 95% confidence intervals).

was categorized as primarily hip/proximal thigh or primarily knee/distal thigh, as recorded in the medical record. The location of pain in SCFE can also be vague and variable; thus, the specific categorization to hip/proximal thigh versus knee/distal thigh may also be imprecise. Family income was determined from US Census Bureau data based on zip code. More-precise methods of per capita income exist, including street- and block-level data.

The demographics of patients in this study are similar to other reports. In this study, the mean patient age was 12.5 years, 54.8% of patients were male, 59.5% of slips involved the left hip, 84.7% of slips were stable, and 21.9% were acute (≤ 3 weeks of symptoms). In a multicenter study of 1993 slips reported by Loder,¹⁴ the mean patient age was 12.9 years, 58.8% of patients were male, 59.7% of slips involved the left hip, and 14.5% were acute.

Other studies have also identified knee or thigh pain as a risk factor for delay in diagnosis compared with thigh pain for SCFE.^{1,3,8-10,15,16} In comparing 15 SCFE patients with distal-thigh or knee pain to 50 SCFE patients with hip or proximal-thigh pain, Matava et al¹ found that those patients with knee or distal-thigh pain were more likely to receive a misdiagnosis, undergo unnecessary radiographs, and have greater slip severity. In addition, there was a trend to a longer delay in diagnosis (8.3 vs 6.5

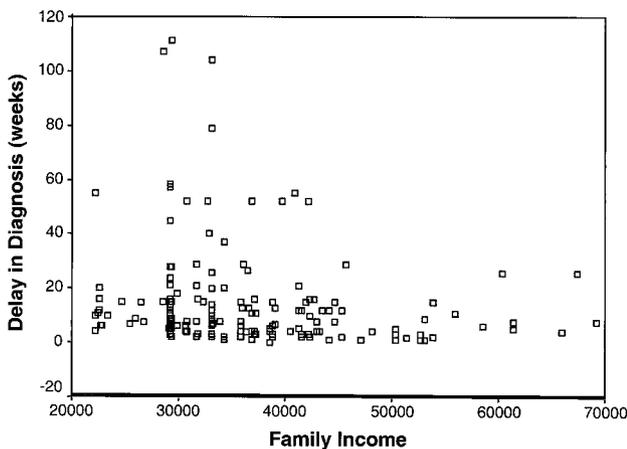


Fig 5. Scatter plot of delay in diagnosis for per capita family income (the histogram represents median values, and bars represent the 95% confidence intervals).

months). In a study of 116 patients with SCFE by Ledwith and Fleisher,¹⁶ a missed diagnosis of SCFE was more likely if hip pain was absent or thigh pain was present.

A quicker diagnosis in patients with acute or chronic unstable SCFE is intuitive, because these patients present with more-severe symptoms of pain and with the inability to bear weight. In this series, the median delay of diagnosis in acute or chronic unstable slips was 6.5 weeks with a median duration of unstable status of 0.6 weeks. Hence, a delay in diagnosis of SCFE has substantial implications, because the patient may progress from a stable slip to an unstable slip during this period, thus increasing the risk of poor outcome from avascular necrosis.¹²

Medicaid patients had greater delays in diagnosis than patients with private insurance, even controlling for family income in the multivariate analysis. Other studies also have documented that children with Medicaid coverage have poorer quality and timeliness of care.¹⁷⁻²⁰ Bratten et al¹⁷ found that children with Medicaid had a significantly higher chance of having complications related to the diagnosis and treatment of appendicitis. Newacheck et al^{18,19} have shown that lack of insurance is associated with lack of access to timely pediatric care. Skaggs et al²⁰ reported on limited access to a timely orthopedic appointment for a hypothetical child with a broken arm, comparing MediCal to private-insurance scenarios. In another report, Skaggs et al²¹ identified 6 children with MediCal with a delayed diagnosis of SCFE. The longer delay in diagnosis in Medicaid patients seen in this study may represent differential access to care, quality of care, timeliness of care, or health care-seeking behavior.

The diagnosis of SCFE can be difficult, because early symptoms can be mild, radiographic diagnosis from anteroposterior radiographs in cases of mild slips can be subtle, and symptoms can be localized to the distal thigh or knee.^{1,8,15,16,22} The implications of a delay in diagnosis of SCFE are profound, because delay is associated with greater slip severity, and greater slip severity is associated with higher risk of short-term treatment complications and poorer long-term hip outcome, including degenerative joint disease.¹⁻¹¹ Focused intervention programs to reduce the delay in diagnosis of SCFE should emphasize patients with knee/thigh pain and patients with Medicaid coverage. Such programs could improve the diagnosis of SCFE by emphasizing the importance of symptoms of hip, thigh, or knee pain in adolescents and by reviewing the need for physical examination of the hip and appropriate radiographic views. Differential access to quality and timely care for children with Medicaid is a major public health issue that demands attention from physicians, policy makers, legislators, and the public.

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