Pediatric Hip Fractures in California: Results from a Community-Based Hip Fracture Registry

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ABSTRACT

Context: Hip fracture registries offer an opportunity to identify and to monitor patients with rare conditions and outcomes, including hip fractures in pediatric patients.

Objective: To report patient demographics and surgical outcomes of pediatric patients treated surgically for hip fractures in a large integrated health care system.

Design: Pediatric patients (< 21 years old at the time of fracture) with hip fractures were identified between 2009 and 2012 using our health care system's hip fracture registry.

Main Outcome Measures: Patient characteristics, type of fracture, surgical treatment, and short-term complications.

Results: Among 39 patients identified, 31 (79.5%) were male, and the median age was 15 years old (interquartile range: 11-17 years). Most patients were Hispanic (n = 17, 43.6%) or white (n = 14, 35.9%). There were 8 patients (20.5%) with 15 comorbidities. Delbet Type IV (intertrochanteric) fractures were the most common fracture type (n = 22, 56.4%), and fixation method was equally distributed between intramedullary, screw and sideplate, and screws (n = 12, 30.8% for each). Most surgeries were performed by medium-volume surgeons (n = 22, 56.4%) at medium- and high-volume hospitals (n = 37, 94.9%). Three 90-day readmissions (7.7%), 1 infection (2.6%), 1 malunion (2.6%), and 1 revision (2.6%) were observed in this cohort during the study period.

Conclusion: In our series using registry data, hip fractures younger than age 21 years were more common in boys and Hispanic patients. Intertrochanteric fractures (Delbet Type IV) were the most frequently observed type in our community-based hip fracture registry. Short-term complications were infrequent.

INTRODUCTION

Hip fractures in the pediatric population, defined here as infants, children, and adolescents younger than age 21 years, are rare, comprising less than 1% of all fractures in this age group.^{1,2} The primary mechanism for hip fractures in this age group is that of high-energy trauma, but pathologic fractures can also occur.² The risk of complication and lifelong disability from hip fracture is high. As a result of anatomical differences, complications observed in pediatric patients with hip fracture tend to differ

from those in adults, making this specific patient population and proper surgical management important to characterize.¹⁻⁵ With only single-institution case series available in the literature, the need exists for large, multicenter studies to allow for the proper sample size required to evaluate best treatment practices and hip fracture outcomes in pediatric patients.⁶⁻⁹

Hip fracture registries offer an opportunity to identify and to monitor patients with rare conditions and outcomes,¹⁰ including hip fractures in pediatric patients. Therefore, we used data from a hip fracture registry to identify a cohort of pediatric patients who had a hip fracture. The purpose of this descriptive article is to report preliminary patient demographics and short-term surgical outcomes of this rare patient population.

METHODS

Setting and Population

The Kaiser Permanente (KP) Hip Fracture Registry is a tool for monitoring hip fracture cases in our integrated health care system, which includes 6.9 million members in California. The KP population is demographically and socioeconomically representative of the general California population.^{11,12} Details on the data collection mechanisms, definitions, and coverage of the hip fracture registry have been previously published.¹⁰ In brief summary, the registry uses electronic medical records and administrative datasets to identify hip fractures in the health care system. Postoperative surgical outcomes are validated using a combination of manual chart review by trained clinical experts and diagnosis codes from the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM).¹³

Patients with hip fracture younger than age 21 years with primary surgeries performed in Northern and Southern California between January 2009 and December 2012 were included in the study sample. Patients with pathologic fractures or slipped capital femoral epiphysis were not included. This study was approved by the institutional review board (no. 6375) before its commencement.

Patient Characteristics and Outcomes

This report describes patient characteristics, including age, sex, body mass index, and race. Additionally, surgical characteristics such as time to surgery, fracture type, fixation type, comorbidities,

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fellowship training, surgeon volume, and hospital volume were described. Fracture type was classified according to the 4-part system described by Delbet: Type I, transepiphyseal separation; Type II, nondisplaced or displaced transcervical fracture; Type III, nondisplaced or displaced cervicotrochanteric fracture; and Type IV, intertrochanteric fracture.¹⁴ Surgeon volume was categorized as low (< 10), medium (10-29), and high ($\geq$ 30) on the basis of average number of surgical procedures performed annually. Hospital volume was categorized as low (< 60), medium (60-129), and high ($\geq$ 130) on the basis of average number of surgical procedures performed annually.

Short-term outcomes of interest described for this series included mortality, all-cause readmission, revision, deep venous thrombosis, dislocation, myocardial infarction, pneumonia, pressure ulcer, pulmonary embolism, and deep surgical site infection. Malunion, nonunion, and avascular necrosis also were described.

Statistical Analysis

Descriptive statistics, including frequencies, proportions, means, standard deviations, medians, interquartile ranges (IQR), and ranges, were computed using SAS Version 9.4 (SAS Institute, Cary, NC). Crude complication rates for all outcomes were provided as proportions of events, with the total pediatric hip fracture population included as the denominator.

RESULTS

Thirty-nine pediatric patients with hip fractures meeting the inclusion criteria were identified during the study period (Table 1). Most patients were male ($n = 31$, 79.5%), and the median age was 15 years old (IQR = 11.0 to 17.0 years). The median body mass index was 20.0 kg/m² (IQR = 18.3 to 23.2 kg/m²). Hispanic patients comprised the majority of this cohort ($n = 17$, 43.6%), followed by whites as the next largest racial/ethnic group ($n = 14$, 35.9%). Most fractures occurred on the right side ($n = 21$, 53.8%). Fracture types were as follows: Type IV ($n = 22$, 56.4%), Type III ($n = 8$, 20.5%), Type II ($n = 5$, 12.8%), and femoral head ($n = 4$, 10.3%). Median time from admission to operation was 10.8 hours (IQR = 3.6 to 18.5). Fixation was as follows: intramedullary ($n = 12$, 30.8%), screw and sideplate ($n = 12$, 30.8%), screw only ($n = 12$, 30.8%), and open fixation ($n = 2$, 5.1%); 1 patient (2.6%) had no internal fixation. At least 1 comorbidity was present in 8 patients (20.5%); the most common comorbidities were chronic pulmonary disease ($n = 4$, 10.3%) and obesity ($n = 3$, 7.7%).

Procedures were performed by 34 surgeons in 19 Medical Centers; see Table 2 for a description of surgeon and hospital characteristics. Of the 39 hip fractures identified, 6 were treated by surgeons who had prior fellowship training (15.4%). Most surgeries were performed by medium-volume surgeons (10-29 cases per year, $n = 22$, 56.4%) and at high-volume hospitals ($\geq$ 130 cases per year, $n = 20$, 51.3%).

The crude 90-day readmission rate was 7.7% ($n = 3$) and the rate of deep surgical site infections was 2.6% ($n = 1$). There were 1 malunion (2.6%) and 1 aseptic revision (2.6%) during the study period postoperatively. No other complications were observed for this cohort (Table 3).

Table 1. Study sample patient characteristics after hip fracture surgery, January 2009 to December 2012 (N = 39)

Characteristic	No. (%) ^a
Age (years)	
Mean (SD)	14.5 (4.1)
Median (IQR)	15.0 (11.0-17.0)
Range	6.0-21.0
Sex	
Male	31 (79.5)
Female	8 (20.5)
Body mass index (kg/m²)^b	
Mean (SD)	21.3 (5.1)
Median (IQR)	20.0 (18.3-23.2)
Range	13.0-34.8
Race/ethnicity	
Asian	2 (5.1)
Black	4 (10.3)
White	14 (35.9)
Hispanic	17 (43.6)
Other/multiracial	1 (2.6)
Not documented	1 (2.6)
Side of fracture	
Left	18 (46.2)
Right	21 (53.8)
Fracture type	
Type IV	22 (56.4)
Type III	8 (20.5)
Type II	5 (12.8)
Femoral head	4 (10.3)
Time to surgery (hours)^c	
Mean (SD)	15.5 (27.5)
Median (IQR)	10.8 (3.6-18.5)
Range	0.4-166.2
Fixation type	
Intramedullary	12 (30.8)
Screw and sideplate	12 (30.8)
Screws	12 (30.8)
Open fixation	2 (5.1)
No internal fixation	1 (2.6)
Comorbidities	
No. of patients with at least 1 comorbidity	8 (20.5)
Chronic pulmonary disease	4 (10.3)
Obesity	3 (7.7)
Deficiency anemias	2 (5.1)
Alcohol abuse	1 (2.6)
Chronic blood loss anemia	1 (2.6)
Drug abuse	1 (2.6)
Other neurologic disorders	1 (2.6)
Paralysis	1 (2.6)
Weight loss	1 (2.6)

^a Data are presented as no. (%) except in age, body mass index, and time to surgery categories.

^b One patient (2.5%) was missing data on body mass index.

^c Four patients (10.0%) were missing data on time to surgery. IQR = interquartile range; SD = standard deviation.

DISCUSSION

Hip fractures in the pediatric population are rare, and the rate of complications is low, as evidenced by the hip fractures identified in this large integrated health care system during a four-year study period. Most published single-institution reports include only a limited number of pediatric patients with hip fracture over many years, making identification of an appropriate cohort for the study of predictors for complications and optimal standardized treatment nearly impossible. We present what we believe is the first report using registry data to describe a fully captured pediatric hip fracture population in an integrated health care system.

Most of the pediatric patients in this report were male, older, and Hispanic. Boys represented the large majority of the population, in line with other previously published reports.^{2,3,6,15} Although our cohort's median age was older at 15 years compared with that in other studies, this finding is most probably because of a broader age range for our inclusion criteria (0-21 years) rather than any actual difference in our patient population.

Table 2. Characteristics of surgeon and hospital for study sample patients after hip fracture surgery, January 2009 to December 2012 (N = 39)

Characteristic	No. (%)
Surgeon had fellowship training	
Yes	6 (15.4)
No	15 (38.5)
Unknown	18 (46.2)
Surgeon volume category (average per year)	
Low (< 10)	10 (25.6)
Medium (10-29)	22 (56.4)
High (≥ 30)	7 (17.9)
Hospital volume category (average per year)	
Low (< 60)	2 (5.1)
Medium (60-129)	17 (43.6)
High (≥ 130)	20 (51.3)

Table 3. Ninety-day quality outcomes after hip fracture surgery in pediatric patients, January 2009 to December 2012 (N = 39)

Complication	No. (%)
No. of patients with at least 1 complication ^a	5 (12.8)
Readmission	3 (7.7)
Malunion	1 (2.6)
Aseptic Revision	1 (2.6)
Surgical site infection (any)	1 (2.6)
Deep vein thrombosis	0 (0.0)
Dislocation	0 (0.0)
Mortality	0 (0.0)
Myocardial infarction	0 (0.0)
Pneumonia	0 (0.0)
Pressure ulcer	0 (0.0)
Pulmonary embolism	0 (0.0)

^a One patient experienced 2 complications.

Most pediatric patients in the report were nonwhite (61.6%), and the greatest proportion of hip fractures was observed in Hispanic patients (43.6%). To our knowledge, this is the first report including race and ethnicity data, contributing to the currently limited literature describing this uncommon patient population. Similarly, this is the first series of which we are aware to include data on comorbid conditions, most likely because the pediatric population is healthier overall. Few patients in our series had any comorbidities (20.5%), with the most frequent being chronic pulmonary disease (10.3%).

Most of the fractures were intertrochanteric fractures (Delbet Type IV, 56.4%). This observation is in contrast to prior reports identifying nondisplaced or displaced transcervical fractures (Delbet Type II) as the most common hip fracture type in the pediatric population, followed by nondisplaced or displaced cervicotrochanteric fractures (Delbet Type III), then intertrochanteric fractures (Delbet Type IV), with transepiphyseal separations (Delbet Type I) being the least common.^{2,3,5,9,15-17} One potential explanation for this might be that patients in our report received their care in an integrated health system, in contrast to prior reports from tertiary children's hospitals. Delbet classification typically is used in the treatment and prognosis of hip fractures in pediatric patients because of its correlation with the incidence of complications; the risk of complications decreases from Delbet Type I to Type IV fractures.⁸

Median time to surgery in our series was 10.8 hours, and most surgical procedures (92.3%) were performed within 24 hours. Although there is general agreement that early treatment and internal fixation is the best clinical practice, controversy exists regarding the relationship between delay in treatment and increased risk of complications. Two reports found a positive correlation between increased time from injury and reduction and risk of complications^{6,8}; however, other reports found no association.^{9,17} Complications may also be associated with the type of treatment and the surgeon's level of experience. Internal fixation utilization in our cohort was almost evenly distributed between intramedullary, screw and sideplate, and screws. This is in contrast to studies by Flynn et al¹⁸ and Shrader et al,⁶ both reporting use of screws as the predominate method of fixation. Togrul et al¹⁹ also suggested complications are more likely to occur with inexperienced surgeons. Most hip fractures in our pediatric cohort were treated by medium- and high-volume surgeons (75.0%) at medium- and high-volume hospitals (95.0%).

Complications of hip fractures well known to occur in adults were rarely encountered. Specifically, there were no deaths, nor were there any complications from deep venous thrombosis, dislocation, myocardial infarction, pneumonia, pressure ulcer, or pulmonary embolism. Of the 5 complications observed, 3 were directly related to the hip fracture injury: 1 infection, 1 malunion, and 1 revision surgery. Our low infection rate corresponds with that reported in a recent systematic review.⁸ However, 2 complications were less directly related to hip pathology, both readmissions within 90 days. One patient was readmitted because of nephrolithiasis, and another because of acute abdominal pain related to perforated diverticulitis. Aside from infection and malunion, other complications commonly

reported after the treatment of hip fractures in pediatric patients, including avascular necrosis, nonunion, and premature closure of the proximal femoral physis/limb length discrepancy,⁷ were not observed in our cohort. One explanation for this may be because most hip fractures observed were Delbet Type IV, intertrochanteric. This region of the femur is well vascularized and has a lower risk for development of complications such as avascular necrosis. Furthermore, although common pediatric complications can develop as early as 6 weeks after injury, patients were not followed-up during a long enough period to adequately assess these complications in our cohort. Extended follow-up to skeletal maturity using the hip fracture registry data over several years is necessary to determine whether long-term complications occur.^{4,15}

Limitations of this report include a reliance on diagnostic and procedure codes (ICD-9-CM). Additionally, this report includes patients whose hip fracture received surgical treatment only; no description of patients treated by closed reduction or other non-operative means is included. Other limitations include limited data capture, including the absence of information on fracture displacement, a strong predictor of complications, and a small amount of missing data.^{1,2} Furthermore, this report is purely descriptive, looking at short-term postoperative outcomes only; no conclusions may be made as to causality of specific variables with hip fracture outcomes in pediatric patients. Future studies using the registry's cohort with longer follow-up accrual for clinical outcomes will address these limitations, which are relevant for the pediatric hip fracture population.

The major strength of this report is the quality of the KP Hip Fracture Registry data. Single-institution case series can span several decades, and changes in patient demographics and treatment over time can create a diverse cohort. Findings from meta-analyses with larger sample sizes are limited because of bias from inclusion of clinically and methodologically heterogeneous studies.^{8,17} In contrast, a variety of outcomes are monitored in registries through a prospective data collection method with a high level of internal validation, thus reducing bias.^{10,20} Validation of outcomes after surgery is performed through review of the electronic health record and verified through additional sources. Finally, registries offer the opportunities to investigate rare events.

CONCLUSION

In a large integrated health care system, hip fractures in a pediatric population were rare and complication rates were low. Hip fractures were more common in boys and Hispanic patients. Few patients had any comorbidities (20.5%). Although this article provides descriptive information on surgically treated pediatric patients and their outcomes, future studies are necessary to evaluate longer-term outcomes, identify predictors of complications, and determine optimal surgical treatment for this patient population. ♦

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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