JOURNAL OF JPOSNA®

Volume 5, Number 4, November 2023

Original Research

Trends in the Management of Femur Fractures in Young Children

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Received: July 22, 2023; Accepted: October 15, 2023; Published: November 15, 2023

DOI: 10.55275/JPOSNA-2023-766

Abstract

Background: Femoral shaft fractures in young children are commonly treated with closed reduction and spica casting; however, there is increasing literature and interest focusing on internal fixation. This study aims to assess trends in the management of femoral shaft fractures in patients under the age of 6.

Methods: This is a retrospective study utilizing the Pediatric Health Information System (PHIS) database. We queried for patients aged 1 to 6 years who had an isolated, closed femoral shaft fracture from October 2015 to December 2020. ICD10 procedure codes were used to determine treatment of the injury. Descriptive statistics and tests of trend were utilized in the analysis of this study.

Results: We identified 4608 patients with a femoral shaft fracture during the study period. The majority of patients were treated with spica casting (n=3398, 73.7%), followed by intramedullary fixation (n=600, 13.0%) and plate osteosynthesis (n=449, 9.7%). In this cohort, 3236 patients were between the ages of 1-3 years, and 1372 patients were between the ages of 4-6 years. There was a significant difference in management between these two age groups with lower rates of spica casting in older patients (92.1% vs. 30.5%) and higher rates of intramedullary fixation (37.3% vs. 2.7%) and plate osteosynthesis (28.2% vs. 1.9%) ($p<0.01$). There was a significant correlation with increasing rates of intramedullary fixation and plate osteosynthesis from 2016 to 2020 ($p=0.03$ and 0.01, respectively), and a decrease in rate of spica casting over time ($p=0.04$).

Conclusion: Femur fractures in young children are treated with spica casting, intramedullary nails, and plate osteosynthesis. There is a significant change in management over time, and children between the ages of 4 and 6 are more likely to be treated with intramedullary nails compared to younger children. Additional studies are needed to

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understand these trends as well as justify the increase in rates of intramedullary nails and plate osteosynthesis in young children.

Level of Evidence: Level III; Retrospective Cohort Comparison using Large Database

Key Concepts

- Historically, spica casting was the gold standard for femur fracture treatment in younger patients.
- There has been recent interest in the utilization of internal fixation for treatment of femur fractures in young children.
- The use of intramedullary nails and plate osteosynthesis in young patients with femur fractures has increased by 34% and 25%, respectively, from 2015 to 2020.
- Spica casting has remained the main treatment option for patients aged 1-3.
- Intramedullary nails and plate osteosynthesis have been used increasingly over time for patients aged 4-6.

Introduction

Femoral shaft fractures account for nearly 2% of all pediatric fractures, and it is the second-most common fracture of the lower extremity.[1,2] These fractures commonly occur in young children and may be challenging to treat due to fracture pattern and patient age.[3-5] The management of this fracture in young children has traditionally been closed reduction and spica casting, which has shown excellent results.[4,5] Original clinical practice guidelines from the American Academy of Orthopaedic Surgeons (AAOS) also suggested closed reduction and spica casting for diaphyseal femur fractures in patients between 6 months and 5 years of age with less than 2 cm of fracture shortening.[5] However, there is emerging research and increasing interest in internal fixation for this younger age group.[6-18]

Internal fixation has become an increasingly popular option in pediatric femur fractures, though there is little consensus on its use in children under 6 years of age.[2,19-21] Updated clinical practice guidelines from the AAOS in 2015 continued to favor spica casting, though indicated that both treatment options may be appropriate.[22] In practice, internal fixation may be considered for young patients with open injuries, length unstable fracture patterns, or the poly-traumatized patient.[23] Despite guidelines, there has been a significant increase in the use of internal fixation and surgery in patients under the age of 11.[24] Closed reduction and spica casting may offer lower complication rates and cost; however, it may result in increased recovery time, risk of skin irritation, compartment syndrome, and increased familial and social burden.[17,25] Internal fixation has the benefit of earlier ambulation, shorter hospital stay, and lower rates of malunion and leg length discrepancy.[21,26] However, significant limitations of internal fixation include the risk of infection, cost, and need for hardware removal.[21,27]

There is a growing body of literature focusing on operative management of diaphyseal femur fractures in young children.[9,21,24,28] However, there are no large studies focusing on trends of management in young patients. This study aims to assess the trends in the management of femoral shaft fractures in patients between the ages of 1 and 6 years over time, as well as assess factors associated with management.

Methods

Patients were identified using the Pediatric Health Information System (PHIS). The PHIS database is an administrative database containing inpatient, emergency department, ambulatory, surgery, and observation

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encounter data from approximately 50 large, tertiary pediatric hospitals throughout the United States.[29] These hospitals are affiliated with the Children's Hospital Association, which assures data reliability amongst participating hospitals.

This study included patients between the ages of 1 and 6 years with international classification of diseases (ICD-10) diagnosis codes corresponding with a femoral shaft fracture and a corresponding ICD-10 procedure code (Appendix 1) between October 2015 and December 2020.

Demographic data such as race, ethnicity, sex, and age were obtained from the PHIS database. Race was standardized to White, Black, Asian, or Other. Ethnicity was made a binary variable reflecting Hispanic or non-Hispanic. Age was collected both as a continuous variable, as well as a binary variable defined as ages 1-3 vs. ages 4-6 years.

Given that the data was collected starting October 2015 at the inception of ICD-10 coding, we only included years 2016-2020 when assessing trends over time.

Descriptive statistics were used to summarize the data contained in the PHIS database. Student's t-tests, Chi-squared tests, Mann-Kendall tests, and Fisher-exact tests were used, as appropriate, to summarize the data and assess trends of pediatric femur fracture management. We utilized STATA/SE 15.1 for all data analysis (StataCorp LP, College Station, TX).

Results

A total of 4608 patients were identified as having femoral shaft fractures between October 2015 and December 2020. The average age of our patient population was 2.9 years (SD: 1.6), with the majority of the patients being White, non-Hispanic males (Table 1). The most common type of treatment was spica casting (73.7%), followed by intramedullary nailing (13.0%) and plate osteosynthesis (9.7%).

When assessing overall trends in management among the entire cohort from 2016-2020, a significant decline in the

Table 1. Demographics and Management Strategies for Pediatric Femoral Shaft Fractures in PHIS from 2016-2020

Pediatric Femoral Shaft Fractures		
N		**4608**
Age yrs (mean, SD)		2.9 (1.6)
Age Group (%)		
	1-3	3236 (70.2)
	4-6	1372 (29.8)
Sex		
	Male	3390 (73.7)
	Female	1211 (26.3)
Race (%)		
	White	3031 (67.9)
	Black	810 (18.1)
	Asian	100 (2.2)
	Other	524 (11.7)
Ethnicity (%)		
	Hispanic	784 (17.8)
	Non-Hispanic	3416 (82.3)
Year (%)		
	2015	269 (5.8)
	2016	1031 (22.4)
	2017	944 (20.5)
	2018	830 (18.0)
	2019	807 (17.5)
	2020	727 (15.8)
Treatment (%)		
	Spica Casting	3398 (73.7)
	Intramedullary Nail	600 (13.0)
	Plate Osteosynthesis	449 (9.7)
	Splint	59 (1.3)
	External Fixation	17 (0.4)
	Brace	4 (0.1)
	Other	81 (1.8)

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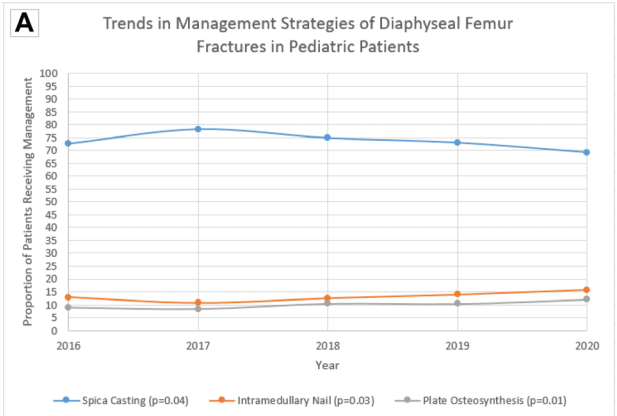
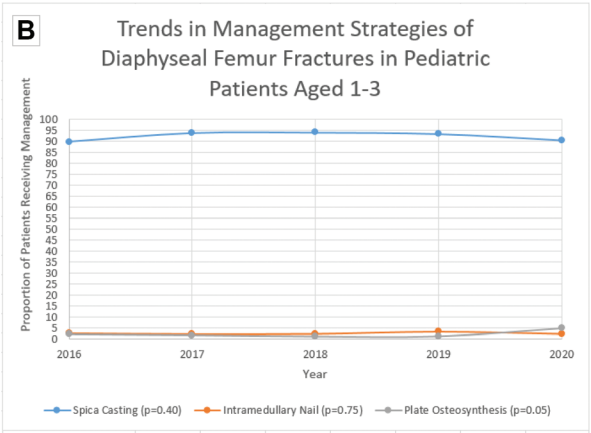
use of spica casting was noted (Tau-b=−0.03, p=0.04), while there was an increase in the use of intramedullary nails (Tau-b= 0.03, p<0.01) and plate osteosynthesis (Tau-b=0.03, p=0.02) (Figure 1A). Rates of external fixation were also noted to significantly increase over time from 0.1% in 2016 to 1.2% in 2020 (Tau-b=0.05, p<0.01). There was no significant change in rates of bracing over time (Tau-b=0.00, p=0.83).

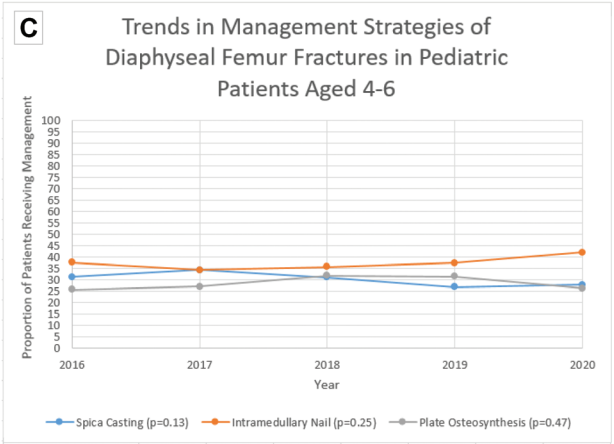
Trends were further stratified based on age. Among patients aged 1-3 years, spica casting was the most common management ranging from 89.8% to 94.1% of total femur fracture cases from 2016-2020, although the trend was not statistically significant (Tau-b=0.01, p-value=0.40). Similarly, trends in intramedullary nail use and plate osteosynthesis were not statistically significant but were noted to increase over the study period (Table 2) (Figure 1B). There was a significant increase in the use of external fixation, however, its utilization ranged from 0.0 to 1.0% of cases (Tau-b=0.06, p-value=0.01). Patients aged 4-6 years were managed most commonly by intramedullary nailing, ranging from 34.4-42.1% of cases. There was an increase in rate of intramedullary nailing and decrease in spica casting



	2016	2017	2018	2019	2020	Tau-b	p-value
Spica Casting	749 (72.6)	738 (78.2)	621 (74.8)	589 (73.0)	503 (69.2)	-0.03	0.04
Intramedullary Nail	133 (12.9)	101 (10.7)	104 (12.5)	112 (13.9)	115 (15.8)	0.03	0.03
Plate Osteosynthesis	93 (9.0)	79 (8.4)	87 (10.5)	84 (10.4)	88 (12.1)	0.03	0.02



	2016	2017	2018	2019	2020	Tau-b	p-value
Spica Casting	654 (89.8)	652 (93.9)	542 (94.1)	522 (93.4)	434 (90.4)	0.01	0.40
Intramedullary Nail	19 (2.6)	15 (2.2)	13 (2.3)	19 (3.4)	11 (2.3)	0.01	0.75
Plate Osteosynthesis	15 (2.1)	11 (1.6)	6 (1.0)	6 (1.1)	23 (4.8)	0.03	0.05



	2016	2017	2018	2019	2020	Tau-b	p-value
Spica Casting	95 (31.4)	86 (34.4)	79 (31.1)	67 (27.0)	69 (27.9)	-0.04	0.13
Intramedullary Nail	114 (37.6)	86 (34.4)	91 (35.8)	93 (37.5)	104 (42.1)	0.03	0.25
Plate Osteosynthesis	78 (25.7)	68 (27.2)	81 (31.9)	78 (31.5)	65 (26.3)	0.02	0.47

Figure 1. *Trends in the use of spica casting, intramedullary nails, and plate osteosynthesis in pediatric diaphyseal femur fractures. (A) Ages 1-6, (B) Ages 1-3, (C) Ages 4-6.*

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Table 2. Trends in Pediatric Femoral Shaft Fracture Management by Age

	2016	2017	2018	2019	2020	Tau-b	p-value
All Ages							
Spica Casting	749 (72.6)	738 (78.2)	621 (74.8)	589 (73.0)	503 (69.2)	−0.03	0.04
Intramedullary Nail	133 (12.9)	101 (10.7)	104 (12.5)	112 (13.9)	115 (15.8)	0.03	0.03
Plate Osteosynthesis	93 (9.0)	79 (8.4)	87 (10.5)	84 (10.4)	88 (12.1)	0.03	0.01
Splint	24 (2.3)	7 (0.7)	10 (1.2)	9 (1.1)	5 (0.7)	−0.04	0.01
External Fixation	1 (0.1)	2 (0.2)	0 (0.0)	3 (0.4)	9 (1.2)	0.05	<0.01
Brace	1 (0.1)	1 (0.1)	0 (0.0)	1 (0.1)	1 (0.1)	0.00	0.83
Other	30 (2.9)	16 (1.7)	8 (1.0)	9 (1.1)	6 (0.8)	−0.05	<0.01
Ages: 1-3							
Spica Casting	654 (89.8)	652 (93.9)	542 (94.1)	522 (93.4)	434 (90.4)	0.01	0.40
Intramedullary Nail	19 (2.6)	15 (2.2)	13 (2.3)	19 (3.4)	11 (2.3)	0.01	0.75
Plate Osteosynthesis	15 (2.1)	11 (1.6)	6 (1.0)	6 (1.1)	23 (4.8)	0.03	0.05
Splint	18 (2.5)	6 (0.9)	9 (1.6)	6 (1.1)	4 (0.8)	−0.04	0.31
External Fixation	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	5 (1.0)	0.06	0.01
Brace	1 (0.1)	1 (0.1)	0 (0.0)	1 (0.2)	1 (0.2)	0.00	0.80
Other	21 (2.9)	9 (1.3)	6 (1.0)	4 (0.7)	2 (0.4)	−0.06	<0.01
Ages 4-6							
Spica Casting	95 (31.4)	86 (34.4)	79 (31.1)	67 (27.0)	69 (27.9)	−0.04	0.13
Intramedullary Nail	114 (37.6)	86 (34.4)	91 (35.8)	93 (37.5)	104 (42.1)	0.03	0.25
Plate Osteosynthesis	78 (25.7)	68 (27.2)	81 (31.9)	78 (31.5)	65 (26.3)	0.02	0.47
Splint	6 (2.0)	1 (0.4)	1 (0.4)	3 (1.2)	1 (0.4)	0.04	0.15
External Fixation	1 (0.3)	2 (0.8)	0 (0.0)	2 (0.8)	4 (1.6)	0.04	0.12
Brace	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)		
Other	9 (3.0)	7 (2.8)	2 (0.8)	5 (2.0)	4 (0.6)	−0.03	0.19

over time, although these changes were not statistically significant (p-value= 0.25 and 0.13, respectively) (Table 2) (Figure 1C).

When comparing patients between the ages of 1-3 and 4-6 years, a significant difference in management options was noted (p<0.01). Spica casting was the most common management for femoral shaft fractures amongst patients aged 1-3 years (92.1%) while intramedullary nails were most commonly used in patients aged 4-6 years (37.1%) (p-value <0.01). Spica casting and plate osteosynthesis were the second and third most common treatment modalities, respectively, in patients aged 4-6 years (Table 3). There was a significant change in management for patients aged 4-6 years over the study period with an increase in the use of intramedullary nails compared to spica casts (p<0.01)

There were significant differences in treatment between males and females as well (Table 4). When assessing

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Table 3. Demographic and Management Differences for Pediatric Femoral Shaft Fractures by Age

		Age 1-3 yrs	Age 4-6 yrs	p-value
N		**3037**	**1302**	
Sex				0.02
	Male	2272 (74.9)	928 (71.4)	
	Female	760 (25.1)	372 (28.6)	
Race (%)				0.11
	White	2023 (68.6)	838 (66.8)	
	Black	543 (17.3)	267 (20.2)	
	Asian	69 (2.2)	31 (2.4)	
	Other	382 (12.2)	142 (10.8)	
Ethnicity (%)				0.38
	Hispanic	562 (18.1)	222 (17.0)	
	Non-Hispanic	2539 (81.9)	1082 (83.0)	
Year (%)				0.02
	2015	199 (6.2)	70 (5.1)	
	2016	728 (22.5)	303 (22.1)	
	2017	694 (21.5)	250 (18.2)	
	2018	576 (17.8)	254 (18.5)	
	2019	559 (17.3)	248 (18.1)	
	2020	480 (14.8)	247 (18.0)	
Treatment (%)				<0.01
	Spica Casting	2980 (92.1)	418 (30.5)	
	Intramedullary Nail	88 (2.7)	512 (37.3)	
	Plate Osteosynthesis	62 (1.9)	387 (28.2)	
	Splint	46 (1.4)	13 (0.9)	
	External Fixation	8 (0.3)	9 (0.7)	
	Brace	4 (0.1)	0 (0.0)	
	Other	48 (1.5)	33 (2.4)	

trends, males had significant changes in the use of splints and external fixation over the study period (Tau-b=−0.04, p=0.01 and tau-b= 0.04, p=0.01; respectively). In females, the rate of spica casting decreased over time (Tau-b= −0.06, p=0.02), and the rates of intramedullary nails and external fixation increased over time (Tau-b=0.06, p=0.04 and Tau-b=0.06, p=0.02, respectively).

Discussion

There is increasing literature and growing interest in the use of internal fixation for femoral shaft fractures in

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Table 4. Demographic and Management Differences for Pediatric Femoral Shaft Fractures by Sex

		Male	Female	p-value
N		**3390**	**1211**	
Age Group (%)				0.010
	1-3 yrs	2416 (71.3)	815 (67.3)	
	4-6 yrs	974 (28.7)	396 (32.7)	
Race (%)				<0.001
	White	2293 (69.7)	735 (62.8)	
	Black	559 (17.0)	248 (21.2)	
	Asian	62 (1.9)	38 (3.3)	
	Other	374 (11.4)	149 (12.7)	
Ethnicity (%)				0.59
	Hispanic	581 (18.0)	201 (17.3)	
	Non-Hispanic	2653 (82.0)	963 (82.7)	
Year (%)				0.25
	2015	190 (5.6)	79 (6.5)	
	2016	782 (23.1)	247 (20.4)	
	2017	701 (20.7)	243 (20.1)	
	2018	596 (17.6)	234 (19.3)	
	2019	582 (17.2)	222 (18.3)	
	2020	539 (15.9)	186 (15.4)	
Treatment (%)				<0.01
	Spica Casting	2564 (75.6)	830 (68.5)	
	Intramedullary Nail	398 (11.7)	201 (16.6)	
	Plate Osteosynthesis	316 (9.3)	132 (10.9)	
	Splint	40 (1.2)	19 (1.6)	

young children. In this study, we found that even though spica casting continues to remain the most common method of treatment for these fractures, the rates of intramedullary fixation and plate osteosynthesis are increasing over time in those 6 years old and younger. There was a 25% increase in the use of intramedullary nails over the study period (12.9% to 15.8%). Similarly, there was an over 33% increase in the use of plate osteosynthesis (9% to 12.1%). The change from spica casting towards these other modalities was most significant in patients between the ages of 4 and 6 years.

There may be several factors that explain these trends. Operative management gives the benefit of earlier mobilization and weight-bearing with potentially lower

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rates of malunion and leg length discrepancy.[12,13,21,26] Moreover, one study showed that spica casting was 4.4 times more likely to require unplanned revision due to loss of reduction compared to fixation and this risk increased with patient age.[30] Aside from clinical outcomes, quicker recovery with operative management may be associated with improved physical and social development while reducing familial burden.[26,31] It is important to note that both modalities are subject to their respective complications and costs, and these are important factors to consider.[12,13] Additional studies are needed to determine indications for intramedullary fixation in this patient population as well as understand patient clinical and radiographic outcomes.

Our findings are consistent with other studies on this topic. For example, Naranje et al. demonstrated in their 15-year assessment of trends in pediatric femoral fracture management using the Kids' Inpatient Database (KID) that surgical management has become increasingly common in older patients.[2] However, their study included patients from ages 0-17 years, and our study focused on specifically younger children that are traditionally managed with casting. Additionally, our study utilized the PHIS database, which provides continuous data, specifically from children's hospitals, including pediatric trauma centers. It is possible that our rates are lower than national rates since we only included children's hospitals; however, it is important that this trend is observed at specialized children's hospitals.

This study has several limitations. This is a database study, and it is subject to errors in coding and classification. Additionally, the PHIS database gathers data from large, tertiary care referral pediatric hospitals, so the patient population it represents may not be generalizable to community or non-specialty hospitals.[32,33] We are also unable to comment on indications for management or outcomes after surgery. Furthermore, only primary procedure codes were available for analysis, so it is possible that some patients underwent spica casting in addition to internal fixation, in which case, we would only have analyzed it based on the single primary code provided. Lastly, it is important to note the loss of statistical significance when assessing trends by age group. The likely reason for this is that the study may be further underpowered when stratifying the population further. Using the rates and trends shown in this study to achieve 80% power and at an alpha of 0.05 in ages 1-3 years, we would require at least 913 patients each year when assessing spica casting—1129 for intramedullary nails and 1095 for plate osteosynthesis.[34,35]

These estimations only increase with smaller differences between each year as is seen with spica casting trends in patients aged 1-3 years. Post-hoc power analysis shows we currently have a power of 78% which would only go down with stratifying the cohort by age group, especially in the 4-6 years group. Additionally, the differences in treatments in each age group do vary significantly, and it is possible that the ages 4-6 years group, for example, can be driving the significance we are seeing in spica casting, intramedullary nails, and plate osteosynthesis when looking at trends as a whole. As PHIS continues to be populated for the next 5-10 years and the sample size of this population grows, it would be beneficial to again assess trends and observe how these numbers and significance levels change.

Conclusion

In conclusion, there has been a significant increase in the use of internal fixation and significant decrease in the use of spica casting for the management of diaphyseal femur fractures in children ≤6 years old. Specifically, patients between the ages of 4 and 6 years are more likely to be managed with internal fixation. Additional multi-center studies are needed to validate these findings, investigate indications for management, and focus on clinical and radiographic outcomes.

Disclaimer

No funding was received. The authors report no conflicts of interest related to this manuscript.

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Appendix 1
ICD 10 Coding for Diagnoses and Procedures

Diagnosis or Procedure	ICD 10 code	Description of code
Femoral Shaft Fracture		
	S72.326	Nondisplaced transverse fracture of shaft of unspecified femur
	S72.356	Nondisplaced comminuted fracture of shaft of unspecified femur
	S72.366	Nondisplaced segmental fracture of shaft of unspecified femur
	S72.301A	Unspecified fracture of shaft of right femur, initial encounter for closed fracture
	S72.302A	Unspecified fracture of shaft of left femur, initial encounter for closed fracture
	S72.321A	Displaced transverse fracture of shaft of right femur, initial encounter for closed fracture
	S72.322A	Displaced transverse fracture of shaft of left femur, initial encounter for closed fracture
	S72.323A	Displaced transverse fracture of shaft of unspecified femur, initial encounter for closed fracture
	S72.324A	Nondisplaced transverse fracture of shaft of right femur, initial encounter for closed fracture
	S72.325A	Nondisplaced transverse fracture of shaft of left femur, initial encounter for closed fracture
	S72.326A	Nondisplaced transverse fracture of shaft of unspecified femur, initial encounter for closed fracture
	S72.331A	Displaced oblique fracture of shaft of right femur, initial encounter for closed fracture
	S72.332A	Displaced oblique fracture of shaft of left femur, initial encounter for closed fracture
	S72.333A	Displaced oblique fracture of shaft of unspecified femur, initial encounter for closed fracture
	S72.334A	Nondisplaced oblique fracture of shaft of right femur, initial encounter for closed fracture
	S72.335A	Nondisplaced oblique fracture of shaft of left femur, initial encounter for closed fracture
	S72.336A	Nondisplaced oblique fracture of shaft of unspecified femur, initial encounter for closed fracture
	S72.341A	Displaced spiral fracture of shaft of right femur, initial encounter for closed fracture
	S72.342A	Displaced spiral fracture of shaft of left femur, initial encounter for closed fracture
	S72.343A	Displaced spiral fracture of shaft of unspecified femur, initial encounter for closed fracture
	S72.344A	Nondisplaced spiral fracture of shaft of right femur, initial encounter for closed fracture
	S72.345A	Nondisplaced spiral fracture of shaft of left femur, initial encounter for closed fracture
	S72.346A	Nondisplaced spiral fracture of shaft of unspecified femur, initial encounter for closed fracture
	S72.351A	Displaced comminuted fracture of shaft of right femur, initial encounter for closed fracture
	S72.352A	Displaced comminuted fracture of shaft of left femur, initial encounter for closed fracture
	S72.353A	Displaced comminuted fracture of shaft of unspecified femur, initial encounter for closed fracture

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Appendix 1: Continued

Diagnosis or Procedure	ICD 10 code	Description of code
	S72.354A	Nondisplaced comminuted fracture of shaft of right femur, initial encounter for closed fracture
	S72.355A	Nondisplaced comminuted fracture of shaft of left femur, initial encounter for closed fracture
	S72.356A	Nondisplaced comminuted fracture of shaft of unspecified femur, initial encounter for closed fracture
	S72.361A	Displaced segmental fracture of shaft of right femur, initial encounter for closed fracture
	S72.362A	Displaced segmental fracture of shaft of left femur, initial encounter for closed fracture
	S72.363A	Displaced segmental fracture of shaft of unspecified femur, initial encounter for closed fracture
	S72.364A	Nondisplaced segmental fracture of shaft of right femur, initial encounter for closed fracture
	S72.365A	Nondisplaced segmental fracture of shaft of left femur, initial encounter for closed fracture
	S72.366A	Nondisplaced segmental fracture of shaft of unspecified femur, initial encounter for closed fracture
	S72.309A	Unspecified fracture of shaft of unspecified femur, initial encounter for closed fracture
	S72.391A	Other fracture of shaft of right femur, initial encounter for closed fracture
	S72.392A	Other fracture of shaft of left femur, initial encounter for closed fracture
	S72.399A	Other fracture of shaft of unspecified femur, initial encounter for closed fracture
Brace		
	2W3RX3Z	Immobilization of Left Lower Leg using Brace
	2W3PX3Z	Immobilization of Left Upper Leg using Brace
	2W3LX3Z	Immobilization of Right Lower Extremity using Brace
Spica Casting		
	0PSGXZZ	“Reposition Left Humeral Shaft, External Approach”
	0QQ8XZZ	“Repair Right Femoral Shaft, External Approach”
	0QS6XZZ	“Reposition Right Upper Femur, External Approach”
	0QS7XZZ	“Reposition Left Upper Femur, External Approach”
	0QS8XZZ	“Reposition Right Femoral Shaft, External Approach”
	0QS9XZZ	“Reposition Left Femoral Shaft, External Approach”
	0QSBXZZ	“Reposition Right Lower Femur, External Approach”
	0QSCXZZ	“Reposition Left Lower Femur, External Approach”
	0QSGXZZ	“Reposition Right Tibia, External Approach”
	0SS9XZZ	“Reposition Right Hip Joint, External Approach”

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Appendix 1: Continued

Diagnosis or Procedure	ICD 10 code	Description of code
	2W0LX2Z	Change Cast on Right Lower Extremity
	2W0MX2Z	Change Cast on Left Lower Extremity
	2W36X2Z	Immobilization of Right Inguinal Region using Cast
	2W39X2Z	Immobilization of Left Upper Extremity using Cast
	2W3LX2Z	Immobilization of Right Lower Extremity using Cast
	2W3MX2Z	Immobilization of Left Lower Extremity using Cast
	2W3NX2Z	Immobilization of Right Upper Leg using Cast
	2W3PX2Z	Immobilization of Left Upper Leg using Cast
	2W3QX2Z	Immobilization of Right Lower Leg using Cast
	2W3RX2Z	Immobilization of Left Lower Leg using Cast
External Fixation		
	0QS935Z	"Reposition Left Femoral Shaft with External Fixation Device, Percutaneous Approach"
	0QS735Z	"Reposition Left Upper Femur with External Fixation Device, Percutaneous Approach"
	0QS73BZ	"Reposition Left Upper Femur with Monoplanar External Fixation Device, Percutaneous Approach"
	0QS835Z	"Reposition Right Femoral Shaft with External Fixation Device, Percutaneous Approach"
	0QS935Z	"Reposition Left Femoral Shaft with External Fixation Device, Percutaneous Approach"
	0QS905Z	"Reposition Left Femoral Shaft with External Fixation Device, Open Approach"
	0QS80BZ	"Reposition Right Femoral Shaft with Monoplanar External Fixation Device, Open Approach"
	0QS93DZ	"Reposition Left Femoral Shaft with Hybrid External Fixation Device, Percutaneous Approach"
	0QHC45Z	"Insertion of External Fixation Device into Left Lower Femur, Percutaneous Endoscopic Approach"
	0QS835Z	"Reposition Right Femoral Shaft with External Fixation Device, Percutaneous Approach"
	0QS235Z	"Reposition Right Pelvic Bone with External Fixation Device, Percutaneous Approach"
	0QS735Z	"Reposition Left Upper Femur with External Fixation Device, Percutaneous Approach"
Plate Osteosynthesis		
	0QH804Z	"Insertion of Internal Fixation Device into Right Femoral Shaft, Open Approach"
	0QH834Z	"Insertion of Internal Fixation Device into Right Femoral Shaft, Percutaneous Approach"
	0QH904Z	"Insertion of Internal Fixation Device into Left Femoral Shaft, Open Approach"
	0QH934Z	"Insertion of Internal Fixation Device into Left Femoral Shaft, Percutaneous Approach"

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Appendix 1: Continued

Diagnosis or Procedure	ICD 10 code	Description of code
	0QHC04Z	"Insertion of Internal Fixation Device into Left Lower Femur, Open Approach"
	0QP804Z	"Removal of Internal Fixation Device from Right Femoral Shaft, Open Approach"
	0QP904Z	"Removal of Internal Fixation Device from Left Femoral Shaft, Open Approach"
	0QS604Z	"Reposition Right Upper Femur with Internal Fixation Device, Open Approach"
	0QS644Z	"Reposition Right Upper Femur with Internal Fixation Device, Percutaneous Endoscopic Approach"
	0QS704Z	"Reposition Left Upper Femur with Internal Fixation Device, Open Approach"
	0QS734Z	"Reposition Left Upper Femur with Internal Fixation Device, Percutaneous Approach"
	0QS804Z	"Reposition Right Femoral Shaft with Internal Fixation Device, Open Approach"
	0QS80ZZ	"Reposition Right Femoral Shaft, Open Approach"
	0QS834Z	"Reposition Right Femoral Shaft with Internal Fixation Device, Percutaneous Approach"
	0QS904Z	"Reposition Left Femoral Shaft with Internal Fixation Device, Open Approach"
	0QS90ZZ	"Reposition Left Femoral Shaft, Open Approach"
	0QS934Z	"Reposition Left Femoral Shaft with Internal Fixation Device, Percutaneous Approach"
	0QSB04Z	"Reposition Right Lower Femur with Internal Fixation Device, Open Approach"
	0QSB34Z	"Reposition Right Lower Femur with Internal Fixation Device, Percutaneous Approach"
	0QSC04Z	"Reposition Left Lower Femur with Internal Fixation Device, Open Approach"
	0QSC34Z	"Reposition Left Lower Femur with Internal Fixation Device, Percutaneous Approach"
	0QSH34Z	"Reposition Left Tibia with Internal Fixation Device, Percutaneous Approach"
	0QSJ04Z	"Reposition Right Fibula with Internal Fixation Device, Open Approach"
Intramedullary		
	0QH606Z	"Insertion of Intramedullary Internal Fixation Device into Right Upper Femur, Open Approach"
	0QH736Z	"Insertion of Intramedullary Internal Fixation Device into Left Upper Femur, Percutaneous Approach"
	0QH806Z	"Insertion of Intramedullary Internal Fixation Device into Right Femoral Shaft, Open Approach"
	0QH836Z	"Insertion of Intramedullary Internal Fixation Device into Right Femoral Shaft, Percutaneous Approach"
	0QH906Z	"Insertion of Intramedullary Internal Fixation Device into Left Femoral Shaft, Open Approach"
	0QH936Z	"Insertion of Intramedullary Internal Fixation Device into Left Femoral Shaft, Percutaneous Approach"
	0QHB36Z	"Insertion of Intramedullary Internal Fixation Device into Right Lower Femur, Percutaneous Approach"
	0QHC36Z	"Insertion of Intramedullary Internal Fixation Device into Left Lower Femur, Percutaneous Approach"

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Appendix 1: Continued

Diagnosis or Procedure	ICD 10 code	Description of code
	0QS606Z	"Reposition Right Upper Femur with Intramedullary Internal Fixation Device, Open Approach"
	0QS636Z	"Reposition Right Upper Femur with Intramedullary Internal Fixation Device, Percutaneous Approach"
	0QS706Z	"Reposition Left Upper Femur with Intramedullary Internal Fixation Device, Open Approach"
	0QS736Z	"Reposition Left Upper Femur with Intramedullary Internal Fixation Device, Percutaneous Approach"
	0QS806Z	"Reposition Right Femoral Shaft with Intramedullary Internal Fixation Device, Open Approach"
	0QS846Z	"Reposition Right Femoral Shaft with Intramedullary Internal Fixation Device, Percutaneous Endoscopic Approach"
	0QS906Z	"Reposition Left Femoral Shaft with Intramedullary Internal Fixation Device, Open Approach"
	0QS936Z	"Reposition Left Femoral Shaft with Intramedullary Internal Fixation Device, Percutaneous Approach"
	0QSB06Z	"Reposition Right Lower Femur with Intramedullary Internal Fixation Device, Open Approach"
	0QSB36Z	"Reposition Right Lower Femur with Intramedullary Internal Fixation Device, Percutaneous Approach"
	0QSC06Z	"Reposition Left Lower Femur with Intramedullary Internal Fixation Device, Open Approach"
	0QSC36Z	"Reposition Left Lower Femur with Intramedullary Internal Fixation Device, Percutaneous Approach"
	0QSH06Z	"Reposition Left Tibia with Intramedullary Internal Fixation Device, Open Approach"
	0QS93ZZ	"Reposition Left Femoral Shaft, Percutaneous Approach"
	0QS63ZZ	"Reposition Right Upper Femur, Percutaneous Approach"
	0QS83ZZ	"Reposition Right Femoral Shaft, Percutaneous Approach"
	0Q883ZZ	"Division of Right Femoral Shaft, Percutaneous Approach"
	0QS83ZZ	"Reposition Right Femoral Shaft, Percutaneous Approach"
Splint		
	2W38X1Z	Immobilization of Right Upper Extremity using Splint
	2W39X1Z	Immobilization of Left Upper Extremity using Splint
	2W3LX1Z	Immobilization of Right Lower Extremity using Splint
	2W3MX1Z	Immobilization of Left Lower Extremity using Splint
	2W3NX1Z	Immobilization of Right Upper Leg using Splint
	2W3PX1Z	Immobilization of Left Upper Leg using Splint
	2W3QX1Z	Immobilization of Right Lower Leg using Splint
	2W3RX1Z	Immobilization of Left Lower Leg using Splint

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