Influence of Timing of Femur Fracture Fixation on Outcomes Following Major Trauma
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Purpose: Femur fractures are common in trauma, frequently occurring in patients with multiple injuries resulting from high-energy mechanisms. Internal fixation by intramedullary nailing is often considered the best definitive management; however, the optimal timing for fixation remains unclear. While guidelines recommend early fixation, there is a lack of high-quality evidence to support a benefit to patient outcomes. The purpose of this study was to determine the effect of early (<24 hours) versus delayed (≥24 hours) femur fracture fixation on selected patient outcomes.

Methods: We identified all adult patients (≥16 years) with closed femur shaft fractures admitted to trauma centers participating in the American College of Surgeons Trauma Quality Improvement Program (ACS TQIP) over 2012-2014. Patients who died or were discharged before 48 hours were excluded. Two analytic approaches were used. First, we used a propensity score (PS)-matched study design to reduce confounding by indication, matching patients who underwent early fixation (EF) to those who had delayed fixation (DF) based on the propensity for delayed fixation derived from baseline patient and injury characteristics. Outcomes of interest were pulmonary embolism (PE), pneumonia, decubitus ulcer, and death. Secondary outcomes were ICU and overall hospital length of stay (LOS). A subgroup analysis was also performed on patients with isolated femur fractures (defined as femur fracture without severe injury to any other body region). In our second approach, we estimated each trauma center's odds of delayed fixation after adjusting for that center's unique patient case mix. Trauma centers were then categorized by the overall median odds ratio for delayed fixation as "early fixation" or "delayed fixation" centers. This approach allowed for outcomes to be compared between hospitals with different practices with respect to femur fracture fixation timing, and reduced potential for confounding by indication at the patient level.

Results: During the study period 15,055 patients with femur shaft fractures were admitted to 211 trauma centers participating in ACS TQIP. Median age and ISS were 38 years (IQR [interquartile range], 24-61 years) and 10 (IQR, 9-19), respectively. EF was achieved in 11,018 patients (73%). Advanced age, comorbidity, higher ISS, and severe injuries to the head, chest or abdomen were associated with DF (Table 1). PS-matching yielded a well-balanced cohort of 7624 patients. After PS-matching, DF was associated with a significantly higher odds of PE, pneumonia, and decubitus ulcer, but no difference with respect to mortality (Table 2). DF was also associated with significantly longer ICU and hospital LOS (median 9 vs 7 hospital days; RR 1.26; 95% CI 1.21-1.32). Similar results were found in patients with isolated femur fractures. When we compared patient outcomes between trauma centers based on femur fracture fixation timing, patients treated at delayed fixation centers had significantly higher odds of PE (odds ratio [OR] 1.43; 95% CI 1.13-1.81) and longer hospital LOS (RR 1.13; 95% CI 1.11-1.16) compared to those managed at early fixation centers.

TABLE 1. Selected Baseline Characteristics Before Propensity Score Matching

Parameter	Early Fixation (n = 11,018)	Delayed Fixation (n = 4,037)	Standardized Difference (%)
Patient Demographics			
Median age, years (IQR)	34 (23 – 55)	53 (30 – 74)	53.1
Male gender (%)	62.8	52.8	20.4
Comorbid illness (%)			
Coronary artery disease	2.3	6.8	22.1
Hypertension	21.2	38.0	37.5
Diabetes mellitus	7.9	16.7	26.8
Chronic renal failure	0.4	1.8	13.9
Bleeding disorder	3.0	8.5	23.7
Functionally dependent	2.1	5.9	19.2
Injury Characteristics			
Mechanism (%)			41.6
Motor vehicle collision	44.5	33.8	
Fall	25.7	44.8	
Motorcycle	12.1	8.1	
Pedestrian	7.1	6.6	
Other	10.6	6.7	
ISS (%)			27.6
9-15	67.7	62.7	
16-24	17.8	13.0	
25-47	13.7	21.5	
48-75	0.8	2.8	
Severe injury AIS ≥3 (%)			
Head	7.9	14.2	20.2
Chest	21.8	26.8	11.8
Abdomen	6.0	10.7	17.0
ED Characteristics			
Shock (SBP ≤ 90mmHg) (%)	3.7	5.7	9.6
GCS motor component < 3 (%)	4.1	9.3	21.0
Assisted respiration required (%)	6.0	11.3	19.0
Transfusion of pRBCs in first 12 hours (%)	12.2	17.1	14.1
Early Surgical Intervention (<48 hours)			
Craniotomy or intracranial monitor insertion (%)	0.6	3.7	21.2
Thoracotomy or laparotomy (%)	2.3	5.1	14.9

Standardized differences > 10% considered significant

TABLE 2. Outcome Frequency After Propensity Score Matching

Outcome	Early Fixation (n = 3,812)	Delayed Fixation (n = 3,812)	Odds Ratio[†] (95% CI)
Pulmonary embolism, n (%)	67 (1.8)	101 (2.7)	1.53 (1.16 – 2.00)
Pneumonia, n (%)	212 (5.6)	282 (7.4)	1.41 (1.19 – 1.69)
Decubitus ulcer, n (%)	58 (1.5)	99 (2.6)	1.80 (1.37 – 2.36)
Death, n (%)	59 (1.6)	69 (1.8)	1.19 (0.84 – 1.70)

† Estimated using mixed multilevel model accounting for propensity score-matched pairs and clustering of patients within trauma centers

Conclusion: In patients with femur shaft fractures, delayed fixation is associated with increased odds of adverse outcomes, including PE, pneumonia, and decubitus ulcer. Even after adjusting for patient case mix, significant variability exists across trauma centers with

respect to timing of femur fracture fixation. These differences in practice appear to affect patient outcomes, with higher rates of PE and longer hospital LOS at trauma centers with a tendency toward delayed fixation.