

Race May Not Effect Outcomes in Operatively Treated Tibia Fractures

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Abstract

Background A recent review of the literature found worse outcomes and longer length of stay for minorities undergoing TKAs and THAs when compared with whites. It is unclear if this association exists for the operative treatment of tibia fractures.

Questions/purposes The purpose of this study is to determine if there is a difference in etiology or the rate of complications for operative treatment of tibia fractures as a function of racial heritage. Secondary objectives include definition of etiology, mechanism, and fracture location as a function of race in the urban setting, and an attempt to determine if differences in etiology or complications depend on race and fracture location for tibial plateau or shaft fractures.

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Each author certifies that his or her institution approved or waived approval for the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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Methods A retrospective chart review was conducted at our Level 1 urban trauma center from January 1, 2005 to December 31, 2009 using ICD-9 code 823 to identify patients with tibia fractures. Charts were reviewed to confirm operative intervention, location of fracture, mechanism, demographic data, length of stay, and complications (infection, reoperation, compartment syndrome, deep venous thrombosis, pulmonary embolism, death).

Results There was no difference in the rate of infection within 90 days with respect to race. There also was no difference in the rate of reoperation, deep venous thrombosis, pulmonary embolism, mortality, and length of stay between white patients and minority patients. Subgroup analysis showed no difference in the rate of infection for plateau or shaft fractures. Compartment syndrome was more frequent in white patients, specifically white patients with tibia shaft fractures. Minority patients were more likely to have a gunshot wound as a mechanism of injury.

Conclusion With the possible exception of an increased risk of compartment syndrome in white patients, there is no difference in outcomes with respect to race for operatively treated tibia fractures, regardless of fracture location. Gunshot wounds have become an increasingly prevalent mechanism of injury in minority patients.

Level of Evidence Level IV, prognostic study. See the Guidelines for Authors for a description of levels of evidence.

Introduction

There has been recent increased interest related to the variation in outcomes of common orthopaedic procedures regarding race [7, 10]. Nwachukwu et al. [7] noted that research of orthopaedic postoperative outcomes for racial

and ethnic minority groups is sparse. Their recent review of the literature found worse outcomes and longer length of stay for minorities undergoing TKAs and THAs compared with white patients [7]. Walsh et al. [10] described poorer physical function and greater pain in nonwhites after fracture of the distal radius. There is a paucity of literature specifically addressing race as a risk factor in other common orthopaedic procedures.

Tibia fractures are the most common long bone fracture, accounting for nearly half a million fractures per year in the United States [8]. Operative treatment of tibia fractures is complicated by infection in approximately 1% of closed fractures and 5% to 15% of open fractures, depending on the classification of Gustilo and Anderson [5, 9]. Some epidemiologic studies of tibia fractures have had homogenous populations from countries such as Sweden [1] and Scotland [3]. The most common mechanism of injury was sports (soccer) and gunshot wounds were extremely rare. Mechanism of injury and the potential difference in energy imparted to the surrounding soft tissue envelope makes the injuries seen in the urban American trauma center setting much different than those historically described. Although the majority of patients included in historic epidemiologic studies have been white, the urban population is much more heterogeneous. If racial variation in outcomes after surgical interventions occurs, treatment algorithms may need to be modified to accommodate this difference.

The primary purpose of this study is to determine if there is a difference in the rate of complications for operative treatment of tibia fractures regarding race. A secondary objective is to define the etiology, mechanism, and incidence of tibia fractures as a function of race in an urban setting. Finally, the third objective was to determine if differences in etiology or complications depended on race and fracture location, either tibial plateau or shaft.

Patients and Methods

After obtaining IRB approval, a retrospective chart review was conducted at our Level 1 urban trauma center from January 1, 2005, through December 31, 2009 using ICD-9-CM code 823 to identify patients with tibia fractures. Patients were included if they met the following criteria: (1) the patient's race or ethnicity must have been documented; (2) the fracture was treated operatively; (3) the initial surgical intervention was performed at our institution; (4) the patient was 18 to 89 years old; (5) the patient had a fracture of the tibia. Patients were excluded if the fracture was limited to the tibial plafond, the patient had metastatic or bone cancer, the patient had a pathologic fracture, the initial surgical treatment was performed at an outside hospital, or the admitted patient died before

orthopaedic intervention. Subsequent admissions and outpatient charts also were reviewed for evidence of adverse outcomes. Race was determined from patient self-report on the registration face sheet.

This retrospective review identified 324 tibia fractures. After application of the above exclusion criteria, 303 tibia fractures underwent operative fixation: 144 tibial plateau fractures and 159 tibial shaft fractures. White patients accounted for 64 (21%) of the 303 fractures. Minority patients were significantly younger than white patients: 38.3 years versus 48.5 years ($p = 0.001$), respectively. There were no differences between the white and minority groups regarding sex, history of diabetes, and history of tobacco use. There were no differences in history of diabetes, tobacco use, or intravenous drug use between minority and white patients in either group (Table 1).

The principle variable of interest was race and ethnicity. Patients were assigned to one of two groups: white (control or reference) and minority (black, Hispanic, other). Other independent variables that were examined included age, sex, smoking status, comorbidities at time of admission, fracture location and type of fracture, mechanism of injury, and initial and definitive forms of treatment. The outcomes studied include: 30-day mortality (death from any cause within 30 days of initial treatment), wound infection, length of stay (determined from hospital admission to discharge or death), need for reoperation, and presence of deep vein thrombosis (DVT) and/or a pulmonary embolus (PE).

Patient data then underwent subgroup analysis, separated by location of fracture, plateau versus shaft (Table 2). With respect to the subgroups, minority patients were younger than white patients with plateau and shaft fractures: 49.8 years versus 42.8 years ($p = 0.02$) and 46.5 years versus 36.4 years ($p = 0.01$), respectively.

Baseline, demographic, and clinical variables were tested for group differences using t-tests for continuous variables and Fisher's exact test for categorical variables. The analysis of binary outcomes (infection, DVT/PE, reoperation, mortality) was performed using univariate logistic regression. The odds ratios with 95% confidence limits were calculated for each predictor. Differences between groups (rejection of the null hypothesis) and regression effects were considered significant if the

Table 1. Demographic and comorbidities for all tibia fractures

Demographic	White patients	Minority patients	p value
Number of patients	64	238	
Mean age (years)	48.5 ± 17.3	39.3 ± 13.3	0.001
Sex—male	41 (64%)	163 (68%)	0.5
Diabetes mellitus	5 (8%)	19 (8%)	1.0
Smoker	14 (22%)	59 (28%)	0.6

Table 2. Subgroup analysis of fractures by location

Variable	White patients— plateau fractures	Minority patients— plateau fractures	p value	White patients— shaft fractures	Minority patients— shaft fractures	p value
Number of patients	39	105		25	134	
Mean age (years)	49.8 ± 16.2	42.8 ± 12.3	0.02	46.5 ± 19.0	36.4 ± 13.2	0.01
Men	23 (59%)	66 (63%)	0.7	18 (72%)	85 (73%)	1.0
Mean length of stay (days)	7.6 ± 6.9	10.7 ± 7.5	0.002	11 ± 9.5	8.7 ± 7.7	0.5
Infection	3 (8%)	11 (11%)	0.8	2 (8%)	9 (8%)	1.0
Compartment syndrome	5 (13%)	7 (7%)	0.3	5 (20%)	3 (3%)	0.005
Deep vein thrombosis	1 (3%)	5 (5%)	1.0	2 (8%)	4 (3%)	0.3
Diabetes mellitus	3 (8%)	9 (9%)	1.0	2 (8%)	8 (7%)	0.7
Intravenous drug abuse	1 (3%)	0 (0%)	0.3	1 (4%)	1 (1%)	0.3
Smoker	12 (31%)	36 (34%)	0.7	2 (8%)	21 (17%)	0.4
Fall	19 (49%)	36 (35%)	0.12	8 (32%)	34 (28%)	0.8
Gunshot wound	0 (0%)	12 (12%)	0.04	0 (0%)	26 (21%)	0.007
Motor vehicle accident	5 (13%)	19 (18%)	0.6	9 (36%)	27 (23%)	0.2
Automobile versus pedestrian	9 (23%)	20 (19%)	0.6	5 (20%)	21 (18%)	0.8
Direct blow/blunt	4 (10%)	12 (12%)	1.0	2 (8%)	8 (7%)	0.7
Open fracture	1 (3%)	16 (15%)	0.04	11 (44%)	71 (61%)	0.1
Temporary external fixation	9 (23%)	21 (21%)	0.8	7 (28%)	21 (18%)	0.3

probability of chance occurrence was 0.05 or less using two-tailed tests. A post hoc power analysis was performed, assuming an alpha value of 0.05, power value of 0.8, and a value of 2% for a clinically relevant difference in infection rates. The power analysis determined that 1069 patients would be required in each group.

Results

There was no difference in the rate of infection for operatively treated tibia fractures between the two groups (Table 3): five (8%) white patients versus 22 (9%) minority patients (odds ratio [OR], 1.20 [1.44–3.31]) ($p = 1.0$). Of the outcomes assessed, only a difference in the incidence of compartment syndrome was noted with a higher incidence in white patients: 10 (16%) white patients versus 13 (5%) minority patients (OR, 3.21 [1.33–7.70]) ($p = 0.01$). There was also no difference in the rate of reoperation: six (9%) white patients versus 22 (9%) minority patients ($p = 1.0$). The rates of DVT, PE, and 30-day mortality also were found to have no statistical difference between groups ($p = 0.7$, 1.0, and 0.2, respectively).

Regarding mechanism of injury (Table 4), minority patients were more likely to have sustained a fracture attributable to a gunshot wound than white patients: 40 (17%) minority patients versus zero (0%) white patients ($p = 0.004$). There were no other statistical differences in

Table 3. Outcome data for all tibia fractures

Variable	White patients	Minority patients	p value
Compartment syndrome	10 (16%)	13 (5%)	0.01
Infection	5 (8%)	22 (9%)	1.0
Reoperation	6 (9%)	22 (9%)	1.0
Deep vein thrombosis	3 (5%)	9 (4%)	0.7
Pulmonary embolism	0 (0%)	2 (0.1%)	1.0
Mortality (30 days)	1 (1%)	0 (0%)	0.2
Mean length of stay (days)	8.9 (± 8.1)	9.6 (± 7.8)	0.5

Table 4. Mechanism of injury for all tibia fractures

Mechanism	White patients	Minority patients	p value
Fall	27 (42%)	73 (31%)	0.08
Gunshot wound	0 (0%)	40 (17%)	0.004
Motor vehicle accident	14 (22%)	50 (21%)	0.9
Automobile versus pedestrian	14 (22%)	48 (20%)	0.8
Direct blow/blunt	6 (9%)	21 (9%)	0.9
Open fracture	12 (19%)	94 (41%)	0.002

relation to mechanism of injury. Owing to the increased prevalence of gunshot wounds as a mechanism of injury, minority patients had a higher rate of open fractures (94 [41%] patients), when compared with white patients

(12 [19%] patients) ($p = 0.002$). By definition, a fracture attributable to a gunshot wound is an open fracture, as there is direct communication between the fracture and the skin wound and a study found a high rate of contamination at the fracture site [2]. However, some authors have found acceptable infection rates for gunshot fractures managed nonoperatively, suggesting that, although by strict definition, these fractures are open, they are not treated as aggressively as other open fractures [6]. If fractures attributable to gunshot wounds were considered closed injuries, then there were 58 (24%) open fractures in minority patients compared with 12 (19%) open fractures in white patients ($p = 0.3$).

With respect to the analysis of the location of the fracture, there were no significant differences in any of the outcome measurements (infection, reoperation, DVT, PE, and mortality (Table 2). The odds ratios were 1.4 (0.4–5.4) for infection in plateau fractures and 0.95 (0.19–4.73) in shaft fractures. A fall was the most common mechanism of injury, regardless of race, for plateau and shaft fractures. Gunshot wounds accounted for zero (0%) plateau fractures in white patients and 12 (12%) plateau fractures in minority patients ($p = 0.04$), and zero (0%) shaft fractures in white patients and 26 (21%) shaft fractures in minority patients ($p = 0.02$). There were no other differences in mechanism of injury. Minority patients with tibial plateau fractures were more likely to have an open fracture compared with white patients: 16 (15%) versus one (3%), and there was a trend toward a higher rate of open shaft fractures in minority patients when compared with white patients (71 [61%] versus 11 [44%] respectively), although this difference was not found to be statistically significant ($p = 0.1$). There was no difference in the rate of compartment syndrome for patients with plateau fractures, however, five (20%) white patients compared with three (3%) minority patients with shaft fractures had compartment syndrome develop ($p = 0.005$).

Discussion

The question of racial variation of outcomes recently was reported in the orthopaedic literature, most notably for joint arthroplasty [7] and for operative treatment of distal radius fractures [10]. Some studies that comment on the racial variation of outcomes were not primarily designed to address this clinical question, but rather relied on post hoc subgroup analysis for their findings [10]. This type of analysis can inject bias into the interpretation of data, making studies designed to specifically examine race as a variable in outcomes valuable. The primary purpose of this study was to determine if there is a difference in the rate of complications for operative treatment of tibia fractures

regarding race. Secondary objectives included defining the mechanism and incidence of tibia fractures with respect to race in an urban trauma center and to determine if fracture location influenced outcomes with respect to race. This retrospective review confirms that there appears to be no difference in the rate of complications for operatively treated tibia fractures regarding race. Although this may be an obvious conclusion, studies have found differences in outcomes for other common orthopaedic procedures such as distal radius fixation and joint arthroplasty [7, 10].

Several limitations exist in this study. First, the study was underpowered to definitively state that there is no difference between the two groups. The post hoc power analysis showed that more than 1000 patients would have been required in each group, a number unattainable even for high-volume trauma centers. Second, the study was retrospective and susceptible to bias. The lack of standardized protocols for initiation of antibiotics in the presence of fever or erythema complicated the determination of the presence of infection. High crime rates and poor living conditions associated with impoverished areas might contribute to an increased likelihood of having adverse outcomes develop. In addition, our study was limited to data from one institution, limiting the generalizability of the results. Increasing the sample size and broadening it to include different geographic areas and institutions could be measures taken to improve the applicability of the results to the general population. Another limitation was inclusion of patients with polytrauma in the study even though their prevalence in the sample population was limited. Concomitant orthopaedic and nonorthopaedic injuries were not a criterion for exclusion. Adverse outcomes that developed in these patients might have been attributable to another injury. Some patients had a prolonged hospital stay for reasons unrelated to their tibia fracture. Placement issues for the uninsured were another cause for a prolonged hospital stay.

Despite previous series that have cited sports as the most common mechanism of injury [1, 9], our series identified a fall as the most common mechanism. Gunshot wounds have become increasingly prevalent as a mechanism of injury in tibia shaft and plateau fractures, especially in minority patients. Interestingly, despite a higher incidence of open fractures in minority patients (owing to a higher incidence of gunshot wounds), the overall infection rate and complication rate were not different. This may reinforce the principle that gunshot wounds do not require formal operative debridement in most cases. Minority patients were found to be younger than white patients with similar injuries.

This study showed that there is no racial variation in the rate of infection and complications in patients undergoing operative treatment of tibia plateau and tibia shaft fractures. Minority patients are more likely to sustain gunshot

wounds as a mechanism of injury, although this does not appear to result in increased rates of infection. White patients were more likely to have compartment syndrome develop after tibia shaft fracture. This association remains unclear, but could be related to a high incidence of blunt mechanism in shaft fractures in white patients (88% compared with 69% in minority patients). Additional research is needed to determine the cause of this association.

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