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ORTHOPAEDIC SURGERY

Racial disparities in outcomes of operatively treated lower extremity fractures

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Abstract
Purpose Whether racial differences are associated with function in the long term following surgical repair of lower extremity fractures has not been investigated. The purpose of this study is to compare how race affects function at 3, 6 and 12 months post-surgery following certain lower extremity fractures.
Methods Four hundred and eighteen patients treated operatively for a lower extremity fracture (199 tibial plateau, 39 tibial shaft, and 180 rotational ankle fractures) were prospectively followed for 1 year. Race was stratified into four groups: Caucasian, African-American, Hispanic origin, and other. Long-term outcomes were evaluated using the short musculoskeletal function assessment (SMFA) and pain scores were assessed at 3, 6 months and 1 year.
Results There were 223 (53.3%) Caucasians, 72 (17.2%) African-Americans, 53 (12.4%) Hispanics, and 71 (17.0%) patients from other ethnic groups, included in our study population. Minority patients (African-American, Hispanics, etc.) were more likely to be involved in high velocity mechanisms of injury and tended to have a greater percentage of open fractures. Although there were no differences in the rate of wound complications or reoperations, long-term functional outcomes were worse in minority patients as assessed by pain scores at 6 months and functional outcome scores at 3, 6 and 12 months. Multivariate analysis revealed that only African-American and Hispanic race continued to be independent predictors of worse functional outcomes at 12 months.
Conclusions Racial minorities and those on medicaid had poorer long-term function following fractures of the lower extremity. While minority patients were involved in more high velocity accidents, this was not an independent predictor of worse outcomes. These disparities may result from multifactorial socioeconomic factors, including socioeconomic status and education levels that were not controlled in our study.
Level of evidence Prognostic Level III.

Keywords Racial disparities · Lower extremity · Trauma · Fracture · Outcomes

Introduction

Research persistently demonstrates that disparities in care delivery and patient outcomes adversely affect racial and

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ethnic minorities throughout many medical specialties. Biases and limited access to care have led to lower quality and quantity of healthcare for minority groups [1–4], resulting in poorer overall outcomes in these populations [5, 6]. Racial disparities within the United States healthcare system are estimated to cost on average more than $57 billion per year [7]. While there have been reports in the orthopaedic community examining outcomes as it pertains to healthcare disparities, there is insufficient evidence to support generalization to the entire field. The vast majority of published works in the orthopaedic literature on these disparities have focused on how patient racial or ethnic identity has affected treatment decisions, complication rates, and outcomes in either spine surgery or joint replacements [8–11].

Currently, few studies examine health disparities in orthopaedic trauma. Unlike elective procedures, trauma patients are treated on an emergent basis, potentially eliminating the influence of bias on decisions such as when a surgical procedure will be performed and on whom. While poorer outcomes have been demonstrated in minority patients after upper extremity fractures [12], only six studies to date have examined outcomes in minorities with lower extremity fractures, all demonstrating equivocal results [13, 14].

The purpose of this study was to determine if racial disparities exist in functional outcomes, one year following the surgical treatment of certain lower extremity fractures. We hypothesized that while patients of different races may have similar short-term outcomes, long-term functional outcome will vary.

Methods

Using IRB approved prospectively collected lower extremity fracture databases maintained by our institution, we performed a retrospective analysis to identify patients who met the following inclusion criteria: age >18 years, operatively treated isolated fractures and ≥1 year post-operative follow-up. Exclusion criteria included patients ≤18 years old, polytrauma patients, nonoperative treatment, and patients with incomplete 1-year post-operative follow-up. All patients were treated by one of three orthopaedic traumatologists and underwent similar surgical approaches and post-operative physical therapy protocols [15, 16]. All patients underwent informed consent process at initial presentation by IRB approved research staff.

Patient characteristics, including age, gender, race, insurance type, smoking status comorbidities, and injury characteristics were collected on initial presentation by trained research personnel. Functional outcome scores were measured using the short musculoskeletal functional assessment (SMFA). Pain scores were measured using the Visual Analogue Scale (VAS). These two primary outcomes were measured at 3, 6, and 12 months postoperatively. Any reoperations, wound complications, and if the fractures had healed were recorded at all of these follow-up time points.

Patients were stratified into four groups based on self-reported race for analysis: Caucasian, African-American, Hispanic, and other. Univariate analyses were performed using Chi-square test for dichotomous variables and ANOVA analysis when comparing means between multiple groups. A multivariate logistic regression model was created to control for age, Charlson Comorbidity Index (CCI), open fracture, high velocity injuries, insurance type, and race to determine independent risk factors for worse SMFA outcomes at 1 year postoperatively. $P < 0.05$ was considered significant.

Results

Four hundred and eighteen patients (199 tibial plateau, 39 tibial shaft, and 180 rotational ankle fractures) met inclusion criteria and form the basis of this report. Racial breakdown of patients was as follows: 223 (53.3%) Caucasians, 72 (17.2%) African-Americans, 52 (12.4%) Hispanics, and 71 (17.0%) patients from other racial or ethnic minority groups. While age and gender did not significantly differ between the four study cohorts, variations in type of insurance were evident (Table 1). In particular, Caucasian and Hispanic patients had the highest rates of Medicare Insurance at 13.4 and 21.1%, respectively, significantly higher than African-Americans (1.8%) ($p = 0.01$). Racial and ethnic minorities were more likely to be uninsured with rates as high as 13.9% compared to a rate of 2.9% among Caucasians ($p = 0.01$). Workers' compensation and medicaid rates were similar between all racial groups ($p = 0.90$; $p = 0.17$). Injury characteristics also varied across racial and ethnic groups. Minority patients sustained a greater percentage of high velocity trauma and open fractures. While the differences in injury mechanism were significant ($p = 0.04$), the differences in soft tissue status were not ($p = 0.47$). It is also important to note that there were no significant variations in other risk factors, such smoking status or comorbidities as rated by the Charlson Comorbidity Index (CCI), between the various racial and ethnic groups (Table 1).

Mean SMFA outcomes scores over time are illustrated in Fig. 1. African-Americans and Hispanics consistently experienced worst functional outcomes as compared to Caucasians throughout the follow-up period. There were no differences in baseline SMFA ($p = 0.42$). While outcomes

Table 1 Baseline characteristic between races

Race	Caucasian	African-American	Hispanic	Other	*p* value
# of patients ($n = 418$)	223 (53.3%)	72 (17.2%)	52 (12.4%)	71 (17.0%)	
Patient characteristics					
Age (years)	47.4 ± 17.6	43.5 ± 13.4	44.6 ± 15.6	45.9 ± 15.8	0.31
Male	51.6%	45.8%	57.7%	50.7%	0.63
Uninsured	2.9%	13.7%	13.9%	13.7%	0.01
Medicaid	9.5%	14.5%	21.1%	16.9%	0.17
Medicare	13.4%	1.8%	21.1%	5.1%	0.01
Private insurance	70.4%	69.6%	52.6%	64.4%	0.18
Workers comp	6.0%	6.7%	5.4%	3.6%	0.90
CCI	1 ± 1.2	0.7 ± 1.0	0.9 ± 1.3	1.1 ± 1.2	0.59
Smoking	27.4%	29.2%	23.1%	21.1%	0.86
Open fracture	3.8%	10.2%	7.9%	6.5%	0.47
High velocity injuries	45.7%	63.3%	60.5%	67.4%	0.04

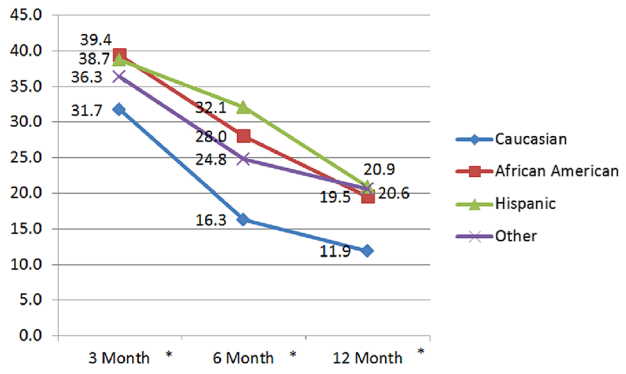

Fig. 1 Total SMFA Scores in lower extremity fractures by race at 3, 6 and 12 months post-injury. *SMFA* short musculoskeletal functional assessment. *Asterisk* denotes significant difference ($p < 0.05$). There was no significant difference in baseline SMFA ($p = 0.42$)

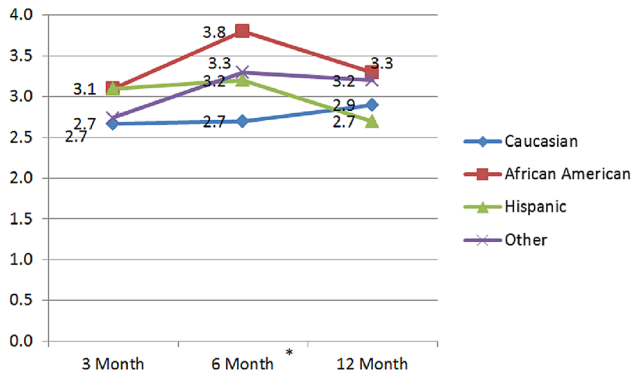

Fig. 2 VAS Pain Scores in lower extremity fractures by race at 3, 6 and 12 months post-injury. *VAS* Visual Analog Scale. *Asterisk* denotes significant difference ($p < 0.05$)

were statistically significant at 3 months ($p = 0.04$), by 6- and 12-month follow-up these differences in SMFA were much more pronounced demonstrating p values less than 0.01. However, similar trends were not seen in pain scores measured with the VAS (Fig. 2). Although Caucasians had better pain scores throughout the follow-up period, these differences were only significant at the 6-month time point ($p < 0.01$). There were no differences across the ethnicities in the rate of wound complications, nonunion rate and reoperations by 1 year post-operation ($p = 0.19$; $p = 0.44$; $p = 0.10$).

Table 2 demonstrates the results from a multiple regression model examining independent predictors of 12-month functional outcomes. Age, comorbidities, mechanism of injury, soft tissue status, and insurance type were included as the dependent variables. African-American race had the greatest influence on the model, resulting in significantly worse adjusted function on the SMFA at 12 months post-injury (regression coefficient = 12.68; 95% confidence interval,

Table 2 Multiple linear regression examining independent predictors of 12-month functional outcomes

	B	95% Confidence interval	Significance
Age	0.07	−0.33 to 0.47	0.73
Open fracture	18.05	−0.55 to 36.65	0.06
CCI	2.57	−2.00 to 7.14	0.27
High velocity injury	−6.37	−12.42 to −0.329	0.04
Uninsured	−13.19	−29.97 to 3.58	0.12
Medicaid	5.61	−13.28 to 24.50	0.56
Medicare	−9.937	−29.49 to 9.62	0.32
Private	−6.71	−24.01 to 10.59	0.45
Workers compensation	4.22	−13.00 to 21.45	0.63
African-American	12.54	4.00 to 21.01	0.004
Hispanic	9.34	0.92 to 17.77	0.03
Other races	2.48	−6.25 to 11.21	0.58

4.18–21.17). Adjusted function was also significantly worse for Hispanics, albeit to a lesser extent (regression coefficient = 8.645; 95% confidence interval, 0.36–16.93). Being in the "other minorities" category was not a significant predictor of worse functional outcomes at 12 months post-injury. In fact, the only other significant independent predictors of functional outcome in the multiple regression model were patients who sustained high velocity injuries.

Discussion

Although racial disparities in American medical care are known to be widespread, little is known about the prevalence of these disparities in orthopaedic surgery. The majority of studies in orthopaedic surgery have been performed in the joint arthroplasty and spine specialties, with a recent systematic review identifying a combined 30 studies that measured complications or mortality rates between races [8]. Not only was there insufficient evidence to support generalization across the entire orthopaedic field, but there was lack of literature addressing disparities specifically in orthopaedic trauma. To our knowledge, only seven reports have been identified that examine how race influences outcomes in this field: four examining effects after hip fracture care [17–19], one after distal radius fractures [12], and two after tibia fractures [13, 20].

Both short- and long-term outcome studies have been performed to determine the effect that race has on hip fracture care. These reports demonstrated that African-Americans exhibited a lower adjusted 30-day mortality rate, and that these rates became almost equivalent at 190 days. By 6 months and 1 year, these rates had reversed with African-Americans having a decreased likelihood of both survival and ambulatory function [17, 18]. Neuman et al. theorized that these trends could be explained from an increased rate of non-operatively treated hip fractures observed in African-Americans in their study, hypothesizing that this might have eliminated short-term risks of surgery and anesthesia, but would be associated with profoundly lower ambulatory function and mortality in the long run [19]. Walsh et al. were able to limit this treatment bias by controlling for operatively treated distal radius fractures, but still found worse long-term outcome disparities in Latinos. These trends have not been found after tibia fractures. In a report by Piposar et al., examining operatively treated tibia fractures, the rate of reoperation or complications did not differ between white and minority patients within 90 days [13]. Here, we present the first study to our knowledge that examined long-term outcomes in these lower extremity fractures as it relates to racial and ethnic minority patients.

In the current investigation, African-Americans and Hispanics were found to have worse functional outcomes based on SMFA at 3, 6 and 12 months following lower extremity fracture fixation. Given that numerous factors are known to play a role in the manifestation of healthcare inequities, appropriate controls are particularly important in these studies. Studies have demonstrated that measurable variables such as education level, salary, and insurance type can influence the effect of race on health outcomes [21]. Many other unquantified factors are also known to be at play, including attitudes towards healthcare, provider unconscious bias, cultural overtones, and community environment [22]. One report has demonstrated that African-Americans are more reluctant to undergo joint replacement surgery, citing less familiarity with the procedure and worse expectations of post-operative pain, functioning and recovery [3]. In this investigation, even after adjusting for insurance status and injury characteristics, disparities for minority patient groups persisted at 12 months post operatively.

Orthopaedic trauma provides an interesting window to examine health care disparities. Typically, we have not thought of these patients as susceptible to treatment bias given that the clinical decisions for operative treatment of fractures are not dictated by skin color or annual income. This is supported by recent reports finding little difference in short-term complications and mortality in this patient population [13]. It is interesting to find that as time after injury increases, differences become more apparent between ethnic and racial patient groups. It could be theorized that these disparities exist due to differences in follow-up care following the 90-day global fee period, in particular the initiation and intensity of physical therapy. In a study examining over 2000 Medicare patients after hip fractures, it was found that African-Americans had a much higher likelihood to receive poor rehabilitative therapy, with only 37% receiving proper therapy compared to 57% of their "non-black" counterparts [23]. Walsh et al. reaffirmed this difference in their report, showing that Latinos obtained less physical therapy sessions for their distal radius fractures at 1 year postoperatively, despite having markedly poorer function [12].

Disparities in pain levels were also observed in this study with significant differences noted only at 6 months postoperatively. Interesting, African-Americans had the worst pain scores throughout the post-operative period, which is not consistent with most of the published literature. It has been demonstrated repeatedly that Hispanics experience more severe chronic joint pain as compared to Caucasians [24–28]. However, it has also been reported that African-Americans generally undergo less aggressive management for their osteoarthritic pain and obtain fewer analgesics compared to Caucasians [29, 30]. These differences are still seen even when they report greater levels of pain [31, 32]. Similar trends after fracture care, therefore,

might explain these disparities in pain control observed in this report. Disparities in pain management and other clinical decisions made for differing racial and ethnic groups have also been attributed to provider unconscious bias [33]. Though unconscious bias was not quantified in this study and other investigations have had mixed results on its influence for clinical assessment, it should not be discounted in future studies accounting for patient outcome disparities [34, 35].

There are several limitations in the study that should be addressed. As a single center retrospective review of prospectively collected data, the study lacked additional demographic data that could affect outcomes in these populations. Although insurance data was collected, this study was unable to control for other socioeconomic factors such as education level and income that could have confounding effects on the racial inequalities described. Additionally, the lower extremity fractures in this study are a sampling of fracture patterns seen in the lower extremity, and not generalizable to all lower extremity traumatic fractures.

It should also be noted that in efforts to define races into distinct stratums, the results might under- or over-represent disparities that could exist. Race is inherently a social construct rather than one based on biological underpinnings, and thus a problematic means of identifying patients and generalizing findings [36]. For example, the designation of Hispanic is a broad category of 400 million people from various countries of origin, cultural values, and socioeconomic class [37]. Therefore, this current classification of race into four distinct groups, while better than grouping all minorities together into a heterogenous classification of non-white is filled with limitations as to why we can say why these disparities exist.

This is the first report to specifically examine whether differences in long-term outcomes in lower extremity fractures are affected by patients' race. Racial and ethnic minority patients tended to have more severe mechanisms of injury and open fractures as compared to Caucasians. A multiple regression analysis created to examine factors that result in worse outcome at 12 months found that only African-American and Hispanic race were significant independent predictors, even after controlling for Medicaid and Workers' Compensation status. While these racial disparities are likely influenced by a multitude of factors, including socioeconomic status, social determinants of health, and education level that were not controlled for in our study, orthopaedic trauma surgeons should still be aware of these differences so as to implement early interventions to improve patient recovery.

Author contribution All authors contributed to the literature search, study design, data collection, data interpretation, writing and critical revision. The first author additionally did all of the data analysis.

Compliance with ethical standards

Conflict of interest None of the authors have financial or institutional disclosures to report related to the research in this paper.

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