

Clinical Research

# Racial Disparities are Present in the Timing of Radiographic Assessment and Surgical Treatment of Hip Fractures

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## Abstract

**Background** Hip fractures are associated with 1-year mortality rates as high as 19% to 33%. Nonwhite patients have higher mortality and lower mobility rates at 6 months postoperatively than white patients. Studies have extensively documented racial disparities in hip fracture outcomes, but few have directly assessed racial disparities in the timing of hip fracture care.

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

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**Questions/purposes** Our purpose was to assess racial disparities in the care provided to patients with hip fractures. We asked, (1) do racial disparities exist in radiographic timing, surgical timing, length of hospital stay, and 30-day hospital readmission rates? (2) Does the hospital type modify the association between race and the outcomes of interest?

**Methods** We retrospectively reviewed the records of 1535 patients aged 60 years or older who were admitted to the emergency department and treated surgically for a hip fracture at one of five hospitals (three community hospitals and two tertiary hospitals) in our health system from 2015 to 2017. Multivariable generalized linear models were used to assess associations between race and the outcomes of interest.

**Results** After adjusting for patient characteristics, we found that black patients had a longer mean time to radiographic evaluation (4.2 hours; 95% confidence interval, -0.6 to 9.0 versus 1.2 hours; 95% CI, 0.1-2.3;  $p = 0.01$ ) and surgical fixation (41 hours; 95% CI, 34-48 versus 34 hours 95% CI, 32-35;  $p < 0.05$ ) than white patients did. Hospital type only modified the association between race and surgical timing. In community hospitals, black patients experienced a 51% (95% CI, 17%-95%;  $p < 0.01$ ) longer time to surgery than white patients did; however, there were no differences in surgical timing between black and white patients in tertiary hospitals. No race-based differences were observed in the length of hospital stay and 30-day hospital readmission rates.

**Conclusions** After adjusting for patient characteristics, we found that black patients experienced longer wait times to radiographic evaluation and surgical fixation than white patients. Hospitals should consider evaluating racial disparities in the timing of hip fracture care in their

health systems. Raising awareness of these disparities and implementing unconscious bias training for healthcare providers may help mitigate these disparities and improve the timing of care for patients who are at a greater risk of delay.

*Level of Evidence* Level III, therapeutic study.

## Introduction

As the population ages, the annual number of hip fractures in the United States is expected to increase from 340,000 [13] to 840,000 [15] by 2040. Hip fractures are associated with substantial rates of morbidity [4, 18], and mortality rates after hip fracture have been reported to range from 3.5% to 10% at 30 days [6, 9] and from 19% to 33% at 1 year [30, 37]. Hip fractures are also expensive to treat, accounting for approximately 72% of total fracture costs but constituting only 14% of all fractures [5]. A recent study reported that the average direct annual medical cost associated with a hip fracture is more than USD 50,000, costing the United States healthcare system nearly USD 6 billion yearly [2]. Enhancing the delivery of hip fracture care can improve patient outcomes and reduce the economic burden of this condition [21].

Despite studies showing racial disparities in orthopaedic care [24, 27], a recent survey of members of the American Orthopaedic Association found that only 9% of orthopaedic surgeons believe that race or ethnicity influences the orthopaedic care patients receive [1]. One study reported that nonwhite patients with hip fractures have lower mobility rates and higher mortality rates at 6 months post-operatively than white patients do [28]. Dy et al. [12] assessed racial disparities in the care of patients with hip fractures, reporting that black patients were at a greater risk of death within 1 year and were more likely to be readmitted to the hospital within 90 days and have delayed surgery than white patients were. Their findings were limited because they used administrative data, which are susceptible to inconsistent reporting and coding inaccuracies [19, 33]. To our knowledge, race-based differences in radiographic timing and length of hospital stay for patients with hip fractures have not been reported. Racial disparities in surgical timing and readmission rates have been examined, with conflicting results because of the quality and settings of the studies [12, 26, 32]. We therefore wished to assess racial disparities in the care provided to patients with hip fractures.

Specifically, we asked, (1) do racial disparities exist in radiographic timing, surgical timing, length of hospital stay, and 30-day hospital readmission rates? (2) Does the hospital type modify the association between race and the outcomes of interest?

## Patients and Methods

### Study Population

After obtaining a waiver of consent from our institutional review board, we performed a retrospective review and extracted patient information from our institution's electronic medical record. We identified all patients aged 60 years or older who were admitted to the emergency department and treated surgically for a hip fracture at five hospitals in our health system from January 1, 2015 through December 31, 2017. We used the International Classification of Diseases, Tenth Revision, diagnosis codes and Current Procedural Terminology codes (27235, 27236, 27244, and 27245) to identify patients with operatively treated hip fractures.

A total of 1535 patients (70% women) met our inclusion criteria (Table 1). Most patients were white (84%), followed by patients who were black (7.6%), Asian (4.5%), and other races (3.9%). Insurance status was categorized as Medicare (82%), private insurance (16%), Medicaid (0.7%), or other (1.9%). The "other" category included worker's compensation, self-pay, and auto mobile insurance.

### Variables

Patient race was classified as white, black, Asian, or other race. Patients who identified as American Indian, Alaska Native, Native Hawaiian, other Pacific Islander, or other were all included in the other race category because of the small sizes of the individual groups. Data on ethnicity were unavailable. Each hospital was categorized as a community hospital (n = 3) or a tertiary hospital (n = 2). Hospitals were classified according to size and location. Community hospitals had fewer than 300 patient beds and were located in suburban areas, whereas tertiary hospitals had more than 300 patient beds and were located in urban areas. Hospital type was explored as an effect modifier between race and the outcomes of interest. We adjusted for the following potential confounders: age, sex, insurance status, BMI, Charlson comorbidity index (CCI) value, and American Society of Anesthesiologists (ASA) score.

### Outcomes

The primary outcomes of interest were the time from rooming in the emergency department to the first radiograph of the hip (radiographic timing) and the time from rooming in the emergency department to surgery (surgical timing). Additional outcomes were the length of hospital stay and 30-day readmission rate.

**Table 1.** Characteristics of 1535 patients treated surgically for hip fractures at five hospitals, 2015 to 2017

Variable	Race								Overall	
	White (n = 1289)		Black (n = 117)		Asian (n = 69)		Other race (n = 60)		(n = 1535)	
	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD	n (%)	Mean ± SD
Age (years)		82 ± 9.3		81 ± 11		81 ± 9.3		82 ± 11		82 ± 9.5
Female sex	907 (70)		73 (62)		48 (70)		43 (72)		1071 (70)	
Medicare insurance	1064 (83)		95 (81)		52 (75)		42 (70)		1253 (82)	
BMI (kg/m <sup>2</sup> )		24 ± 5.5		24 ± 6.2		22 ± 3.8		23 ± 5.6		24 ± 5.5
CCI		5.8 ± 1.8		6.8 ± 2.4		5.5 ± 1.5		5.5 ± 1.9		5.9 ± 1.9
ASA score		2.7 ± 0.8		2.9 ± 0.6		2.6 ± 0.7		2.7 ± 0.8		2.7 ± 0.8
Treated at community hospital	881 (68)		62 (53)		58 (84)		46 (77)		1047 (68)	

**Statistical Analysis**

Generalized linear models were used to assess the association between race and the outcomes of interest, with adjustment for patient age, sex, insurance status, BMI, CCI, and ASA score. Insurance status was dichotomized as Medicare or other in the models. Normal distribution with log link and binomial distribution with logit link were used for continuous and binary outcomes, respectively. These models included within-patient robust variance estimates to account for repeated observations for a patient [31].

Potential effect modification by hospital type was explored by incorporating appropriate statistical interaction terms of race and hospital type in the multivariable models. Because of small sample sizes, only white and black patient groups were used in the effect modification analysis.

All tests were two-sided, and statistical significance was considered to be  $p < 0.05$ . Analyses were performed using Stata software, version 15 (StataCorp LLC, College Station, TX, USA).

**Results**

**Radiographic Timing**

The mean ± standard deviation of radiographic timing was 1.8 hours ± 6.9 hours. After adjusting for age, sex, insurance status, BMI, CCI, and ASA score, black patients waited, on average, 3.0 hours longer than white patients for their first hip radiograph (4.2 hours; 95% confidence interval, -0.6 to 9.0 versus 1.2 hours; 95% CI, 0.1-2.3;  $p = 0.01$ ) (Table 2). Compared with a radiographic timing of less than 2 hours, a wait time of more than 4 hours was associated with a 57% increase in time to surgery ( $p < 0.01$ ). Hospital type did not

modify the difference in radiographic timing between white and black patients (effect size = 21.3; 95% CI, 0.01-34000;  $p = 0.42$ ).

**Surgical Timing**

The mean ± SD surgical timing was 35 hours ± 34 hours. After adjustment for patient characteristics, black patients had a longer time to surgery (mean 41 hours; 95% CI, 34-48) than white patients did (mean 34 hours; 95% CI, 32-35;  $p = 0.045$ ) (Table 3).

Hospital type modified the difference in surgical timing between white and black patients (95% CI, 1.08-2.41; effect size 1.62;  $p = 0.02$  for interaction). In the adjusted analysis, black patients who were treated at community hospitals had a wait time to surgery that was 51% (95% CI, 17%-95%;  $p = 0.002$ ) longer than that experienced by white patients. However, in tertiary hospitals, there was no association between race and surgical timing (ratio of means 1.07; 95% CI, 0.80-1.44;  $p = 0.65$ ).

**Table 2.** Associations between patient race and radiographic timing for 1535 patients treated surgically for hip fractures at five hospitals, 2015 to 2017

Race	Mean (95% CI) radiographic timing (hours) <sup>a</sup>	p value
White	1.2 (0.1-2.3)	Referent
Black	4.2 (-0.6 to 9.0)	0.01
Asian	2.3 (0.7-3.9)	0.09
Other race	5.5 (-0.5 to 12)	0.14

<sup>a</sup>Adjusted for age, sex, insurance status, BMI value, CCI, and ASA score.

**Table 3.** Associations between patient race and surgical timing for 1535 patients treated surgically for hip fractures at five hospitals, 2015 to 2017

Race	Mean (95% CI) surgical timing (hours) <sup>a</sup>	p value
White	34 (32-35)	Referent
Black	41 (34-48)	0.045
Asian	37 (31-43)	0.36
Other race	42 (28-56)	0.21

<sup>a</sup>Analysis adjusted for age, sex, insurance status, BMI, CCI, and ASA score.

### Length of Hospital Stay

The mean  $\pm$  SD length of hospital stay was 5.9 days  $\pm$  4.2 days. No racial disparities in the length of hospital stay were observed (Table 4). Hospital type did not modify the difference in the length of hospital stay between white and black patients (effect size 1.02; 95% CI, 0.65-1.59;  $p = 0.95$ ). Older age and higher BMI, CCI, and ASA score were associated with longer hospital stays.

### Thirty-day Hospital Readmissions

Overall, the 30-day readmission rate was 9.1%. We found no racial disparities in 30-day readmission rates (Table 5). Hospital type did not modify the association between race and the 30-day readmission rate (effect size 1.29; 95% CI, 0.36-4.63;  $p = 0.69$ ). Male sex and higher CCI values were associated with a greater risk of 30-day readmission.

### Discussion

Few studies have directly assessed racial disparities in hip fracture care. The studies that have examined these disparities reported inconsistent results because of differences in the quality of data and study setting. We used clinical

**Table 4.** Associations between patient race and length of hospital stay for 1535 patients treated surgically for hip fractures at five hospitals, 2015 to 2017

Race	Mean (95% CI) length of stay (days) <sup>a</sup>	p value
White	5.7 (5.5-5.9)	Referent
Black	6.9 (5.4-8.4)	0.10
Asian	5.9 (5.1-6.6)	0.69
Other race	6.3 (5.3-7.4)	0.26

<sup>a</sup>Analysis adjusted for age, sex, insurance status, BMI, CCI, and ASA score.

data from five hospitals in our health system to determine whether patient race is associated with radiographic timing, surgical timing, length of hospital stay, and 30-day hospital readmission rates. We also wanted to determine whether the hospital type modified the association between race and the outcomes of interest.

### Limitations

Our study has several limitations in addition those that generally apply to retrospective studies. The results from this study are based on one health system and are not generalizable to other locations. In addition, we were unable to include ethnicity in our analysis. Similarly, we could not conduct analyses of individual racial groups (for example, American Indian or Alaska Native) because of small sample sizes. Additionally, because of the limited sample sizes of racial groups other than black and white, modification of hospital type was not analyzed, and some conclusions are limited for these groups. Although we had small sample sizes for nonwhite racial groups, our study was more representative of the racial diversity of the United States population than previous studies were [12, 26] (the United States population is 76.5% white, 13.4% black, and 5.9% Asian) [35]. We made our selection criteria as inclusive as possible and adjusted for various patient factors in our analysis to minimize selection bias. We also used objective outcome measures to limit concerns of assessment bias.

Another potential limitation is the lack of data on the time between injury and presentation to the emergency department. This could have affected the assessment of acuity and consequently the timing of radiographic assessment, but it is unclear what effect this would have on our analysis because, to our knowledge, racial disparities in seeking care for acute injuries have not been described. Moreover, we examined only two patient outcomes: length of hospital stay and the 30-day hospital readmission rate. Ideally, we would have examined outcomes such as post-operative death and complication rates and determined whether disparities in the timing of care were associated with poorer outcomes based on these measures. Finally, we were unable to document readmissions to hospitals outside our system. This may have caused us to underestimate the 30-day readmission rate, but we are unsure about the effect this underestimation may have on our analysis.

### Racial Disparities in Key Metrics of Treatment

Racial disparities in emergency department wait times have been reported. Nonwhite [34] and black [3] patients who presented to the emergency department with chest pain waited longer than white patients did to undergo initial

**Table 5.** Odds and rates of 30-day hospital readmission by patient race for 1535 patients treated surgically for hip fractures at five hospitals, 2015 to 2017

Race	Number of patients	30-day readmission rate (%)	Adjusted analysis <sup>a</sup>	
			OR (95% CI)	p value
White	1289	8.8	1.00	Referent
Black	117	13	1.2 (0.6-2.2)	0.58
Asian	69	7.2	0.8 (0.3-2.1)	0.67
Other race	60	8.3	0.9 (0.4-2.4)	0.87

<sup>a</sup>Analysis adjusted for age, sex, insurance status, BMI, CCI, and ASA score.

electrocardiography. Similarly, black patients with acute ischemic stroke waited longer in the emergency department than white patients did to undergo initial CT [17]. After adjustment for patient characteristics, we found that black patients experienced longer time to radiographic assessment than did white patients. The longer time to radiography experienced by black patients may be attributable to conscious or unconscious biases of healthcare professionals, which may be heightened in the emergency department setting [23, 38]. Addressing this disparity is important because we found that patients who waited more than 4 hours for a radiographic evaluation also waited longer for surgical treatment than did patients who waited less than 2 hours for a radiographic assessment. Extensive research has reported the association between longer surgery delays and worse hip fracture outcomes [11, 14, 22, 29, 36].

Several studies have examined the association between patient race and delayed surgical treatment of hip fractures. Dy et al. [12] used administrative data to retrospectively review nearly 200,000 patients who had hip fracture surgery in New York State between 1998 and 2010. After adjusting for patient characteristics, they reported that black patients had greater odds (odds ratio 1.49; 95% CI, 1.42-1.57) of delayed surgery (defined as more than 48 hours after presentation) than did white patients. Similarly, Ryan et al. [32] analyzed data from more than 2.1 million patients who underwent surgery for hip fractures and found that black patients had greater odds (odds ratio 1.48; 95% CI, 1.39-1.58) of experiencing surgery delays than did white patients. Similarly, our adjusted analysis showed that black patients waited longer for surgery (41 hours) than did white patients (34 hours). In contrast, Okike et al. [26] analyzed data from the Kaiser Permanente Hip Fracture Registry and found no differences in surgery delays between black patients and white patients. The authors attributed the lack of racial disparities to the implementation of standardized protocols by their health system. Although the acceptable waiting time for surgery is debated, a high-quality study found that 24 hours is a threshold above which patients have a higher risk of complications and death [29]. To our knowledge, our study is the first to explore race-based differences in the length of hospital stay

for patients with hip fractures. We did not find race-based differences in the length of hospital stay. Surgery within 24 hours has been shown to be associated with a shorter length of stay [36], and none of the racial groups we analyzed had a mean surgery wait time of less than 24 hours. Larger multi-system studies are needed to further explore the presence of racial disparities in the length of hospital stay. Shorter hospital stays not only reduce healthcare costs [20] but are also associated with lower 30-day mortality rates for patients with hip fractures [25].

The 30-day readmission rate is a metric used by the Centers for Medicare & Medicaid Services to assess the quality of care [7]. We found that nonwhite patients had similar rates of 30-day readmission to white patients. Dy et al. [12] and Okike et al. [26] found that black and Asian patients had higher and lower rates, respectively, of 90-day readmission than did white patients. However, 30-day readmissions might be a more accurate measure of quality of hospital care than 90-day readmissions because community- and household-level factors beyond the hospital’s control are associated with higher rates of readmission after the seventh day of discharge [8].

**Association Between Hospital Type and Surgical Timing**

The hospital types we studied differed in terms of racial disparities in surgical timing. At our three community hospitals, black patients experienced longer wait times for surgery than did white patients. At our two tertiary hospitals, black and white patients experienced similar wait times for surgical fixation of their hip fracture. This difference based on hospital type may be attributable to residential racial segregation, which has resulted in a differential race composition of the patient population treated at tertiary and community hospitals [39]. We found that black patients comprised 11.3% of patients treated at tertiary hospitals but only 5.9% of patients treated at community hospitals. In a previous study, black people living in predominantly white residential areas reported facing higher levels of discrimination than did black people



living in predominantly black residential areas [16]. Our three community hospitals are located in suburban areas where black residents constitute only 5% [10], 20%, and 20% [35] of the population. In contrast, our two tertiary hospitals are located in a city where black residents constitute 63% of the population [35].

## Conclusions

After adjusting for patient characteristics, we found that black patients experienced longer wait times to radiographic evaluation and surgical fixation of hip fractures than white patients. Although these disparities in care did not translate to poorer outcomes in terms of length of hospital stay or 30-day hospital readmission rates, it is crucial to address disparities in the timing of care and ensure equitable treatment, regardless of race. Raising awareness of these disparities in the care of hip fractures, especially among orthopaedic surgeons, is imperative because only a small percentage of orthopaedic surgeons perceive that patient race influences orthopaedic care [1]. Furthermore, hospitals should consider evaluating their own time to radiographic assessment and surgical fixation to determine whether racial disparities exist in their health systems. Healthcare institutions can play an active role in mitigating healthcare disparities by facilitating discussions and training sessions for clinicians to promote bias literacy and by considering the implementation of standard pathways.

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