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The impact of race on the development of severe heterotopic ossification following acetabular fracture surgery

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ABSTRACT

Objectives: To determine the association between race on severe heterotopic ossification (HO) following acetabular fracture surgery.
Design: Retrospective case control study.
Setting: Level I university trauma centre.
Methods: Two hundred and fifty-three patients who were surgically treated for acetabular fractures were retrospectively evaluated. Postoperative radiographs were evaluated for HO by a blinded musculoskeletal radiologist, and classified based on a modified Brooker classification.
Results: Of the 253 patients that met inclusion and exclusion criteria, 175 (69%) were male and 78 (31%) were female. One hundred and fifty-four (61%) patients were Caucasian, and 99 (39%) were African American (AA). Fifty-five (21%) patients developed severe HO. Of those who developed severe HO, 25 were Caucasian (45%), 30 were African American (55%). Forty-one patients (75%) with severe HO were male, and 14 (25%) were female. No statistical differences ($p > 0.05$) were found between groups in terms of age, days to surgery, GCS at presentation, surgical approach, perioperative HO prophylaxis, or AO/OTA fracture classification. The patient population was then stratified by race, gender, and race/gender. AA were more likely than Caucasians to develop severe HO (odds ratio [OR], 2.24; confidence interval [CI], 1.22–4.11). When gender was considered independent of race, no statistical differences ($p > 0.05$) were observed (OR, 1.40; CI, 0.71–2.75). AA males were much more likely to develop severe HO when compared to Caucasian females (OR, 4.4; CI, 1.38–14.06).
Conclusion: Race is associated with different rates of severe HO formation following acetabular fracture surgery. AA patients are significantly more likely to develop severe HO following acetabular fracture surgery when compared to Caucasian patients.

Introduction

Heterotopic ossification (HO), is defined as the development of mature bone within soft tissues [1,2]. Although the cellular aetiology for HO formation has not been clearly identified, it likely involves pluripotent mesenchymal cell differentiation into osteoprogenitor cells as a result of both local and systemic changes [3–5].

The development of HO following surgical fixation of acetabular fractures is a well-recognised complication in the orthopaedic literature [3,6–10]. Additionally, significant HO development has been correlated with worse functional outcomes [8,11–13], and may be associated with increased post-operative pain [13]. Severe HO formation necessitating exploration and surgical excision is often associated with significant morbidity and poor functional outcomes. Patients requiring HO prophylaxis are usually treated with non-steroidal anti-inflammatory medications (NSAIDS), such as indomethacin, and/or radiation. Both treatments are effective [7,14–17], yet have significant untoward effects. Indomethacin may cause gastroenteritis, gastrointestinal bleeding, renal dysfunction, and increases the risk of long-bone nonunion in patients with concurrent long-bone and acetabular fractures [4,16–18].

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Radiation therapy is costly, has been known to increase the risk of malignancy, negatively affects male and female fertility, and may increase the rate of nonunion after trochanteric osteotomy [4,14,18–20]. The identification of patients who are more susceptible to HO development may potentially allow for selective HO prophylaxis, and minimise the treatment to those at low risk for HO formation. The purpose of this study was to determine if race predisposes patients to develop severe HO formation following acetabular fracture surgery.

Reports of HO formation following acetabular fracture surgery range from 10 to 90% [10,21–23], with rates of severe HO formation from 5 to 25% without routine HO prophylaxis [10,21,23]. Although many studies identify risk factors for HO development following total hip arthroplasty, less exist with regard to HO formation following acetabular fracture surgery. Known patient-related risk factors for HO formation include: male gender, prior hip surgery, history of HO, obesity, diffuse idiopathic skeletal hyperostosis, or ankylosing spondylitis [18,24,25]. Clinical risk factors include: T-type fractures, chest and abdominal trauma, craniocerebral trauma, multiply inured patients, time to surgery, prolonged mechanical ventilation, and fractures with associated dislocations [18,24,26–28]. Extensile surgical approaches and/or trochanteric osteotomy have been identified as surgical risk factors [18,24,29,30]. To the best of our knowledge, no study to date has demonstrated race to be a significant risk factor for the development of HO following acetabular fracture surgery.

Methods

After approval from the institutional review board, patients who had surgical fixation of acetabular fractures at our institution over a 9-year time period were identified through institutional records. A total of 460 patients were identified. Only African American (AA) and Caucasian patients were included in the study. Patients with less than 12 weeks of radiographic follow-up and prisoners were excluded from the study. Additionally, patients necessitating trochanteric osteotomy were excluded from the study based on high rates of HO following trochanteric osteotomy, which has been well established in the orthopaedic literature [29,30].

Demographic data recorded included: age, sex, race, fracture type according to the AO/OTA classification [31], surgical approach, days from injury to surgery, presenting Glasgow Coma Scale, the use of perioperative HO prophylaxis, and the need for subsequent HO excision. Radiographs were reviewed by a blinded, fellowship-trained musculoskeletal radiologist. HO was classified based on the modified Brooker classification: Class 0 – no radiographic evidence of HO, Class I – islands of bone within the soft tissues about the hip, Class II – bone spurs in the pelvis or proximal end of the femur leaving at least 1 cm between the opposing bone surfaces, Class III – bone spurs that extend from the pelvis or the proximal end of the femur, which reduce the space between the opposing bone surfaces to less than 1 cm, Class IV – radiographic ankylosis of the hip [32]. The most-recent available radiographs were used for the purposes of HO classification, unless a secondary procedure was performed (e.g., removal of hardware, HO excision, total hip arthroplasty) in which case the radiograph immediately prior to that procedure was used.

Collected data was entered into a REDCap™ Database (NIH/NCATS UL1TR000062). Data analysis was performed with IBM-SPSS Statistics Version 20 for Windows (SPSS, Chicago, IL). Nonparametric chi-square was used for dichotomous and categorical variable analysis. Differences between AA and Caucasians were assessed with independent *t*-tests. Bivariate correlations between groups were performed with the use of Pearson and Spearman correlations. Logistic regression was used to predict the dependent variable, severe HO, from the series of independent variables.

Results

A total of 253 patients met inclusion and exclusion criteria. No statistical differences were demonstrated between Caucasian and AA groups for age ($p = 0.09$), days to surgery ($p = 0.45$), GCS at presentation ($p = 0.76$), surgical approach ($p = 0.32$), perioperative HO prophylaxis ($p = 0.38$), or AO/OTA fracture classification ($p = 0.32$) (Table 1). The patient population was subsequently stratified by race, gender, and race/gender. Patients with Brooker grades 3 and 4 were considered to have severe HO for the purposes of statistical analysis. Fifty-five (21%) patients in this cohort developed severe HO.

HO prophylaxis

A total of 23 patients (9%) received perioperative HO prophylaxis with either radiation or indomethacin. Twelve (52%)

Table 1
Demographic and clinical characteristics of patients undergoing acetabular fracture surgery.

Variable	Caucasian males ($N = 113$)	African American males ($N = 62$)	Caucasian females ($N = 41$)	African American females ($N = 37$)	*p*-Value
Age (year)	39.6 ± 15.4	36.4 ± 14.4	43.8 ± 18.7	39.2 ± 16.3	0.15
Days to surgery	3.9 ± 3.5	4.3 ± 4.4	4.5 ± 5.0	4.7 ± 4.0	0.67
GCS at presentation	14.8 ± 1.1	14.5 ± 2.3	14.4 ± 2.3	15.0 ± 0.2	0.31
HO prophylaxis	10 (8.8%)	8 (12.9%)	2 (4.9%)	3 (8.1%)	0.57
Surgical approach					0.72
Posterior	78	50	28	28	
Anterior	20	7	8	6	
Iliofemoral	5	2	3	1	
Combined	3	1	0	2	
Percutaneous	7	2	2	0	
Fracture type					0.78
OTA 62-A1 (posterior wall)	43	26	12	12	
OTA 62-A2 (posterior column)	4	4	3	2	
OTA 62-A3 (anterior)	13	2	3	1	
OTA 62-B1 (transverse)	29	17	12	15	
OTA 62-B2 (T-type)	5	5	2	2	
OTA 62-B3 (ant. column-post. hemitransverse)	1	1	1	0	
OTA 62C (both column)	18	7	8	5	
Severe HO formation	21 (18.6%)	20 (32.2%)	4 (9.8%)	10 (27.0%)	*0.03*
HO excision	3 (2.7%)	8 (12.9%)	2 (4.9%)	2 (5.4%)	

Italics signify $p < 0.05$