Orbital blow-out fractures and race

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ABSTRACT

Purpose: To examine the type of orbital blowout fracture and its variation with race.

Design: Retrospective review of computerized tomography (CT) scans and demography in an unselected cohort of patients with orbital blowout fractures.

Participants: Patients with a high-resolution CT scan of adequate quality for analysis who presented with an orbital blowout fracture to the Orbital Clinic at Moorfields Eye Hospital. Patients with fractures involving the orbital rim or the cranium, or with penetrating injuries of the globe or orbit, were omitted from the study.

Methods: Demographic and ethnic information was collected for each patient and the orbital scans reviewed by a single observer. Based on coronal and axial imaging, a fracture was classified as affecting up to 4 areas: the floor lateral to the infraorbital canal (Area 1; “A1”), the floor medial to the canal (“A2”), the maxillo-ethmoidal strut (“infero-medial” strut; “A3”) and the medial wall blowout fracture (“A4”); with fractures involving the infero-medial strut, it was noted whether there was displacement or rotation of the strut. Ethnic origin was classified as Caucasian, Afro-Caribbean or Asian (Oriental or Indian).

Main Outcome Measure: The proportion of different walls involved in orbital blowout fractures within three ethnic groups.

Results: One hundred and fifty-two patients (125 men; 82%) had imaging adequate for analysis, there being 103 (68%) Caucasian, 19 (12%) Afro-Caribbean and 30 (20%) Asian patients. Caucasians most commonly suffered floor fractures (A1 and/or A2 in 56 orbits; 54%), as compared to 10/103 purely medial fractures (A4; 10%); in contrast, medial fractures were the commonest type in Afro-Caribbean patients (7/19 cases; 37%) and purely floor fractures occurred in only 2 cases (10%) (P < 0.005). Asian patients had results similar to Caucasian, with isolated floor fractures being most common (14/30 cases; 47%).

Conclusions: As compared to Caucasians and Asians where most blowout fractures involve the orbital floor, in Afro-Caribbean patients the commonest site for fracture is the medial wall.
Blunt orbital trauma commonly results in a blow-out fracture of the orbital floor or medial wall, in which there may be trapping or prolapse of orbital soft-tissues. Medial fractures are less frequent and were often undetected with conventional plain x-ray imaging.

Although the risk of medial blowout fracture has been recognized in black patients, there has been no study to specifically evaluate the position of fractures in relation to ethnic group – and this investigation was designed to address this issue.

**Patients and Methods**

Patients from the Orbital Clinic at Moorfields Eye Hospital were included if they had an orbital fracture due to blunt trauma, computerized tomography (CT) imaging (thin-slice coronal and axial images) had been performed and was of adequate quality to accurately locate the position of fractures, and the patient’s ethnicity was known. Exclusion criteria were orbital fractures involving the rim or with globe perforation, where the imaging was of inadequate quality, or where the ethnic and demographic details were incomplete. Institutional Review Board (IRB)/Ethics Committee approval was obtained.

CT scans were reviewed in a masked fashion by a single observer (GER) and the coronal and axial images used to classify fractures into four principal types: the floor lateral to the infraorbital canal (Area 1; “A1”), the floor medial to the canal (“A2”), the maxillo-ethmoidal strut (“infero-medial” strut; “A3”) and the medial wall blowout fracture (“A4”); with fractures involving the infero-medial strut (A3), it was noted whether there was displacement or rotation of the strut. For each area, the severity was arbitrarily graded as mild, moderate or severe – determined by the extent of bone and soft-tissue displacement.

Ethnic origin was later classified as Caucasian, Afro-Caribbean or Asian (Oriental or Indian), although the grouping of Oriental Asians and Indian Asians may be an oversimplification of true anthropological descent.

**Outcome measures and statistical methods**

The primary outcome was defined by the type of fracture assessed from CT imaging, in relation to the ethnic origin of the patient. The demographics of the three groups were compared
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with Fisher’s F-test or Student t-testing, and non-parametric details compared with Chi-square testing. An \( \alpha \)-risk of 0.05 was accepted as clinically significant and the analysis completed using SPSS 10.0. (SPSS software for Windows, version 13; Chicago, IL).

Results

Imaging, taken at Moorfields Eye Hospital between 1991 and 2008, was available for 174 patients with orbital fractures and the image quality and demographic data was adequate for analysis in 152 (87%). Seven patients were excluded as having complex orbital injuries involving the rim or globe.

Of the 152 patients (125 men; 82%), 103 (68%) were Caucasian, 19 (12%) were Afro-Caribbean and 30 (20%) were Asian. The patients presented at an average age of 35 years (median 32 years; range 10-87 years), the ages being similar in the three groups (F=1.18; \( p = 0.31 \)) (Table 1). Seventy-eight (51%) of fractures involved the right orbit and 74 (49%) left-hand side.

Within the whole group (Table 2), isolated fractures of the floor were commonest (areas A1 or A2: 72/152; 47%), with most being classified as “mild” (37/72; 51%). Pure medial fractures were less frequent (area A4: 19/152; 13%) and predominantly of “moderate” severity (11/19; 58%). Of 61 fractures involving both the floor and medial wall (A4 and A2), the maxillo-ethmoidal strut -- area A3 -- was injured in about a half of cases (29/61 cases; 48%); where the strut was injured, it was most commonly displaced (24/29; 83%)(Figure 1).

Caucasians most commonly had isolated floor fractures (56/103, 54%), followed by strut-sparing fractures (24 orbits; 23%), fractures involving the strut (13 cases; 13%) and only 10 cases with isolated medial wall fracture (10%) (Table 3). This contrasted with Afro-Caribbean patients, in whom isolated medial wall fractures were the most frequent (7/19; 37%) and purely floor fractures occurred in only 2 patients (10%; Chi squared analysis of the 3 ethnic groups; \( p < 0.005 \)). Asians had patterns of fracture similar to those for Caucasians, with isolated floor fractures in 14/30 cases (47%), strut-sparing in 5 (16%), strut-involving in 9 (30%) and isolated medial fractures in just 2 patients (7%) (a similar proportion to Caucasians; \( p > 0.05 \)).
There was an apparent similarity between the proportion of patients with involvement of the strut fractures in the African (37%) and Asian (30%) patients compared to the Caucasians (13%), (Chi squared analysis of the 3 ethnic groups; p=0.053).

Discussion

The orbital floor is widely regarded as most liable to blowout fractures, even though the medial wall (comprising the extremely thin lamina papyracea) would reasonably be regarded as the area most susceptible to injury, and it has been proposed that the ethmoid labyrinth buttresses and strengthens the medial wall.\(^\text{5}\) After some case reports,\(^\text{3,6-8}\) it was suggested that black patients have a higher risk of medial wall fracture due to fewer ethmoidal septa,\(^\text{4}\) but there are very few studies comparing ethnic variations in orbital osteology. Caucasian and Chinese orbits are similar with regard to the position of foramina and fissures\(^\text{9}\) and, within the current study, this might account for the similar pattern for blowout fractures in the two groups (Table 3), unfortunately there have not been further osteological studies on African orbital walls.

Classification of fracture sites for this study was based on anatomical landmarks that are particularly well defined on coronal imaging, but otherwise the classification varies widely in the literature: Jank and colleagues grouped fractures using landmarks similar to this study\(^\text{10}\) whereas others have based it on specific features, such as orbital location, displacement of soft-tissues, or muscular involvement with diplopia.\(^\text{11-13}\) Variations in the classification of fractures renders comparison between studies difficult: a similar study identified isolated floor fractures in 84% of patients, and only a small number of combined medial and floor fractures (7%) or medial wall fractures (1 to 9%).\(^\text{10}\) As compared to autopsy evidence, the apparently small proportion of medial fractures might suggest that lack of symptoms, or limitations of earlier forms of imaging, might have led to under-diagnosis of this injury.\(^\text{14}\)

The current study, addressing ethnic variations in the pattern of blowout fractures, has the minor limitations of being a retrospective review and of including only those patients considered – on clinical grounds – to require imaging; the Orbital Clinic having a policy of avoiding unnecessary imaging in patients where surgical intervention is not being considered, although this does present a selection bias. Although overall results suggest that pure fractures of the orbital floor are
commonest (in 47% cases) and medial fractures the rarest (13%), this masks a significant (p < 0.005) difference between the Caucasian and Afro-Caribbean patients. Afro-Caribbean patients appear more likely to have a medial wall fracture which may suggest greater resistant to floor fractures -- this almost certainly reflecting a much thicker orbital floor in these patients: this conjecture would accord with the experience of the senior author (GER) during a very large number of orbital decompressions. There was an increased proportion of patients with involvement of the strut fractures in the African (37%) and Asian (30%) patients compared to the Caucasians (13%), (p=0.053) These findings may be a consequence of the African and Asian patients receiving a greater impact during the trauma, or a weaker strut for the same amount of kinetic energy.

There remains controversy about whether blowout fractures are due to the “hydraulic” mechanism, with pressure being transmitted via the globe,15 or the “buckling” theory, with impact energy being disseminated from a force distorting the inferior orbital rim.16 It is probable that both mechanisms apply and the much thicker bone of the orbital floor in Afro-Caribbean patients would be more resistant to injury by either mechanism.
References


