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Patterns and injuries associated with orbital wall fractures in elderly patients who visited the emergency room: a retrospective case–control study

Youn-Jung Kim, Shin Ahn, Dong-Woo Seo, Chang Hwan Sohn, Hyung-Joo Lee, In-June Park, Dong-Jin Yang, Seung Mok Ryoo, Won Young Kim, Kyung Soo Lim

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Y-JK and SA contributed equally.

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Department of Emergency Medicine, University of Ulsan, College of Medicine, Asan Medical Center, Seoul, Korea

Correspondence to
Dr Dong-Woo Seo;
leiseo@gmail.com

ABSTRACT

Objectives: This study aimed to determine orbital wall fracture (OWF) patterns and associated facial injuries in elderly patients and compare them with those in their younger adult counterparts.
Design: A retrospective case–control study.
Setting: An emergency department of a university-affiliated hospital located in an urban area.
Participants: A total of 1378 adult patients with OWF diagnosed by CT from 1 January 2004 through 31 March 2014 were enrolled. Patients were categorised into elderly (≥65 years) and non-elderly (<65 years) groups.
Results: The elderly group (n=146) had a mean age of 74.0 years compared with 37.5 years in the non-elderly group (n=1232). Slipping was the most common cause of OWF in the elderly group (43.8%, p<0.001), whereas violence was the most common cause in the non-elderly group (37.3%, p<0.001). The lateral orbital wall was the more common site of fracture in the elderly group, and their injuries were more often associated with concurrent facial bone fractures, including the mandible, maxilla and zygoma, compared with the non-elderly group. After adjusting for sex and the mechanism of injury, inclusion in the elderly group was a significant risk factor for fracture of the lateral wall (OR 1.658; 95% CI 1.074 to 2.560) and concomitant facial bone fractures of the maxilla (OR 1.625; 95% CI 1.111 to 2.377) and zygoma (OR 1.670; 95% CI 1.126 to 2.475).
Conclusions: Elderly patients were vulnerable to facial trauma, and concurrent facial bone fracture associated with OWF was more commonly observed in this age group. Therefore, a high index of suspicion and thorough investigation, including CT, for OWF-associated facial bone fractures are important.

Strengths and limitations of this study

- To the best of our knowledge, this is the first study to describe the patterns of orbital wall fracture (OWF) and associated facial bone fractures in the elderly.
- We found that older age was associated with fracture of the maxilla and zygoma, which might cause significant disruption of the orbit, and residual visual and cosmetic defects.
- The study was limited by its observational retrospective design with a high possibility of referral bias and interpretation variability.
- The generalisability of our results was limited by the variations in the criteria used to perform a CT scan.

INTRODUCTION

The proportion of elderly individuals aged ≥65 years is growing, expecting one out of five people being in this age group by the year 2050.[1] Elderly patients with trauma are more likely to have a poor outcome than young adults, irrespective of the injury severity.[2–4] Reduced physiological reserve, impaired immune function and an altered cardiopulmonary response to injury might affect the outcome of trauma in elderly patients.[5]

The incidence of facial fractures in elderly patients accounted for 5.3–8.6% of all cases of facial injury and was increasing.[6] Further, there is some evidence that the mean age of people with facial fractures has been increasing over time.[6 7] In recent years, there has been a decreasing trend in motor vehicle accident-related facial trauma; however, violence and falls have become increasingly important as aetiological factors.[7] Falls are prevalent in the elderly population.[7 8] Approximately half of the patients with orbital wall fracture (OWF) present with other facial bone fractures as well and 30% of these cases have associated ocular injuries.[9] Immediate diagnosis and treatment of OWF is important because these fractures can lead to complications, such as diplopia.[9 10]

Patients with OWF associated with facial bone fractures often have significant disruption of the orbit, and residual visual and cosmetic defects may occur.[11]

Until now, no study has compared OWF patterns and associated facial injuries between elderly and non-elderly adult patients. To provide efficient care and preventive measures, epidemiological analysis of OWF is important. We hypothesised that patterns of OWF and associated facial bone fractures in elderly patients would be clinically different from those that occur in non-elderly adult patients. This study aimed to identify OWF patterns and associated facial injuries in elderly patients and compare them with those in non-elderly adults.

METHODS

Study design and population

This was a retrospective case–control study. A retrospective chart review was undertaken for 1378 patients with a diagnosis of OWF at the emergency department (ED) at our hospital between 1 January 2004 and 31 March 2014. Our hospital is a university hospital located in an urban area that treats ~100 000 patients per year in the ED.

In this study, patients who underwent facial bone CT scans at our hospital with a specific International Classification of Diseases, 10th revision (ICD-10) code at the ED were included. All orbital fractures were confirmed using CT scans. There are five major bones of the skull that form the orbit—the frontal bone, sphenoid bone, zygoma, maxillary bone and ethmoid bone. Fractures of the orbit can involve one or more walls of the orbit, the orbital rim or both. Axial and coronal CT scans of the facial bone were obtained with a 1.0 mm slice thickness using a 128-channel multidetector CT scanner (Somatom Definition AS Plus; Siemens Medical Solutions, Cary, North Carolina, USA). Patients who were 65 years or older were categorised as the elderly group and patients younger than 65 years were included in the non-elderly group. Exclusion criteria included patients younger than 18 years at the time of injury and patients who were referred to our hospital after a diagnosis of OWF was made at another hospital. The patients were of Asian (Korean) ethnicity.

Data collection

Patient clinical and demographic characteristics were retrieved from the Asan Biomedical Research Environment (ABLE), a de-identified clinical data warehouse,[12 13] which included age, sex, history, clinical characteristics and formal interpretive reports of CT scans that were made by radiology specialists. Emergency physicians did the history-taking and performed the initial ophthalmic examinations. The mechanism of injury was categorised into five groups: falls from heights, ground-level falls, motor vehicle accident, violence and other causes (penetrating and other blunt trauma). After arriving at a diagnosis of orbital fracture by CT, an ophthalmologist performed a full ophthalmic examination. Ophthalmologists recorded the relevant signs and symptoms, including diplopia, ecchymosis, emphysema, enophthalmos and periorbital swelling.

Statistical analysis

Data were expressed as means±SD for continuous variables and as percentages for categorical variables. Comparisons between baseline variables were made using Student's t-test for continuous variables and Pearson's χ^2 test or Fisher's exact test for categorical variables. Logistic regression analysis was used to calculate the odds ratio (OR) for the 'elderly' associated with the type of orbital fracture and facial bone fracture. For all analyses, a two-sided p value <0.05 was considered to indicate a statistically significant difference. Statistical analyses were performed using SPSS V.20 (SPSS, Chicago, Illinois, USA).

RESULTS

A total of 1378 patients were included. Among these patients, 146 were elderly patients with a mean age of 74.0 years and 1232 were non-elderly patients with a mean age of 37.5 years. The age distribution of the study population is presented in online supplementary figure S1. The demographic and clinical characteristics of the two groups are presented in table 1. Significant differences were found for gender distribution, mechanisms of injury and fracture patterns. While most OWF patients in the non-elderly group were men (81.5%), men accounted for only 62% of patients in the elderly group. The most common cause of injury in the elderly group was ground-level falls (43.8%), which was a relatively infrequent cause of injury in the non-elderly group (18.1%). In contrast, violence was the most common cause of OWF in the non-elderly group (37.3%). The clinical signs and symptoms, including diplopia, ecchymosis, emphysema, enophthalmos and periorbital swelling, were not significantly different between the groups.

Approximately one-third of all patients had multiple OWFs, with 30.1% and 32.5% occurring in the elderly and non-elderly groups, respectively. Medial and inferior orbital fractures were common in both groups, but the frequencies of these fractures were different. Medial OWFs occurred ~15% more often in the non-elderly group than in the elderly group (elderly group, 49.3% vs non-elderly group, 64.0%; p=0.001). However, lateral OWFs occurred approximately twice more frequently in the elderly group than in the non-elderly group (elderly group, 24.0% vs non-elderly group, 12.7%; p<0.001). Associated facial bone fractures were common and occurred at significantly different rates in the different age groups, except for frontal bone fractures. Generally, elderly patients had more OWFs associated with facial bone fractures (elderly group, 58.2% vs non-elderly group, 47.8%; p=0.017). Fractures in the mandible (elderly group, 6.8% vs non-elderly group, 2.1%;

Table 1 Characteristics of the study patients with orbital wall fracture

Variable	Total (N=1378)	Elderly group (N=146)	Non-elderly group (N=1232)	p Value
Age (mean±SD)	41.4±16.8	74.0±6.6	37.5±13.1	<0.001
Gender, males	1094 (79.4%)	90 (61.6%)	1004 (81.5%)	<0.001
Mechanism of injury				
Fall from a height	78 (5.7%)	11 (7.5%)	67 (5.4%)	0.3
Ground-level fall	287 (20.8%)	64 (43.8%)	223 (18.1%)	<0.001
Motor vehicle accident	297 (21.6%)	38 (26.0%)	259 (21.0%)	0.164
Violence	466 (33.8%)	7 (4.8%)	459 (37.3%)	<0.001
Other cause	250 (18.1%)	26 (17.8%)	224 (18.2%)	0.912
Signs and symptoms				
Diplopia	122 (8.9%)	7 (4.8%)	115 (9.3%)	0.068
Ecchymosis	533 (38.7%)	51 (34.9%)	482 (39.1%)	0.325
Emphysema	294 (21.3%)	30 (20.5%)	264 (21.4%)	0.806
Enophthalmos	28 (2.0%)	3 (2.1%)	25 (2.0%)	0.983
Periorbital swelling	1131 (82.1%)	115 (78.8%)	1016 (82.5%)	0.27
Type of orbital wall fracture				
Medial wall	861 (62.5%)	72 (49.3%)	789 (64.0%)	0.001
Lateral wall	191 (13.9%)	35 (24.0%)	156 (12.7%)	<0.001
Superior wall	171 (12.4%)	25 (17.1%)	146 (11.9%)	0.068
Inferior wall	710 (51.5%)	72 (49.3%)	638 (51.8%)	0.572
Multiple orbital wall fractures	444 (32.2%)	44 (30.1%)	400 (32.5%)	0.569
Associated facial bone fracture	674 (48.9%)	85 (58.2%)	589 (47.8%)	0.017
Frontal bone	146 (10.6%)	16 (11.0%)	130 (10.6%)	0.88
Mandible	34 (2.5%)	10 (6.8%)	24 (2.1%)	0.023
Maxilla	376 (27.3%)	59 (40.4%)	317 (25.7%)	<0.001
Nasal bone	340 (24.7%)	25 (17.1%)	315 (25.6%)	0.025
Zygoma	276 (20.0%)	49 (33.6%)	227 (18.4%)	<0.001
Multiple facial bone fractures	338 (24.5%)	52 (35.6%)	286 (23.2%)	0.03

p=0.023), maxilla (elderly group, 40.4% vs non-elderly group, 25.7%; p<0.001) and zygoma (elderly group, 33.6% vs non-elderly group, 18.4%; p<0.001) were significantly more common in the elderly group, while nasal bone fractures (elderly group, 17.1% vs non-elderly group, 25.6%; p=0.025) were more common in the non-elderly group. Furthermore, 61.2% of elderly patients had multiple facial bone fractures compared with 48.6% of patients in the non-elderly group (p=0.03).

Old age was a significant factor for the site of OWF after adjusting for sex and the mechanism of injury (figure 1). In contrast with medial OWF (OR 0.667, 95% CI 0.465 to 0.955), old age was an independent risk factor for lateral OWF (OR 1.658, 95% CI 1.074 to 2.560). Moreover, old age was independently associated with fractures of the maxilla (OR 1.625, 95% CI 1.111 to 2.377) and zygoma (OR 1.670, 95% CI 1.126 to 2.475).

DISCUSSION

The results of this study confirmed the hypothesis that there are different OWF patterns and associated facial injuries in elderly patients when compared with their non-elderly counterparts. A ground-level fall was the most common cause of OWF in the elderly group, whereas violence was the most common cause in the non-elderly group. OWF in the elderly group was likely to be associated with the lateral wall of the orbit, and these fractures were more likely to be associated with concurrent facial bone fractures than in the non-elderly group. Old age was associated with fractures of the maxilla and zygoma.

In the maxillofacial trauma literature, motor vehicle accidents, violence and falls are the leading causes of OWF, with a wide range of relative frequencies.[7 14] Trends in maxillofacial trauma are changing for several reasons, in particular because of population ageing.[6 7] OWFs caused by violence and falls have been reported to outnumber those caused by motor vehicle accidents.[7] Falls in particular are reported to be responsible for most cases of maxillofacial trauma in the elderly age group.[7 8 15] Prompt diagnosis and treatment of maxillofacial trauma that includes OWF is fundamental in emergency medicine,[10] given that OWF may lead to acute and chronic complications.[10 11] Some descriptive studies of the clinical features of paediatric OWF have been reported,[11 16–19] but no study until now date has focused specifically on OWF in the elderly age group.

Falls are generally considered to be a low energy mechanism for OWF.[15] Atisha *et al*[15] suggested that elderly patients have less severe facial fractures, most likely secondary to low energy mechanisms of injury. In this study, ground-level falls (43.8%) represented the most common cause of OWF in elderly patients, and

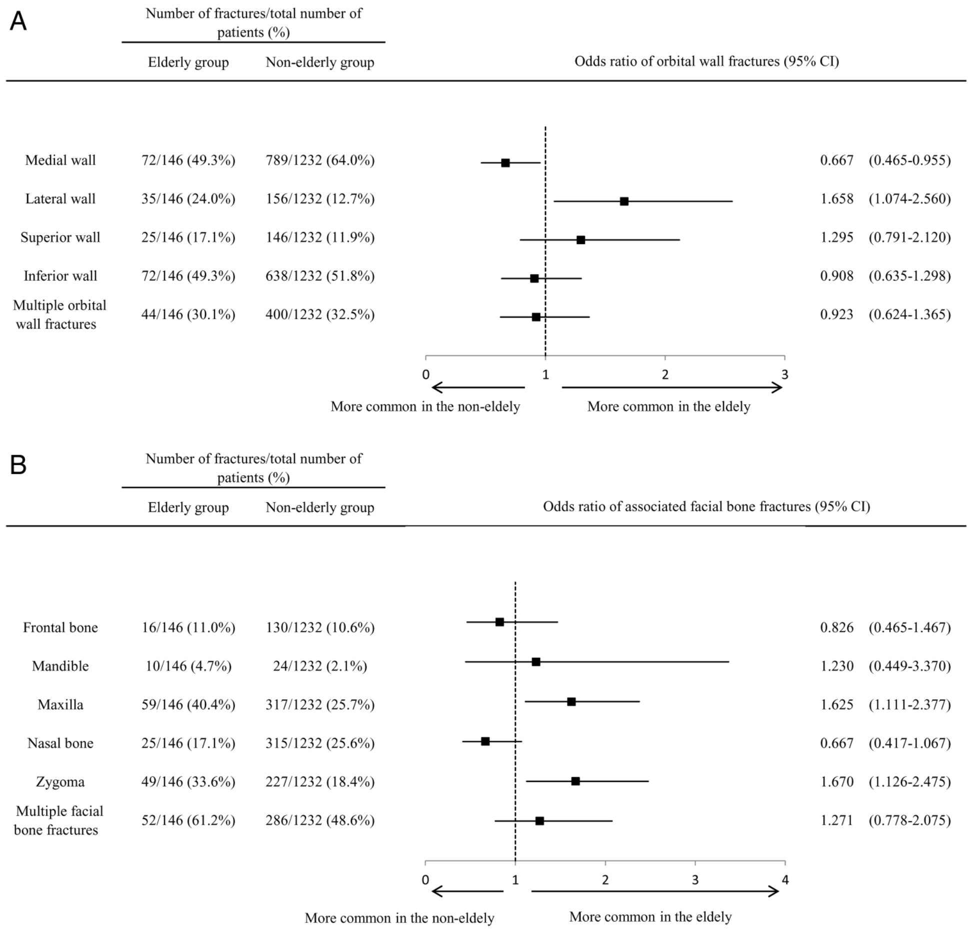

Figure 1 Adjusted ORs for sex and the injury vector in elderly patients with orbital wall fractures and associated facial bone fractures. (A) Type of orbital wall fracture. (B) Associated facial bone fractures.

associated facial bone fractures were more common in the elderly group. This supports the notion that elderly patients are vulnerable to facial trauma. Generally, more energy is required to fracture the mandible than to fracture the upper facial structures, and previous maxillofacial trauma studies have reported a lower incidence of mandibular fracture in elderly patients.[15 20] However, in our study, mandibular fracture associated with OWF was more common in the elderly group. This finding may be explained by the vulnerability of elderly patients to facial trauma.

Patients with OWF associated with facial bone fracture, particularly in the zygomatic-maxillary or nasal-ethmoid regions, often have significant disruption of the orbit.[11] Surgical repair is typically complex, and residual visual and cosmetic defects may occur. After adjusting for sex and the mechanism of injury, we found that older age was associated with fracture of the maxilla (OR 1.625; 95% CI 1.111 to 2.377) and zygoma (OR 1.670; 95% CI 1.126 to 2.475). Given that elderly patients are vulnerable to OWF-related facial trauma and facial bone fracture, a high index of suspicion and thorough investigation, including CT, is important in this age group. However, variations in the criteria used to perform a CT scan in the real-world setting and patient ethnicity must be considered when assessing the generalisability of our results. Only Asian people were included in our study, so its findings should be interpreted with caution.

Our study had several limitations. The first is its retrospective design, with all the potential errors inherent in this type of research. Assessment was limited to a single large academic centre, so our findings may not apply at other hospitals. Prospective cohorts of patients with OWF could provide more valuable knowledge. Second, there is a high possibility of referral bias, which is known to affect the results of case–control studies. In our study, this bias relates to the criteria used in the ED for performing a CT scan in a patient with head or facial trauma. We have used the Canadian CT Head Rule in principle since 2001;[21] however, in general, CT scans are performed more often than recommended, and it is possible that the criteria for performing CT vary from doctor to doctor. This bias seems to affect case and exposure (age) distributions. Third, we could not report on missing data. Maxillofacial trauma is generally accompanied by head trauma, and to minimise the effect of missing data on the study results, data for head trauma also had to be gathered. However, as mentioned earlier, CT scans were performed more often than recommended, so the effect on the age distribution of patients with OWF (positive cases) would be minimal. Finally, we used formal interpretive CT scan reports for a number of variables, including fracture location and the names of the bones involved. These reports were prepared by multiple radiology specialists. However, the effect of this variability would be minimal because the fracture locations and bone names were almost uniform.

In conclusion, we have identified different patterns of OWF between elderly and non-elderly patients. In the elderly patients, despite a ground-level fall being considered a low energy mechanism, it was the most common cause of OWF, and associated facial bone fractures were more common in this age group than in the non-elderly group. We found that older age was associated with fracture of the maxilla and zygoma. Given the vulnerability of elderly patients to facial trauma and facial bone fractures associated with OWF, a high index of suspicion and thorough investigation including CT are important.

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Data sharing statement The original data set is available on individual request by emailing the corresponding author, leiseo@gmail.com.

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