Facial Fractures as a Result of Falls in the Elderly: Concomitant Injuries and Management Strategies

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Abstract

Mechanical falls are a common cause of facial trauma in the elderly population. It has been shown that the likelihood of sustaining a facial fracture due to a fall or activities of daily life significantly increases with age. Craniomaxillofacial fractures are most common during the first three decades of life; however, elderly patients more frequently require lengthy hospital stays and surgical intervention, and have shown increased complication rates compared with younger patients. The objective of this study was to examine the prevalence of facial fractures secondary to mechanical falls in the elderly population to analyze mechanism of injury, comorbidities, and fracture management. A retrospective review of all facial fractures as a result of falls in the elderly population in a level 1 trauma center in an urban environment was performed for the years 2002 to 2012. Patient demographics were collected, as well as location of fractures, concomitant injuries, and surgical management strategies. During the time period examined, 139 patients were identified as greater than 60 years of age and having sustained a fracture of the facial skeleton as the result of a fall. The average age was 75.7 (range, 60–103) years, with no gender predominance of 50.4% female and 49.6% male. There were a total of 205 fractures recorded. The most common fractures were those of the orbit (42.0%), nasal bone (23.4%), zygoma (13.2%), and zygomaticomaxillary complex (7.32%). The average Glasgow Coma Scale on arrival was 12.8 (range, 3–15). Uncontrolled hemorrhage was noted on presentation to the trauma bay in five patients. Twenty-one patients were intubated on, or prior to, arrival to the trauma bay, and 44 required a surgical airway. The most common concomitant injury was a long bone fracture (23.5%), followed by cervical spine fracture (18.5%), skull fracture (17.3%), intracerebral hemorrhage (17.3%), rib fracture (17.3%), ophthalmologic injuries (6.2%), short bone fracture (4.9%), pelvic fracture (2.9%), thoracic spine fracture (1.2%), and lumbar spine fracture (1.2%). Of the 114 patients admitted to the hospital, 53 were admitted to an intensive care setting. The average hospital length of stay was 8.97 days (range, 0–125). Sixteen patients expired. Surgical management of fractures in the operating room was required in 47 of the 139 patients. Of the patients treated, 36.2% required an open reduction and internal fixation procedure. Facial

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- facial trauma in the elderly
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fractures as a result of falls in the geriatric population represent an increasing number of cases in clinical practice as life expectancy steadily rises. These patients require a specific standard of treatment since they are more susceptible to nosocomial infections, as well as have higher complication rates and longer recovery time. Concomitant injuries such as cervical spine and pelvic fractures can greatly increase risk of mortality. Surgical and soft tissue management must be approached with caution to optimize function and aesthetics while preventing secondary infection. The authors hope that this study can provide some insight and further investigation as there is a dearth of literature to the management of facial fractures in falls in elderly patients.

As the elderly demographic of the United States' population continues to rapidly increase, health care is faced with new challenges in terms of policy, as well as disease prevention and management. By 2050, the number of people age 65 and older is projected to be 83.7 million, doubling the 43.1 million in 2012.[1] According to the Centers for Disease Prevention and Control's 2016 U.S. Health Status Report, unintentional injuries were the eighth leading cause of death in people age 65 and over, with falls being the prevailing cause of such trauma each year for the past 10 years since 2005.[2] Falls with injury have been shown to add on average 6.3 days to the length of hospital stay and $14,000 to the cost of care.[3,4] Trauma is no longer solely associated with the young male population, and elderly patients are more likely to die of traumatic injury than their younger counterparts.[5,6] Since older patients inevitably present with more predisposing factors, concurrent health issues, medication usage, and variation in environmental influences, many studies have delved into deciphering the exact leading risks of these traumatic falls in the hopes of finding more specific solutions to prevention. Different studies have concluded various main risk factors including age-related factors, chronic medical complications, deterioration in activities of daily living, polypharmacy, and hospitalization, while all studies urge further research.[7–11]

Fracture sites such as the hip have been studied extensively due to associated high complication and institutionalization rates as well as a recent focus on osteoporosis prevention, screening, and consequences.[12,13] However, fractures of the facial skeleton are also affected by these mechanisms of aging, and their consequences severely impact quality of life as they often present with concomitant injuries due to proximity to areas such as the brain, ophthalmologic structures, cranial nerves, and the cervical spine. Elderly patients with facial fractures present an additional challenge as their management cannot be the same as younger patients because of conditions including bone atrophy, decreased tissue regeneration, increased infection risk, and increased cardiovascular instability.[14] Thus, fully analyzing and comprehending the demographics, fracture locations, consequences, and current management of facial fractures in the elderly is vital in improving future prevention and treatment.

The objective of this study is to examine facial fractures secondary to mechanical falls in the elderly population to elucidate demographics, patterns and distribution of fractures, concomitant injuries, hospital course, and fracture management at a level 1 trauma center.

Methods

A retrospective review of all facial fractures in a level 1 trauma center in an urban environment (University Hospital, Newark, NJ) was performed for the years 2002 to 2012 based on International Classification of Disease, revision 9 (ICD-9) codes. The facial fractures were diagnosed radiologically via facial computed tomography scans, magnetic resonance imaging, and plain X-ray films. The results were then refined by falls as the modality of injury, and the patient population was restricted to the elderly, defined as greater than 60 years of age. Chart review was performed for each case that met the predefined criteria, and information was collected on patient demographics, location of fractures, concomitant injuries, length of hospital stay, critical complications, and surgical management strategies. Results from these categories were then stratified by incidence, and trends were analyzed and compared with outside findings. Patients admitted with uncontrolled hemorrhage, defined as widespread or uncontrolled loss of blood that requires intervention, were noted and treated by means of packing, interventional radiology embolization, or direct vessel ligation. Final data were recorded on an Excel spreadsheet, and relevant statistical tests including Pearson's χ^2 test and odds ratio were performed, with the $p < 0.05$ set as the degree of statistical significance.

Results

During the time period examined, 319 patients identified as greater than 60 years of age were admitted to the emergency department due to facial fractures. Of the 319 patients, 139 had sustained a fracture of the facial skeleton as the result of a fall. Of the 3,147 facial fractures treated at our institution from 2000 to 2012, 205 fractures were due to elderly falls. The average age of the patients was 75.7 (range, 60–103) years, with no gender predominance of statistical significance as there were 50.4% female and 49.6% male, or a male:female ratio of 1.02. Over 80% of facial fractures overall occurred in males; the proportion of females in this population was much higher. Distribution of the number of patients admitted for facial fractures by month is depicted in ►**Fig. 1**. Seventy-three

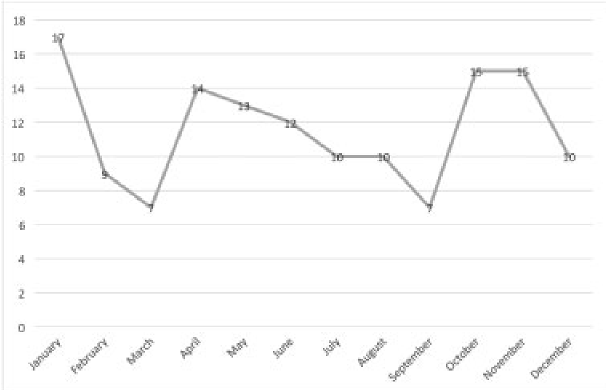

Fig. 1 Distribution of the number of elderly patients admitted for facial fractures by month from 2002 to 2012.

patients were admitted from October to March, and 66 patients were admitted from April to September.

There were a total of 205 fractures recorded in our 139 patients. The most common fracture sites were those of the orbit ($n = 86$), nasal bone ($n = 48$), and zygoma ($n = 27$). Distribution of the fractures by anatomical location is demonstrated in ►**Fig. 2**. When stratified by sex, there were significantly more orbital fractures in female ($n = 53$) than males ($n = 34$) ($p < 0.05$; ►**Fig. 3**). The average Glasgow Coma Scale on arrival was 12.8 (range, 3–15). Uncontrolled hemorrhage was noted on presentation to the trauma bay in five patients, four of which were due to the respective facial fractures and one was due to a right axillary artery bleed. Uncontrolled hemorrhage was defined as the need for some form of intervention to arrest bleeding, including packing, interventional radiology embolization, and direct vessel ligation.

Twenty-one patients were intubated on, or prior to, arrival to the trauma bay, and 44 required a surgical airway. Most patient who required a surgical airway or intubation were found to have unprotected airways at the scene of the fall. Thus, these procedures were often performed by emergency medical services prior to admission to the hospital. The facial fracture locations of the 44 patients who required surgical airway are demonstrated in ►**Table 1**. Intubation in the emergency department was significantly associated with fatality ($p < 0.0001$; ►**Fig. 4**) and increased length of hospital stay ($p < 0.001$; ►**Fig. 5**). The average length of hospital stay was 8.97 days (range, 0–125). Sixteen patients expired. Causes of death were not due to facial fractures or fracture management, but were caused by traumatic brain injury ($n = 9$), respiratory insufficiency ($n = 4$), cardiovascular decompensation ($n = 2$), and septic shock ($n = 1$). Of the 16 fatalities, 6 of the patients had Do Not Resuscitate or Do Not Intubate statuses.

Of the 81 concomitant injuries, the most common injury was a long bone fracture (23.5%), followed by cervical spine fracture (18.5%), skull fracture (17.3%), intracerebral hemorrhage (13.6%), rib fracture (12.3%), ophthalmologic injuries (4.9%), short bone fracture (4.9%), pelvic fracture (2.5%), thoracic spine fracture (1.2%), and lumbar spine fracture (1.2%) (►**Fig. 6**). The significant relationships found between the fracture location and concomitant injuries are demonstrated in ►**Table 2**. The fractures and concomitant injuries excluded did not have adequate data points in our series to conduct statistical tests of relevance. Of the total patients admitted to the hospital, 53 were admitted to an intensive care setting.

Surgical management was required in 49 of the 139 patients; the most common concomitant injuries requiring surgical management were long bone fractures (16%), intracranial hemorrhage (12%), ruptured globe (12%), and spine injuries (6%). Twenty-two patients required operative fixation of their facial fractures, and underwent open reduction and internal fixation with titanium plates and screws. An additional four patients required surgical repair of facial soft tissue injuries. Two patients with mandible fractures were treated

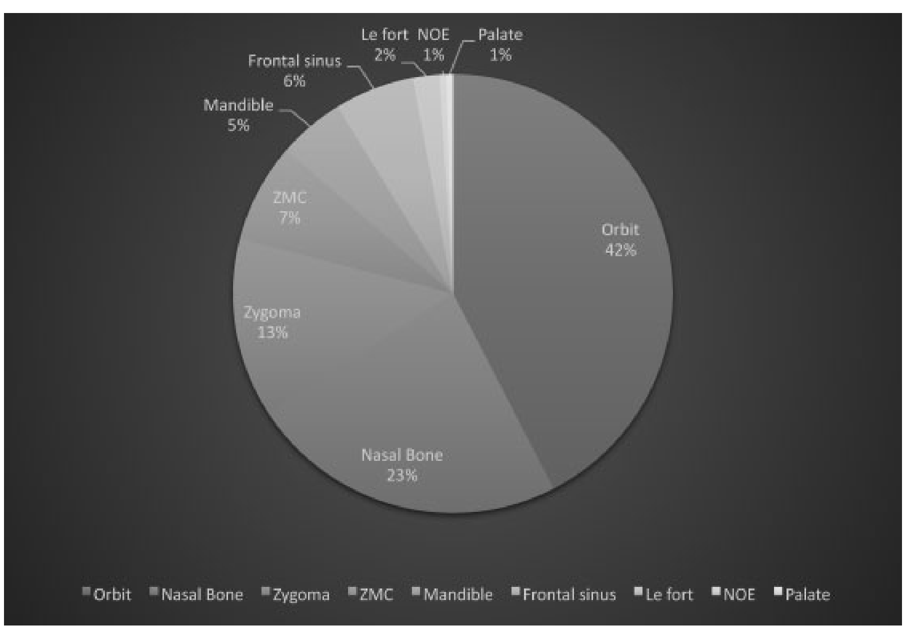

Fig. 2 Distribution of facial fractures by anatomical site.

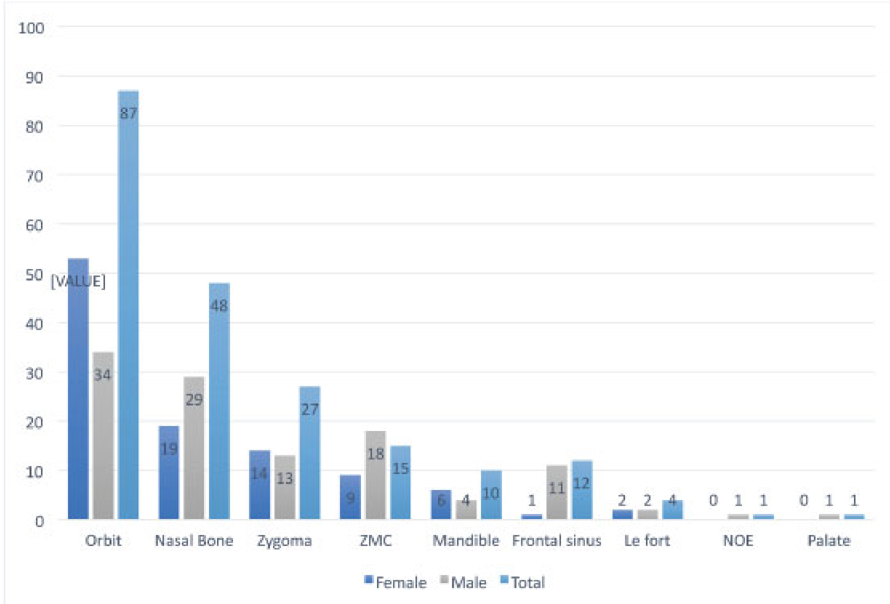

Fig. 3 Distribution of facial fractures by sex.

with closed reduction and maxillomandibular fixation. The remainder of the patients underwent closed reduction and soft tissue management. The differences in fracture location and concomitant injuries between the patients who did and did not require surgery are presented in ►**Tables 3** and **4**. The specific fracture locations, operative management, and indications for surgery for each of the 22 patients are documented in ►**Table 5**. Over 50% of the facial fractures requiring operative treatment were in the periorbital region. Other common fracture types requiring surgical management were mandible fractures (31%) and zygoma fractures (18%).

Discussion

Several studies exist that have examined aspects of elderly facial fractures that are comparable with our series. A large retrospective analysis had found that women age 60 or greater had significantly increased facial fracture predilection than men of the same age group.[15] Other studies found the ratio of male:female facial fracture rates to be 1:2.47[16] and 1.59:1.[6] This inconsistency may be because these studies analyzed trauma facial fractures of all causes, including motor vehicle accidents, assault, and falls. These wide etiologies would bring in different variables as, for instance, elderly males could be more likely to operate vehicles or engage in more strenuous activity than elderly females. Our series found a male:female fracture ratio of 1.02 solely due to falls. While there is no statistically significant difference, the predilection for female fractures mirrors previous studies and may be explained by the earlier onset and greater severity of osteoporosis. In 2008, the Fracture Risk Assessment Tool (FRAX) was developed, and studies found that the probability for a major osteoporotic fracture ranged from 3 to 15% in men and 4 to 31% in women under the same circumstances.[17] In our study, the most commonly fractured bone, the orbit, was significantly fractured in more female than male patients.

When the number of elderly patients admitted to the hospital for facial fractures due to falls were stratified by month, 73 patients were admitted from October to March (closer to winter months), while 66 patients were admitted during the remaining months. There are also sudden rises in admissions from March to April, September to October, and December to January. These findings closely reflect changes in the weather; when the ice freezes and melts in the beginning and end of winter, respectively, the ground becomes slippery, increasing the risk for falls.

The three most common sites of fracture in descending order were the orbit, nasal bone, and zygoma. Adeyemo et al found the zygomatic complex to be the most common location, followed by dentoalveolar, and Le Fort II.[18] Velayutham et al found falls to be the most common mechanism of trauma in their study, and showed that zygomatic complex

Table 1 Distribution of facial fractures in patients who required surgical airway

Mandible	7
Palate	0
Zygoma	11
ZMC	6
Orbit	27
NOE	1
Nasal	10
Frontal sinus	2
Le Fort	3

Abbreviations: NOE, nasoorbitoethmoid; ZMC, zygomaticomaxillary complex.

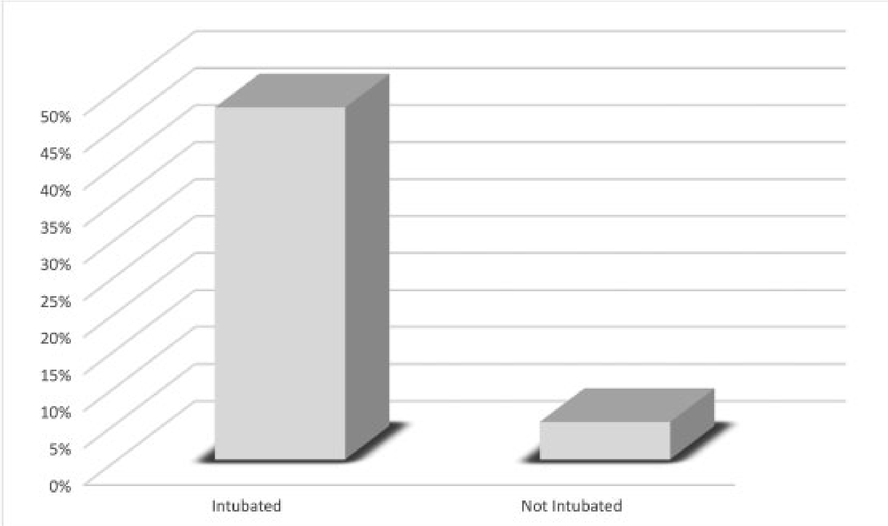

Fig. 4 Comparison of patients who were intubated in the emergency department with percent fatality.

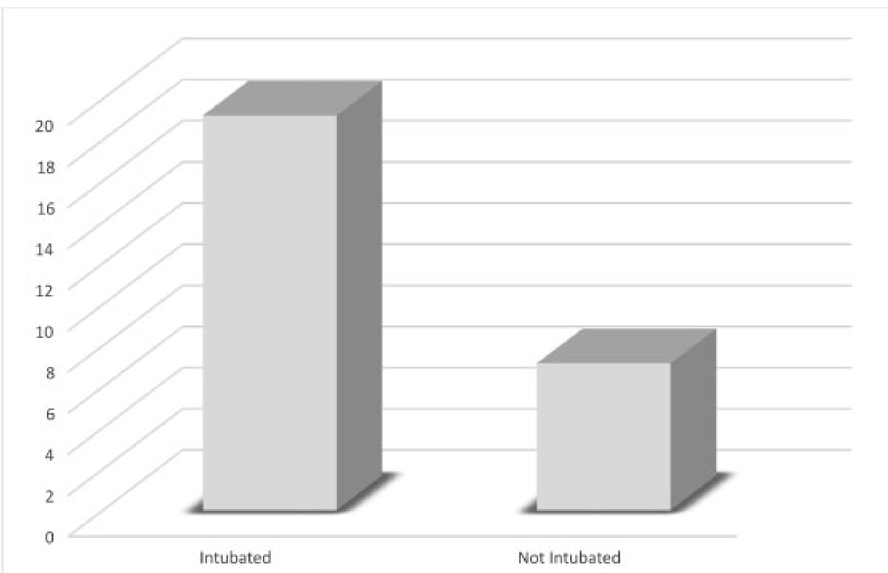

Fig. 5 Comparison of patient who were intubated in the emergency department with the length of hospital stay in days.

was the most common fracture, followed by the nasal bone and the orbital complex.[19] Another study by Werning et al where falls were the predominant etiology of trauma, the most common fractures were of the nasal bone, maxilla, and orbit.[16] Thus, our series more similarly echoed the findings where falls were the main cause of the facial fractures. While most people attempt to break their fall with the upper extremities, elderly patients may experience changes in vestibular and visual changes, as well as impairments in balance, strength, flexibility, cognition, and reflex, decreasing the appropriate response time and actions during a fall. In a recent study, elderly patients enrolled in a ballroom dancing program significantly improved their balanced and reduced falls from a standing height.[20] Thus, with a lack of ability to break the fall, the nasal bone and zygoma are more protruding than other structures of the midface, and the orbit covers a relatively larger surface area, providing a possible explanation for the commonly found fractures in these sites.

Endotracheal intubation in the emergency department is significantly associated with increased length of hospital stay and fatality, most likely because the patients requiring intubation present with severe injuries to nearby anatomical structures or to the brain that prevent patency of the airway. Of note, 18 of the 22 patients who required surgical intervention also required a surgical airway, correlating to the severity of the sustained fractures. It is not surprising that long bone fractures were the most commonly significant concomitant injury (associated with the zygoma, zygomaticomaxillary complex, and Le Fort) as the upper extremities,

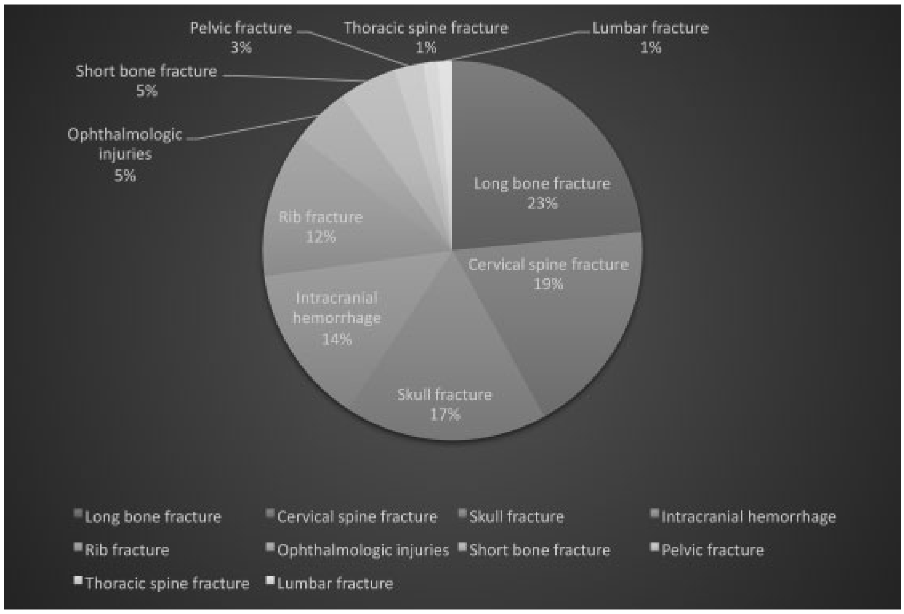

Fig. 6 Distribution of concomitant injuries.

Table 2 Fracture types and concomitant injuries

	Long bone fracture	No long bone fracture	Odds ratio (95% CI)	Cervical spine fracture	No cervical spine fracture	Odds ratio (95% CI)
Orbit fracture	11	76	NS	11	76	3.7 (1.1–12.2)**
Nasal fracture	8	40	NS	5	43	NS
Zygoma fracture	8	19	6.1 (2.2–17.0)*	4	23	NS
ZMC fracture	4	11	4.1 (1.2 -14.6)**	2	13	NS
Mandible fracture	2	8	NS	–	–	–
Frontal fracture	–	–	–	1	11	NS
Le Fort fracture	2	2	10.7 (1.4–80.9)**	–	–	–
	Skull fracture	**No skull fracture**	**Odds ratio (95% CI)**	**ICH**	**No ICH**	**Odds ratio (95% CI)**
Orbit fracture	4	83	NS	5	82	NS
Nasal fracture	5	43	NS	4	44	NS
Zygoma fracture	2	25	NS	2	25	NS
ZMC fracture	2	13	NS	2	13	NS
Mandible fracture	1	9	NS	–	–	–
Frontal fracture	3	9	5.4 (1.3–22.9)**	5	7	21.7 (5.3–88.4)*
Le Fort fracture	1	3	NS	1	3	NS
	Rib fracture	**No rib fracture**	**Odds ratio (95% CI)**			
Orbit fracture	2	85	NS			
Nasal fracture	2	46	NS			
Zygoma fracture	6	21	12.0 (3.1–46.0)*			
ZMC fracture	4	11	10.9 (2.7–44.4)*			
Mandible fracture	1	9	NS			
Frontal fracture	1	11	NS			
Le Fort fracture	–	–	–			

Abbreviations: CI, confidence interval; ICH, intracranial hemorrhage; NS, not significant; ZMC, zygomaticomaxillary complex.
$^{*}p < 0.01$; $^{**}p < 0.05$.

Table 3 Distribution of fracture location between the fractures that required operative fixation versus no operative fixation

Fracture location	No operative fixation (%)	Operative fixation (%)
Mandible	3 (1.9%)	7 (15.9%)
Palate	0 (0.0%)	1 (2.3%)
Zygoma	21 (13.0%)	6 (13.6%)
ZMC	11 (6.8%)	4 (9.1%)
Orbit	72 (44.7%)	15 (34.1%)
NOE	0 (0.0%)	1 (2.3%)
Nasal	43 (26.7%)	5 (11.4%)
Frontal sinus	10 (6.2%)	2 (4.5%)
Le Fort	1 (0.6%)	3 (6.8%)

Abbreviations: NOE, nasoorbitoethmoid; ZMC, zygomaticomaxillary complex.

such as the positioning of outstretched hands, are often used reflexively to break a fall and absorb the strong mechanical forces.[21] The force of the falls causing orbital fractures is likely transmitted in the cranial direction, traumatizing the cervical region in the process and hence the significant association with cervical spine fractures.[22] Zygoma and zygomaticomaxillary complex fractures were both significantly associated with rib fractures. Frontal bone fractures were significantly associated with skull fractures and intracranial hemorrhage. The hard mineral matrices of both the frontal bone and the skull protect the brain and are relatively more difficult to break. Extremely strong forces are required to fracture them, and frontal bone fractures are associated with serious systemic injuries, as well as higher rates of morbidity and mortality.[23–25] Thus, the association with intracranial hemorrhage is expected as the barriers protecting meninges and the blood vessels of the brain are breached. An increased rate of intracranial hemorrhage may also be observed in the elderly population due to the U.S. Preventive Services Task Force's current recommendation of initiating low-dose aspirin use for adults ages 60 to 69 years who have a 10% or greater 10-year cardiovascular risk.[26] While the U.S. Preventive Services Task Force classifies this as a C grade recommendation, meaning the aspirin use should depend on individual circumstances, the 2015 National Health Interview Survey found that 21.8% of patients are on low-dose aspirin therapy.[27]

Table 4 Distribution of concomitant injury between the fractures that required operative fixation versus no operative fixation

Concomitant injury	No operative fixation (%)	Operative fixation
Long bone fracture	14 (20.6%)	5 (38.5%)
Cervical spine fracture	15 (22.1%)	0 (0.0%)
Skull fracture	12 (17.6%)	2 (15.4%)
Intracranial hemorrhage	9 (13.2%)	2 (15.4%)
Rib fracture	8 (11.8%)	2 (15.4%)
Ophthalmic injury	3 (4.4%)	1 (7.7%)
Short bone fracture	4 (5.9%)	0 (0.0%)
Pelvic fracture	1 (1.5%)	1 (7.7%)
Thoracic spine fracture	1 (1.5%)	0 (0.0%)
Lumbar spine fracture	1 (1.5%)	0 (0.0%)

There were several patterns of injury noted for the patient who required operative fixation. Many of the mandible fractures sustained were unable to be closed or reduced with maxillomandibular fixation due to the patients' edentulous condition, primarily secondary to age. Additionally, many of these patients had osteoporotic mandibles, leading to the decision for reduction and fixation with titanium plates in the operating room. Most orbital floor immediately repaired were due to large "blowout" defects that fractured or displaced most of the orbital floor. However, many of these orbital fractures were not repaired during the initial admission as the patients had significant swelling around the fracture site and more life-threatening concomitant injuries that needed to be addressed first. Throughout the next few weeks, these patients often became symptomatic from enophthalmos or diplopia. Once the swelling had resolved, the severity of the symptoms would no longer be masked, and the resulting damage became more apparent. One patient underwent concomitant repair of a distal femur fracture with an orthopedic surgeon. Zelken et al concluded in an analysis of 1,047 elderly patients that only 5% of fractures required operative treatment as most were minimally displaced midfacial fractures that could heal through conservative management.[28] Our study similarly found that only 22 of 139, or 15.8%, of patients required operative fixation. The higher percentage may be attributed to our sole etiology of falls, which led to orbital fractures that became symptomatic as well as more mandibular fractures rather than midfacial fractures.

Only one patient in our study required reoperation, more specifically for enophthalmos after orbital floor repair. However, some patients had readmissions for repeated fractures and complications, such as deep vein thromboses and infections. These patients often had comorbidities, most commonly hypertension, hyperlipidemia, and diabetes mellitus. Thus, the focus of management of elderly patients should be shifted to fall prevention. Caretaker awareness and education is necessary across all environments, including hospitals, homes, and nursing and ambulatory care. Standardization of fall evaluation, such as the Morse Fall Scale, is integral for caretakers to understand each patient's risks when there is transition of care. Continued reassessment is also important as these risks may constantly change as an elderly patient's condition may worsen or improve. Both the patient and the caretaker require one-on-one education on the appropriate actions should a fall actually occur to prevent further accruing of injuries. Mundinger et al similarly concluded in a study with 1,087 elderly patients that resources should be allocated differently than for nongeriatric adults. Since elderly patients had significantly longer hospital stays, increased fatality, and increased likelihood of being

Table 5 Fracture sites and indications for operative fixation

Patient	Fracture site	Indication for operative fixation
1	Orbital floor	ORIF performed for displaced fractures Concomitant placement of subclavian line and periprosthetic distal femur replacement
2	Orbital floor	Pain with eye movements and diplopia Floor completely blown out Delayed repair (1 mo)
3	Orbital floor	Enophthalmos/hypoglobus Delayed repair (>1 mo)
4	Orbital floor	Blowout with retrobulbar hematoma and proptosis Repaired during initial admission
5	Orbital floor/lateral wall	Enophthalmos, restricted eye movements Delayed repair (>1 mo)
6	Orbital floor/medial wall	Blowout with 4-mm enophthalmos Delayed repair (1 mo)
7	Orbital floor/medial wall	Blowout with 5-mm enophthalmos Delayed repair (1 mo)
8	Maxillary alveolus	Removal of multiple teeth Required appropriate occlusion
9	Bilateral mandibular body	ORIF because unable to close reduce (edentulous patient)
10	Mandibular angle	ORIF because unable to close reduce (edentulous patient)
11	Parasymphysis Mandibular body	ORIF because unable to close reduce (edentulous patient)
12	Subcondylar Mandibular angle/ramus	ORIF because unable to close reduce (edentulous patient)
13	Subcondylar	Gunning splint/MMF (edentulous patient)
14	ZMC	ORIF when patient became symptomatic with trismus Delayed repair (1 mo)
15	ZMC orbital floor	ORIF during initial admission Symptomatic with diplopia and infraorbital nerve numbness 0.3×0.4 cm anterolateral floor defect extending into orbital rim
16	ZMC orbital floor Hemi Le Fort I	ORIF performed for refractory diplopia Delayed repair (1 mo) 2×1 cm floor defect
17	ZMC orbital floor (nondisplaced)	ORIF performed for displaced ZMC fracture
18	Le Fort I/II	ORIF performed for displaced fractures
19	Le Fort II/III, frontal sinus	ORIF performed because patient had open bite and free-floating maxilla CSF leak was discovered during frontal sinus repair and cranialization performed with pericranial flap and lumbar drain placed by neurosurgery
20	Bilateral nasal bone	Closed reduction with laceration repair
21	Nasal bone	Closed reduction with laceration repair Associated avulsion injury
22	Le Fort II (nondisplaced) Medial orbital wall Nasal bone Zygoma (nondisplaced) Bilateral mandibular condyles Mandibular symphysis	Closed reduction of mandibular fractures/MMF with teeth 8/9/10 extracted

Abbreviations: CSF, cerebrospinal fluid leak; MMF, maxillomandibular fixation; ORIF, open reduction internal fixation; ZMC, zygomaticomaxillary complex.

discharged with assistive services, resources for supportive care become much more integral in the process of a successful recovery.[29] Finally, falls that do not result in serious damage may often be underreported; thus, a transparent system for reporting falls is necessary for honest studies and evaluation of the system of care.

As this is a retrospective study, certain limitations exist that can be improved in future endeavors. The data were solely obtained through imaging and chart review, some of which has been more than a decade old. Improvements in technology and imaging may shed more or different diagnoses if these cases had presented today. Further, the accuracy of the history and findings may have been compromised during transfer from the patient to the physician to the hospital chart to the researcher. Another added layer of complication is the ability of the elderly patients, some of which may have cognitive impairment, to present the exact circumstance and nature of the fall under such emergent conditions. Thus, many gaps in knowledge may have been provided or inferred by a family member. Finally, follow-up for potential complications to the interventions and the degree of restoration in function and aesthetics was not possible in our series.

Conclusion

Facial fractures as a result of falls in the geriatric population represent an increasing proportion of trauma cases as life expectancy steadily rises. Decreased reflexes, balance, and other capabilities of coordination predispose elderly patients to fall in the winter months, and decrease their means to break their fall, resulting in common fractures of the orbit, nasal bone, and zygoma. Falls that result from forces travelling cranially are associated with cervical spine fractures, while fractures of the thick frontal and skull bones increase the risk of intracranial hemorrhage as the delicate brain is no longer fully protected. Only when the specific demographics, predisposing factors, mechanical causes, and associated injuries are elucidated can the steps of prevention occur efficiently in the right direction. The authors hope that this study can provide some insight and instigate further investigation.

Conflict of Interest
None.

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