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Are the Elderly With Maxillofacial Injuries at Increased Risk of Associated Injuries?

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Purpose: As the geriatric population continues to increase, more elderly patients with maxillofacial injuries are encountered in emergency rooms. It can be hypothesized that advanced age increases the risk of associated injuries (AIs). The purpose of the study was to estimate the frequency of AI and measure the association between age and risk for AI among a sample of patients with facial fractures.

Methods: A retrospective cohort study was designed and implemented. The study sample comprised patients aged 18 years or older who presented to the Töölö Trauma Centre, Helsinki University Hospital, Finland, between 2013 and 2018 for diagnosis and treatment of facial fractures. The primary outcome variable was the presence or absence of AI. AI was defined as any major injury outside the facial region, including injuries to brain, major vessels, internal organs or respiratory organs, and fractures. Secondary outcome variables were affected organ system (classified as brain, cranial bone, neck, upper extremity, lower extremity, chest, spine, and abdomen), number of affected organ systems (classified as 1 and ≥2), need for intensive care, and mortality. The primary predictor variable was age (adults vs elderly). Controlled variables were sex, mechanism of trauma, intoxication by alcohol, and type of facial fracture. Descriptive statistics, univariable, and multivariable logistic regression analysis were executed to measure the association between age groups and AI. P value less than .05 was set as the threshold for statistical significance.

Results: Of the total 2,682 patients, 1,931 (72.0%) were adults, and 751 (28.0%) were elderly. Elderly had a 1.6-fold risk (95% confidence interval [CI], 1.5-1.8; $P < .001$) of AIs as compared with adults. Moreover, after adjusting for mechanism of trauma and type of facial fracture, elderly had 1.8 times greater odds for injuries to 2 or more organ systems (95% CI, 1.3-2.5; $P < .001$), 2.2 times greater odds for brain injuries (95% CI, 1.6-2.9; $P < .001$), 2.3 times greater odds for neck injuries (95% CI, 1.5-3.6; $P < .001$), and 6.8 times greater odds for mortality (95% CI, 2.9-15.6; $P < .001$).

Conclusion: Elderly patients have AIs significantly more frequently than younger adults. Age-specific features should be taken into consideration in the multiprofessional evaluation and treatment of facial fracture patients.

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Adult patients with facial fractures typically have these features: they are predominantly male, there is a high frequency of assault-related trauma, and they commonly include a mandibular fracture.[1] In geriatric patients, on the other hand, females are often in the majority, with their injuries most commonly being due to falls. Additionally, facial fractures in geriatric patients are most often sustained in the orbital-zygomatic-maxillary complex.[2,3] Compared to younger adults, several characteristics in the elderly leave them susceptible to different types of injury mechanisms and injuries. Age-related physiological changes, cognitive and somatic comorbidities, and polypharmacy increase the risk of multiple injuries in general and severe injuries in particular. Despite this, geriatric facial trauma has received fairly little attention in the literature.

We have previously observed that some 25% of patients with facial fractures have associated injuries (AIs) outside the facial region[4] and that AIs are significantly more common in geriatric patients than in patients aged 20-50 years.[5] Since the publication of these 2 studies, we have observed an increase in the yearly number of facial fracture patients in general, and geriatric patients in particular. This suggests a need for targeted screening to detect changes in injury patterns.

The aim of the present study was to clarify the occurrences and types of AIs in a sample of patients with facial fractures. The specific aims were to *1)* estimate and compare the frequencies of AIs between adults and elderly patients and *2)* identify risk factors associated with AIs. We hypothesized that AIs are more frequent in elderly patients and that their injury characteristics differ from those in younger adults.

Materials and Methods

STUDY DESIGN AND SAMPLE

To address the research aims, a retrospective cohort study was designed and implemented. The study sample comprised all patients who presented to the Töölö Trauma Centre, Helsinki University Hospital, Finland, between 2013 and 2018 for diagnosis and treatment of facial fractures. Included in the study sample were patients who were at least 18 years of age at the time of the injury and had adequate information available for data abstraction.

STUDY VARIABLES

The primary predictor variable was age, ie, adults vs elderly. The group of elderly consisted of patients who were at least 60 years of age at the time of the injury.

The primary outcome variable was the presence or absence of AI. AIs included any major injuries outside the face, ie, brain injuries; injuries to major vessels, internal organs, or respiratory organs; and fractures. Wounds and other superficial soft-tissue injuries were excluded.

The secondary outcome variables were *1)* affected organ systems, *2)* number of affected organ systems (1 vs 2 or more affected organ systems), *3)* need for intensive care, and *4)* mortality during hospitalization. Affected organ systems included the brain, cranial bones (excluding fractures of the upper facial third, ie, fractures of the orbital roofs and the frontal sinus), upper extremities, neck (including cervical spine injuries as well as blunt cerebrovascular and laryngeal injuries), chest, lower extremities (including the pelvis), spine (excluding the cervical spine), and abdomen.

Controlled variables were grouped into the following categories: sex, mechanism of trauma (assault, fall at ground level, fall from height, fall from stairs, bicycle accident, struck by object, and motor vehicle accident), intoxication by alcohol, and type of facial fracture. Type of facial fracture was classified according to the facial third as follows: *1)* exclusively mandibular fracture ($\geq$1), *2)* exclusively midfacial fracture ($\geq$1), *3)* exclusively upper third fracture (orbital roof and/or the frontal sinus), and *4)* combined fracture (ie, mandibular + midfacial fractures, midfacial + upper third fractures, or panfacial fracture extending to all facial thirds).

DATA ANALYSIS

Descriptive statistics were calculated for all variables. The Pearson χ^2 test was used to determine the associations between controlled variables and primary predictor and between secondary outcomes and primary predictor. The risk ratio was calculated between the primary outcome and primary predictor. The statistical modeling was executed using logistic regression. Odds ratio with 95% confidence intervals were calculated to examine the associations between primary and secondary outcomes and primary predictor. The association between primary outcome and primary predictor was evaluated with multivariable logistic regression. Controlled variables were included in the multivariable model if the controlled variable associated with the primary outcome and primary predictor are alike with a P value less than .05. Data analysis was performed using SPSS software (IBM SPSS v27.0, IBM Corp., Armonk, NY). A P value less than .05 was set as the threshold for statistical significance.

ETHICAL CONSIDERATIONS

The Helsinki declaration guidelines were followed, and the study was approved by the Internal Review

Board of the Head and Neck Center of the Helsinki University Hospital, Helsinki, Finland (HUS/356/2017).

Results

In total, 2,682 patients were identified for the present study. Of these, 1,931 (72.0%) were adults, and 751 (28.0%) were elderly patients.

Table 1 presents the descriptive statistics of the 2,682 patients. Most of the patients were male (71.8%). The mean age of the patients was 47.4 years (range, 18 to 102.5 years). Assault (30.1%) and fall at ground level (30.0%) were the most common mechanisms of injury. Exclusively midfacial fracture was the most common fracture type (58.4%). AIs occurred in 31.8% of patients, the brain being the most commonly affected organ system (15.1%). One affected organ system was more frequent (19.2%) than 2 or more affected organ systems (12.7%). Intensive care was required for 10.1% of patients. The mortality rate was 1.3% for the whole sample.

Table 2 shows the associations between the controlled variables and age groups. The variables sex ($P < .001$), mechanism of trauma ($P < .001$), intoxication ($P < .001$), and type of facial fracture ($P < .001$) were statistically associated with age groups.

Table 1. DESCRIPTIVE STATISTICS OF PATIENTS (N = 2,682) WITH FACIAL FRACTURES

Variable	Number of Patients	%
Sex		
Male	1,926	71.8
Female	756	28.2
Age (yr)		
Mean	47.4	
Range	18.0-102.5	
Adults	1,931	72.0
Elderly	751	28.0
Mechanism of trauma		
Assault	806	30.1
Fall at ground level	805	30.0
Bicycle	326	12.2
Struck by object	216	8.1
Motor vehicle accident	182	6.8
Fall from height	155	5.8
Fall from stairs	115	4.3
Other/unknown	77	2.9
Intoxication/yes	986	36.8
Type of facial fracture		
Exclusively midfacial	1,566	58.4
Exclusively mandibular	754	28.1
Combined	278	10.4
Exclusively upper third	84	3.1
Associated injury (AI)/yes	854	31.8
Affected organ systems		
Brain	405	15.1
Upper extremity	307	11.4
Cranial bone	256	9.5
Chest	165	6.2
Neck*	112	4.2
Lower extremity	104	3.9
Spine†	46	1.7
Abdomen	28	1.0
Number of affected organ systems		
1	514	19.2
≥2	340	12.7
Intensive care/yes	271	10.1
Mortality/yes	35	1.3

* Including cervical spine, blunt cerebrovascular, and laryngeal injuries.

† Excluding cervical spine injuries.

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Table 2. CONTROLLED VARIABLES BY AGE GROUPS

	Adults (n = 1,931)		Elderly (n = 751)		
Variable	Number of Patients	%	Number of Patients	%	P Value*
Sex					<.001
Male	1,555	80.5	371	49.4	
Female	376	19.5	380	50.6	
Mechanism of trauma					<.001
Assault	779	40.3	27	3.6	
Fall at ground level	326	16.9	479	63.8	
Bicycle	258	13.4	68	9.1	
Struck by object	199	10.3	17	2.3	
Motor vehicle accident	134	6.9	48	6.4	
Fall from height	125	6.5	30	4.0	
Fall from stairs	57	3.0	58	7.7	
Other/unknown	53	2.7	24	3.2	
Intoxication					<.001
Yes	832	43.1	154	20.5	
Type of facial fracture					<.001
Exclusively midfacial	1,055	54.6	511	68.0	
Exclusively mandibular	621	32.2	133	17.7	
Combined	193	10.0	85	11.3	
Exclusively upper third	62	3.2	22	3.0	

* χ^2 Test.

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Table 3. CONTROLLED VARIABLES BY ASSOCIATED INJURIES (AIS)

	AI Present		AI absent		
Variable	Number of Patients	% Of n	Number of Patients	% Of n	*P* Value*
All patients (n = 2,682)	854	31.8	1,828	68.2	
Sex					.076
Male (n = 1,926)	594	30.8	1,332	69.2	
Female (n = 756)	260	34.4	496	65.6	
Mechanism of trauma					<.001
Assault (n = 806)	126	15.6	680	84.4	
Fall at ground level (n = 805)	241	29.9	564	70.1	
Bicycle (n = 326)	124	38.0	202	62.0	
Struck by object (n = 216)	29	13.4	187	86.6	
Motor vehicle accident (n = 182)	129	70.9	53	29.1	
Fall from height (n = 155)	120	77.4	35	22.6	
Fall from stairs (n = 115)	58	50.4	57	49.6	
Other/ unknown (n = 77)	27	35.1	50	64.9	
Intoxication					.392
Yes (n = 986)	304	30.8	682	69.2	
Type of facial fracture					<.001
Exclusively midfacial (n = 1,566)	522	33.3	1,044	66.7	
Exclusively mandibular (n = 754)	111	14.7	643	85.3	
Combined (n = 278)	161	57.9	117	42.1	
Exclusively upper third (n = 84)	60	71.4	24	28.6	

* χ^2 Test.

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Table 3 shows the associations between the controlled variables and AI. There were significant associations between the AI and mechanism of trauma (*P* < .001) and type of facial fracture (*P* < .001).

Table 4. CALCULATION OF RISK RATIO (RR) BY ASSOCIATED INJURY (AI) BETWEEN AGE GROUPS

Age Group	AIs Present	AIs absent	Total
Elderly n (%)	330 (43.9)	421 (56.1)	751 (28.0)
Adults n (%)	524 (27.1)	1,407 (72.9)	1,931 (72.0)
Total n (%)	854 (31.8)	1,828 (68.2)	2,682

Note: Elderly are 1.6 times more likely to have AI than adults. RR 1.6 (95% CI, 1.5-1.8; *P* < .001).
Abbreviations: CI, confidence interval.

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Table 4 shows the risk analysis between age groups and AIs. Elderly patients had a 1.6-fold risk of AIs as compared with adults (95% CI, 1.5-1.8; *P* < .001).

Table 5 summarizes the multivariable logistic regression analysis for AI. Significant predictors for AIs were age, type of facial fracture, and mechanism of trauma. Elderly patients had 1.9 times greater odds (95% CI, 1.5-2.5; *P* < .001) for AIs than adults. As compared to patients with exclusively mandibular fracture, those with exclusively midfacial fracture had 2.3 times greater odds (95% CI, 1.8-3.0; *P* < .001), those with combined fracture had 5.6 times greater odds (95% CI, 4.0-7.9; *P* < .001), and those with exclusively

Table 5. SUMMARY OF MULTIVARIABLE LOGISTIC REGRESSION ANALYSIS FOR ASSOCIATED INJURY (AI)

Variable	OR (95% CI)	*P* Value
Age group		
Adult	ref	
Elderly	1.9 (1.5-2.5)	<.001
Sex		
Female	ref	
Male	1.1 (0.9-1.3)	.522
Type of facial fracture		
Exclusively mandibular	ref	
Exclusively midfacial	2.3 (1.8-3.0)	<.001
Combined	5.6 (4.0-7.9)	<.001
Exclusively upper third	12.5 (7.2-21.8)	<.001
Mechanism of trauma		
Struck by object	ref	
Assault	1.3 (0.9-2.1)	.200
Fall at ground level	2.1 (1.4-3.4)	.001
Bicycle	3.8 (2.4-6.1)	<.001
Motor vehicle accident	13.7 (8.1-23.1)	<.001
Fall from height	19.2 (10.9-33.6)	<.001
Fall from stairs	4.5 (2.6-8.0)	<.001
Other/unknown	2.7 (1.4-5.1)	.003

Abbreviations: CI, confidence interval; OR, odds ratio; ref, reference category.

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Table 6. ASSOCIATIONS BETWEEN SECONDARY OUTCOMES AND AGE GROUPS

	Adults (n = 1,931)		Elderly (n = 751)	
Secondary Outcome	Number of Patients	%	Number of Patients	%
Affected organ systems				
1	307	15.9	207	27.6
≥2	217	11.2	123	16.4
Separated affected organ systems				
Brain	233	12.1	172	22.9
Upper extremity	190	9.8	118	15.7
Cranial bone	170	8.8	86	11.5
Chest	115	6.0	50	6.7
Neck*	57	3.0	55	7.3
Lower extremity	83	4.3	21	2.8
Spine†	33	1.7	13	1.7
Abdomen	23	1.2	5	0.7
Intensive care	191	9.9	80	10.7
Mortality	10	0.5	25	3.3

* Including cervical spine, blunt cerebrovascular, and laryngeal injuries.
† Excluding cervical spine injuries.

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upper third fracture had 12.5 times greater odds (95% CI, 7.2-21.8; $P < .001$) for AI.

Table 6 summarizes the associations between secondary outcomes and age groups. As compared to adults, brain injuries, upper extremity injuries, cranial bone fractures, neck injuries, and mortality in particular were more frequent in elderly patients.

Table 7 summarizes the logistic regression analysis for secondary outcomes between age groups. After adjusting for mechanism of trauma and type of facial fracture, elderly patients had 1.8 times greater odds for injuries in 2 or more organ systems (95% CI, 1.3-2.5; $P < .001$), 2.2 times greater odds for brain injuries (95% CI, 1.6-2.9; $P < .001$), 2.3 times greater odds for neck injuries (95% CI, 1.5-3.6; $P < .001$), and 6.8 times greater odds for mortality (95% CI, 2.9-15.6; $P < .001$) than adults. Moreover, in the unadjusted analysis, elderly patients had 1.3 times greater odds for cranial bone fracture, but the adjusted analysis resulted in statistical nonsignificance ($P = .054$).

Discussion

The main aim of the present study was to estimate the frequency of AIs and measure the association between age and risk of AI among a sample of patients with facial fractures. We hypothesized that AIs are more frequent in elderly patients and that their injury characteristics differ from those in younger adults. The hypotheses were confirmed. Elderly patients had a 1.6-fold risk of AIs as compared with adults. Moreover, elderly patients had 1.8 times greater odds for injuries in 2 or more organ systems, 2.2 times greater odds for brain injuries, 2.3 times greater odds for neck injuries, and 6.8 times greater odds for mortality than adults.

Previously published studies have revealed that 5.3% to 19.4% of patients with facial fractures are elderly, ie, those aged 60 years or older.[4,6-12] Several of these studies have shown that the proportion of elderly

Table 7. LOGISTIC REGRESSION ANALYSIS BY SECONDARY OUTCOMES BETWEEN AGE GROUPS

	Unadjusted Logistic Regression OR (95% CI)			Adjusted* Logistic Regression OR (95% CI)		
Secondary Outcome	Elderly	Adults	P Value	Elderly	Adults	P Value
Affected organ systems ≥2	1.5 (1.2-2.0)	Ref	<.001	1.8 (1.3-2.5)	ref	<.001
Brain	2.2 (1.7-2.7)	Ref	<.001	2.2 (1.6-2.9)	ref	<.001
Upper extremity	1.7 (1.3-2.2)	Ref	<.001	1.3 (0.95-1.7)	ref	.100
Cranial bone	1.3 (1.02-1.8)	Ref	.037	1.4 (0.99-2.0)	ref	.054
Chest	1.1 (0.8-1.6)	Ref	.497	1.5 (0.97-2.2)	ref	.069
Neck	2.6 (1.8-3.8)	Ref	<.001	2.3 (1.5-3.6)	ref	<.001
Lower extremity	ref	1.6 (0.96-2.5)	.073	ref	1.6 (0.9-2.7)	.119
Spine	1.0 (0.5-1.9)	Ref	.968	1.3 (0.6-2.6)	ref	.497
Abdomen	ref	1.8 (0.7-4.7)	.236	ref	1.4 (0.5-3.8)	.543
Intensive care	1.1 (0.8-1.4)	Ref	.557	1.3 (0.9-1.8)	ref	.185
Mortality	6.6 (3.2-13.8)	Ref	<.001	6.8 (2.9-15.6)	ref	<.001

Abbreviations: CI, confidence interval; OR, odds ratio; ref, reference category.
* Adjusted with mechanism of trauma and type of facial fracture.

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patients has increased with time. Yamamoto et al[9] showed an increased rate of elderly patients from 5.7% to 19.4% when they compared the periods 1981 to 1991 and 2000 to 2010. Lee[10] showed an increase in the rate from 7.0% during the period 1996 to 2001 to 9.7% during 2001 to 2006. Kloss et al[8] observed that the yearly number of geriatric patients in 2003 was almost double the number in 1991. The proportion has also systematically increased with time in our unit, having been 6.6% in 1981,[6] 9.8% in 1997,[6] 11% in 2003 to 2004,[4] and 28% in the present study covering the years 2013 to 2018. The results clearly reflect the progressive aging of the population in the Western world.

A recently published European multicenter study focusing on maxillofacial trauma in patients aged 70 years or older revealed a 27.3% rate of concomitant injuries.[3] The rate is much lower than what we observed among patients who were aged 60 years or older (43.9%) and also among those who were older than 70 years (44.8%). There are several potential reasons for the discrepancy in results, such as variations in the occurrence of underlying medical conditions and regular medications of the patients, as well as different distributions of trauma mechanisms. Moreover, the units that participated in the multicenter study mentioned[3] seem to have variable protocols when examining facial fracture patients. Patients in the present study were all examined not only by oral and maxillofacial surgeons but also by orthopedic trauma surgeons according to our hospital protocol and, when needed, by representatives of other medical specialties.

In our unit, the AI rate among elderly has remained relatively constant when compared to the periods of 2003 to 2004 and 2006 to 2007, the rates for the respective periods being 49% in patients aged 60 years or older[4] and 44% in those aged 65 years or older.[5] The mortality rate observed in the present study, 3.3%, is close to the rate of 4.4% observed by Spaniolas et al.[13] Parallel to our findings, Spaniolas et al[13] observed that the rate in elderly patients was significantly higher than the rate in younger patients. They found in particular that patients older than 70 years and with a Glasgow Coma Scale score less than 15 represented significant in-hospital mortality.

In elderly patients with facial fractures, multiple medications, the presence of comorbidities, and a high risk of AIs in general and brain injuries in particular are important predisposing factors for mortality. An additional factor may be undertriage of elderly patients. A paper published in 2012 by Rogers et al[14] showed that as many as 15.1% of 4,534 trauma patients aged 65 years or older in total were undertriaged and subsequently more likely to die. Other recently published papers have also highlighted this phenomenon, both in prehospital care[15] and in major trauma center environments.[16] Patients aged 65 years and older were less likely to receive trauma team activation or see a consultant first attender and showed higher mortality rates despite having a lower median injury severity score than younger patients.[16]

In our unit, the mortality rate of elderly patients with facial fractures has decreased somewhat with time, from 5.1% in patients diagnosed during 2006 to 2007[5] to 3.3% in the present study. One reason for this finding may be the slight difference in age criteria of the studies mentioned (ie, ≥60 years in the present study vs ≥65 years in the earlier one). Another reason may be an increased alertness among public health personnel regarding geriatric trauma, resulting in a lower referral threshold. As shown by Velez et al,[17] elderly patients with mild brain injuries transferred to level I/II trauma centers have improved outcomes.

Many studies have confirmed that falls dominate as etiological factors among the elderly. The rate of falls on ground level or down stairs was 71.5% in the present study, which is close to the previously reported range of 72% to 79%.[3,8] Some 70% to 80% of facial fracture patients have 1 or more comorbidities,[3,18] many of which predispose for falls. However, an important finding in the present study was the notable rate of intoxication by alcohol among the elderly at the time of the accident, the rate having increased from 11.1% in Finnish elderly patients diagnosed during 2006 to 2007[18] to 20.5% in the present study. As shown by Shakya et al,[19] alcohol-related falls in elderly patients were more likely to result in severe head injuries in general, and traumatic brain injuries as well as facial injuries in particular, than falls that were not related to alcohol consumption. Units that care for elderly patients in general and trauma patients in particular should perform screening for alcohol and other substance use whenever an intoxicated patient is encountered and provide for necessary interventions.

The main limitation of the present study is its retrospective nature, involving the risk that some data are inadequate. The rates of intoxication in particular may be underestimated due to time lag between injury and diagnosis or lack of documentation. In addition, rates of mortality might be somewhat underestimated because of referral of patients to other hospitals after the primary examination or because some patients died already at the scene of the injury. These limitations highlight even more strongly the high risk of AIs in facial fracture patients in general and elderly patients in particular.

In conclusion, the distributions of sex, etiologies, facial fracture types, and AIs are significantly different in elderly patients than in younger adult patients. Elderly patients have AIs significantly more frequently. Age-specific features should be taken into consideration in the multiprofessional evaluation and treatment of facial fracture patients.

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