

The impact of ageing on cranio-maxillofacial trauma—a comparative investigation

F. R. Kloss¹, T. Tuli¹, O. Hächl¹,
K. Laimer¹, S. Jank¹, K. Stempf¹,
M. Rasse¹, R. Gassner¹

¹Department of Cranio-Maxillofacial and Oral Surgery, Medical University of Innsbruck, Maximilianstr. 10, 6020 Innsbruck, Austria;

²Department of Medical Statistics, Medical University of Innsbruck, Schöpfstr. 41/1, 6020 Innsbruck, Austria

F. R. Kloss, T. Tuli, O. Hächl, K. Laimer, S. Jank, K. Stempf, M. Rasse, R. Gassner: *The impact of ageing on cranio-maxillofacial trauma—a comparative investigation. Int. J. Oral Maxillofac. Surg. 2007; 36: 1158–1163.* © 2007 International Association of Oral and Maxillofacial Surgeons. Published by Elsevier Ltd. All rights reserved.

Abstract. The number of patients older than 65 is increasing in developed societies. The impact of age on injuries and their outcome has been well documented in several fields of traumatology. Data on a broad cohort suffering from oral and maxillofacial injuries are missing. In this study, the data of 12,572 such patients were collected, of which 11,798 were younger and 774 were older than 65 years. With increasing age the risk of a domestic accident increased. The accident mechanism in elderly people was most frequently a fall (72%) or was not reproducible (12%). There was a significant difference between groups regarding concomitant injuries. Additional neurological symptoms occurred in 26% of the older and 15% of the younger patients ($P < 0.001$). Until the age of 65 the risk of concomitant neurological injury increases. Injuries in the older patients mainly affected the soft tissue and midface. No statistical differences in surgical postoperative complications were observed. Due to the changing face of society, the treatment of elderly people is of high relevance. To enable an independent life after trauma, pre- and post-therapeutic care is of major importance. These data support surgical treatment of all patients, regardless of age, driven by general health condition whenever possible.

Key words: ageing; oral and maxillofacial; trauma; concomitant injuries; elderly patient; epidemiology.

Accepted for publication 5 July 2007
Available online 5 September 2007

According to the WHO elderly people are specified as persons older than 65 years of age. The proportion of this cohort within societies in the developed world is increasing. In the United States the percentage of elderly people within the population is expected to reach 50% by the year 2050²⁰. As the number of active persons aged over 65 years is stepping up, the number of elderly patients sustaining injuries followed by hospitalization is increasing². This fact has socio-economic

consequences. Statistics in the US show 1.5 million osteoporosis-related and age-related fractures annually; 700,000 of these are vertebral, 300,000 are hip and 250,000 are wrist fractures, resulting in a mortality rate of 25%⁵. One out of every two women and one out of every four men will have a fracture related to osteoporosis⁵. These age-related fractures are associated with certain changes at the morphological and molecular level. Morphologically bone becomes porous, Haversian canals and

canaliculi are plugged, and the number of empty osteocyte lacunae increases with increasing age³. On the molecular level a change in bone strength occurs, due to structural changes in the collagen network. These structural changes are mainly caused by non-enzymatic glycation-induced collagen cross links of pentosidine, thus hydroxy-lysylpyridinoline and lysylpyridinoline exhibit a significant rise with increasing age^{21,22}. These changes display a significant correlation with strength,

elastic modulus and work of fracture, but have little correlation with transverse fracture toughness of bone³. It was also demonstrated that both bone mass and age influence the risk of sustaining fractures. These effects on the actual rate of fracture are multiplicative¹⁰. Beside these morphological and structural changes, elderly people become frail, coordinative capabilities decrease and subsequently the risk of sustaining an accident increases. The influence of osteoporosis on the cranio-maxillofacial skeleton is still unclear and controversial¹³. The fact, that the maxilla and mandible underlie age-related changes is not doubted. Data screening an ample cohort, in order to demonstrate the influence of age on trauma of the facial bones and concomitant injuries, are missing in the literature. The increasing number of aged people in our society and hence the increasing number of older patients gave the reason to investigate the influence of age on the probability of sustaining maxillofacial injuries. It was the aim of the present retrospective investigation to assess the incidence of injuries in the cranio-maxillofacial skeleton in an elderly population, and to describe the causes, type, distribution and concomitant injuries of those trauma patients in comparison to a younger population.

Methods

During the period 1991–2003, at the Department of Cranio-Maxillofacial and Oral Surgery at the Medical University of Innsbruck, the data of all patients undergoing treatment due to trauma-related injuries were collected. Data were registered regarding diagnosis, cause, type and localization of the injury, concomitant injuries, age and gender distribution. The concomitant injuries were summarized in different categories, such as neurological injuries (e.g. concussion, contusion) and neurosurgical injuries (e.g. subdural haematoma, epidural haematoma).

According to the WHO definition of elderly people the collected data were divided into those referring to persons older than 65 years of age and those younger than this age. The data of both groups were compared and statistically analysed.

Statistical analysis was performed in SPSS (Version 7.5) using χ^2 test, Fisher's exact test and Mann-Whitney *U*-test. This was followed by a logistic regression analysis in order to investigate trends and to demonstrate significant differences between the groups.

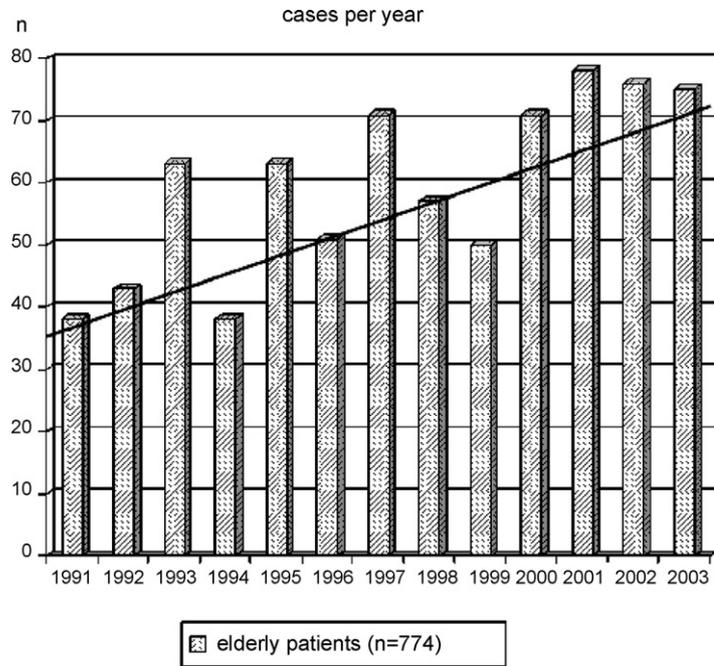


Fig. 1. Number of patients older than 65 years per year from 1991 to 2003.

Results

Within 13 years a total number of 12,572 patients with oral and maxillofacial injuries were recorded. Of these 11,798 patients (♀ 31%, ♂ 69%) were younger than 65 years (mean age 22.68 years), while 774 (♀ 45%, ♂ 55%) were older (mean age 74.79 years). The annual distribution showed a slight increase in the number of elderly people suffering from oral and maxillofacial injuries towards the year 2003 (Fig. 1). The major causes of injuries for younger people were accidents at home (37%) followed by sporting acci-

idents (33%) (Fig. 2). No significant difference between male and female patients in the probability of sports-related injury was observed (Table 1). In the younger population there was an age-dependent risk of sporting accidents (maximum for adolescents), but this was not the case in the elderly population (Table 1). In the elderly population a domestic accident (72%) was responsible for the majority of injuries (Fig. 2). Statistical evaluation revealed a significant trend in this group: the older the person the more likely was the occurrence of a household accident (Table 1). The female population also

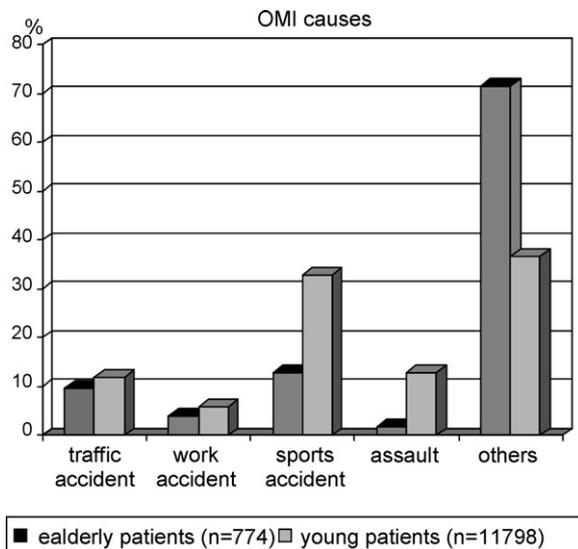


Fig. 2. Main causes of oral and maxillofacial injuries (OMI) in the younger and older groups.

Table 1. Regression analysis of the main causes of oral and maxillofacial injuries in the younger and older groups

Patients > 65 years	B	SE	Wald	df	Sig	Exp (B)	95% C.I. for Exp (B)		
							Lower	Upper	
Traffic accident									
Age	-0.037	0.016	4.136	1	0.042	0.963	0.930	0.999	
Sex	0.152	0.259	0.345	1	0.557	1.164	0.701	1.935	
Constant	0.481	1.350	0.125	1	0.724	1.618			
Sports accident									
Age	-0.106	0.021	24.488	1	0.000	0.900	0.683	0.938	
Sex	0.996	0.265	14.128	1	0.000	2.708	1.611	4.552	
Constant	5.549	1.537	13.033	1	0.000	257.08			
Others									
Age	0.074	0.012	35.742	1	0.000	1.077	1.051	1.103	
Sex	-0.996	0.170	34.510	1	0.000	0.389	0.285	0.515	
Constant	-4.698	0.919	26.131	1	0.000	0.009			
Patients < 65 years		B	SE	Wald	df	Sig	Exp (B)	95% C.I. for Exp (B)	
								Lower	Upper
Traffic accident									
Age	0.018	0.002	114.94	1	0.000	1.018	1.015	1.022	
Sex	-0.108	0.062	3.018	1	0.082	0.894	0.794	1.014	
Constant	-2.476	0.054	2075.8	1	0.000	0.084			
Sports accident									
Age	0.004	0.001	13.173	1	0.000	1.004	1.002	1.007	
Sex	0.010	0.043	0.059	1	0.808	1.010	0.929	1.099	
Constant	-0.836	0.035	578.76	1	0.000	0.434			
Others									
Age	-0.038	0.001	752.70	1	0.000	0.962	0.960	0.965	
Sex	-0.672	0.043	248.85	1	0.000	0.511	0.470	0.555	
Constant	0.354	0.035	103.81	1	0.000	1.424			

had a higher risk of sustaining a domestic injury with increasing age (Table 1). The mechanism of accident was most frequently a simple fall (72%) or was not reproducible (11.5%) (Fig. 3). Statistically for aged people ($P < 0.003$), the chance of being injured by a fall was significantly higher. The younger group suffered from

simple falls in 50% of cases, and in 20% they were involved in affrays or traffic collisions (9%) (Fig. 3).

Regarding concomitant injuries, significant statistical differences between the two groups were detected. Of the elderly people 26% showed additional neurological symptoms, whereas only 15% of the

younger population revealed these symptoms ($P < 0.001$) (Fig. 4). While 9% of the old, only 5% of the young patients sustained severe neurosurgical injuries ($P < 0.005$) (Fig. 4). The regression analysis revealed that within the group of patients over 65 years of age there is no significant rise in concomitant injuries with increasing age. In contrast, the younger population showed a significant increase in additional injuries with increasing age (Table 2). The same phenomenon was observed with concussion and subdural haematoma (Table 2).

Interestingly, of the 774 elderly patients only one sustained a concomitant femur fracture, but 15 had rib fractures and 13 cervical spine fractures, while fractures of the upper limb accounted for fractures of the radius in 15 cases, humerus in 8 cases and hand in 6 cases.

The 774 elderly patients showed a total number of 2192 injuries. Of these, 46% affected the soft tissue, 41% were midfacial fractures, 7% caused dental trauma and 6% were mandibular fractures (Fig. 5). The group of 11798 younger people presented a total number of 28350 injuries: 38% involved the soft tissue, 32% the dental system, 23% the midface and 7% the mandibular bone (Fig. 5).

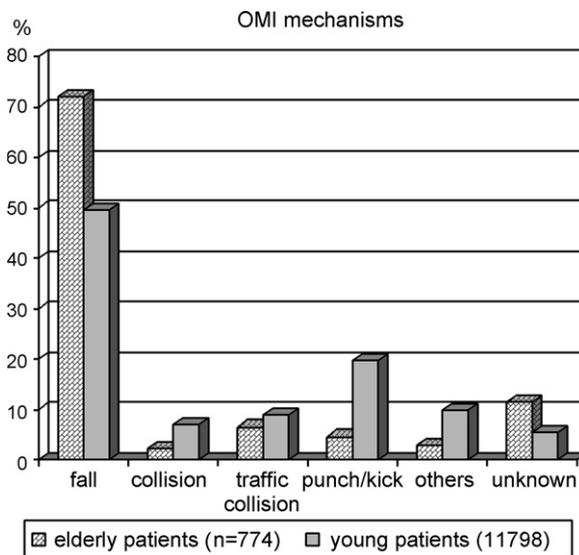


Fig. 3. Main mechanisms for oral and maxillofacial injuries (OMI) in the younger and older groups.

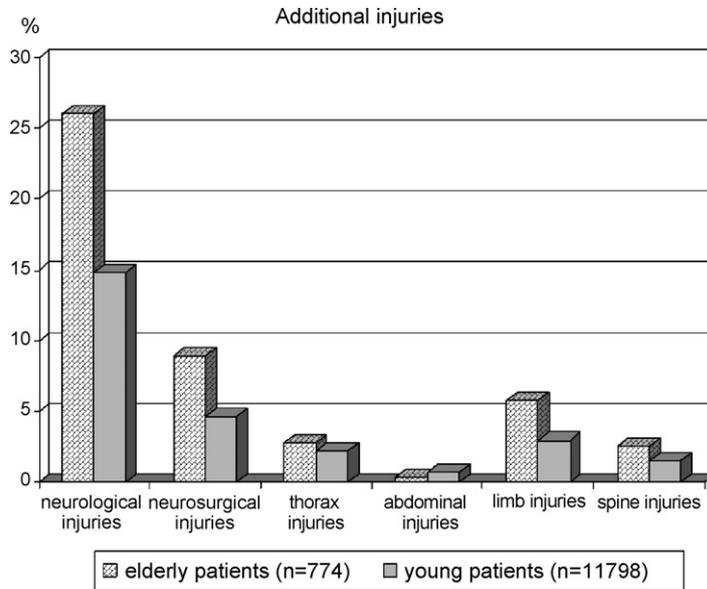


Fig. 4. Concomitant injuries in oral and maxillofacial injury (OMI) patients older and younger than 65 years.

In the 3-year time period 2001–2003, all the patients were also evaluated for pre- and postoperative findings regarding double vision, loss of vision, other ophthalmic conditions, occlusion, deficits in sensitivity and motor function, and weather sensations. This assessment including sta-

tistical evaluation did not reveal significant age-dependent differences. The only exception was the total number of weather sensations which was elevated over the postoperative periods of 0.5 and 1 year in elderly patients when compared with those younger than 65 years of age. All other

evaluated variables – all related to the facial injury itself – did not change in such a way that age should be considered a risk factor for complications following surgical treatment. Postoperative persistence or occurrence of symptoms or presence of complications following indicated surgical treatment did depend on the patient's general condition of health.

Discussion

Thanks to major progress in general health care, the percentage of elderly and most notably active old people in societies in the developed world has been constantly stepping up in the past three decades¹⁵. This is also reflected in the rising number of patients suffering from injuries in the cranio-maxillofacial area. At the Department of Cranio-maxillofacial and Oral Surgery of the Medical University of Innsbruck, the annual number of patients per year older than 65 has doubled since 1991 (Fig. 1). Generally, trauma-related injuries in older persons carry a high morbidity. Based on the literature 28% of traumatic deaths and 75% of deaths due to falls occur in the elderly^{14,16}. Treatment in a nursing home is required in 12% of elderly patients who suffer from a fall^{2,17}.

Table 2. Regression analysis for the most common concomitant injuries in the older and younger groups

Patients > 65 years	B	SE	Wald	df	Sig	Exp (B)	95% C.I. for Exp (B)	
							Lower	Upper
Additional injuries								
Age	-0.013	0.011	1.418	1	0.234	0.987	0.967	1.008
Sex	0.379	0.162	5.451	1	0.020	1.461	1.063	2.008
Constant	0.140	0.817	0.029	1	0.864	1.150		
Concussion								
Age	-0.001	0.016	0.006	1	0.939	0.999	0.967	1.031
Sex	0.278	0.250	1.242	1	0.265	1.321	0.810	2.154
Constant	-2.116	1.248	2.873	1	0.090	0.121		
Subdural haematoma								
Age	-0.17	0.034	0.235	1	0.628	0.984	0.920	1.052
Sex	1.123	0.545	4.239	1	0.039	3.074	1.055	8.951
Constant	-2.591	2.580	1.008	1	0.315	0.075		
95% C.I. for Exp (B)								
Patients < 65 years	B	SE	Wald	df	Sig	Exp (B)	Lower	Upper
Additional injuries								
Age	0.043	0.001	837.59	1	0.000	1.044	1.041	1.047
Sex	0.156	0.056	8.876	1	0.003	1.180	1.058	1.316
Constant	-2.671	0.052	2660.3	1	0.000	0.069		
Concussion								
Age	0.025	0.002	123.13	1	0.000	1.026	1.021	1.030
Sex	-0.112	0.086	1.711	1	0.191	0.894	0.755	1.058
Constant	-3.450	0.079	1921.9	1	0.000	0.032		
Subdural haematoma								
Age	0.037	0.009	15.164	1	0.000	1.037	1.018	1.057
Sex	0.107	0.373	0.083	1	0.774	1.113	0.536	2.312
Constant	-6.837	0.366	348.23	1	0.000	0.001		

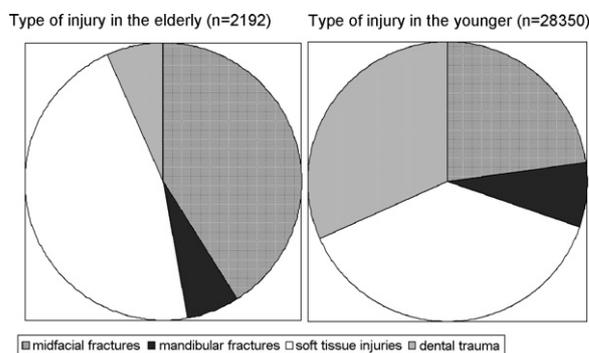


Fig. 5. Distribution of type of injury in the young (right) and elderly (left) patients.

Due to the regional conditions (within the Alps) the main cause of accidents in the younger population in this study were sports related, especially skiing during winter time and bicycling in the summer^{6,18,7}. The older people became the higher was the risk of a domestic injury, with females being involved in a significantly greater number of cases. Domestic accidents concerning elderly patients exhibit problems, as a lot of these people live alone. The distribution of the type of injury varied between the younger and older populations. In the younger patients soft-tissue injuries (38%) and dental trauma (32%) were the most frequent types. The younger the patient, the more probable is a dental injury¹⁹. In the elderly patients a dental trauma was rare (7%); this might be due to the fact that this group are often suffering from partial or full edentulism. The most common types of injury in the elderly were soft-tissue injuries (46%) and midfacial fractures (41%). Although age-related changes in the mandible after tooth loss lead to atrophy, only 6% of all injuries were related to mandibular fractures in the elderly. In another investigation of elderly patients, of all facial fractures evaluated 28% were mandibular and 66% were midfacial fractures⁸, which is in accordance with the present data. It has been reported that falls from the standing position or below lead in 76% of cases to a mandibular fracture and in 22% to a midfacial fracture¹¹. This difference might be due to the fact that the investigation made no age-related analysis of the fracture localization.

One main factor in the prognosis of injured elderly patients is co-morbidity. It has been demonstrated in older patients with hip fractures that up to 90% suffer from coexisting medical problems at the time of trauma¹² which often deter them from acute therapeutic treatment or even impede surgical treatment.

The effect of age and osteoporosis on trauma in the elderly is well documented in the literature regarding fractures of the

vertebrae, hips and extremities¹⁰. Few articles with a small number of patients demonstrate the influence of age on trauma in the maxillofacial area⁸. Comparable to findings in patients with hip fractures⁹, the gender distribution of maxillofacial injuries is changing with increasing age. In the younger population men are at a higher risk of sustaining injuries; in the elderly, women and men are almost equally endangered. The older the patients get the more women are involved in cranio-maxillofacial trauma. Data show that women over 70 are especially prone to falls from a standing or lower position¹¹.

In accordance with investigations of trauma in the elderly² the simple fall was the most frequent accident mechanism. In the present cohort, 72% of the injuries affecting patients older than 65 years were related to falls. The simple fall as a so-called slow velocity accident is of high significance in traumatology as approximately one quarter of all patients entering emergency rooms suffered from an injury due to a fall¹. Although elderly people mainly suffer from low-velocity accidents, the number of concomitant neurological and neurosurgical injuries as well as lesions of the extremities is significantly higher compared to younger patients. The data revealed that elderly patients with oral and maxillofacial injuries usually do not sustain lower limb injuries such as femur fractures, but they are prone to concomitant trauma such as fractures of the cervical spine, rib and upper limb bones. Interestingly, the risk of an accompanying neurological injury increased until the age of 65 years, but was without significant difference in the cohort of older people. Those concomitant injuries have a major impact on postoperative rehabilitation. A study on bicycle-related injuries showed a significantly higher risk of persistent disability with increasing age⁴. It was shown that 11% of children, 47% of adults and 67% of elderly patients suffered from permanent disabilities⁴.

The fact that in 12% of the elderly patients the accident mechanism was not known is of importance. This is in contrast to the younger group where 5% of the patients did not know the origin of their accident. Due to the unconsciousness of the patient the time period before emergency treatment or subsequent care is very often prolonged. The increasing trend of housing for elderly people being directly connected to emergency units is one way to abbreviate the time period between the actual accident and first medical aid. An unknown accident mechanism requires a precise preoperative examination of the internal and neurological status of the patient. Early surgical treatment has to be avoided, except in the case of life-threatening injury. The present data support surgery for elderly patients depending on their general medical health condition. Age itself did not turn out to be a risk factor for increased postoperative persistence or occurrence of symptoms or presence of complications.

In conclusion, with the increasing number of older patients the type of injury as well as the type of concomitant injuries are changing. Severe neurological symptoms are frequent and are of high medical and socio-economical impact. Surgical treatment in all patients, regardless of age, should be driven by the general condition of health whenever possible. Restoring function and aesthetics via surgical procedures in elderly patients with facial injuries should always accompany necessary treatment of life-threatening conditions. It is possible that the presence of co-morbidity will only allow emergency treatment of cranio-maxillofacial injuries initially, but following stabilization of such patients definitive state-of-the-art procedures of oral and cranio-maxillofacial surgery should always be considered, as they represent the best treatment option for elderly as well as other injured patients.

References

1. ALLANDER E, GULLBERG B, JOHNNELL O, KANIS JA, RANSTAM J, ELFFORS L. Circumstances around the fall in a multinational hip fracture risk study: a diverse pattern for prevention. *Accid Anal Prev* 1998; **30**: 607–616.
2. BERGERON E, CLEMENT J, LAVOIE A, RATTE S, BAMBITA JM, AUMONT F, CLAS D. A simple fall in the elderly: not so simple. *J Trauma* 2006; **60**: 268–273.
3. CHAN GK, DUQUE G. Age-related bone loss: old bone, new facts. *Gerontology* 2002; **48**: 62–71.
4. EKMAN R, WELANDER G, SVANSTRÖM L, SCHELP L, SANTESSON P. Bicycle-related

- injuries among the elderly—a new epidemic? *Public Health* 2001; **115**: 38–43.
5. FDA. Americans over 50 at risk for bone fractures. *FDA Consum* 2005; **39**:10–11.
 6. GASSNER R, TULI T, EMSHOFF R, WALDHART E. Mountainbiking—a dangerous sport: comparison with bicycling on oral and maxillofacial trauma. *Int J Oral Maxillofac Surg* 1999; **28**: 188–191.
 7. GASSNER R, TULI T, HÄCHL O, RUDISCH A, ULMER H. Cranio-maxillofacial trauma: a 10 year review of 9,543 cases with 21,067 injuries. *J Craniomaxillofac Surg* 2003; **31**: 51–61.
 8. GOLDSCHMIDT MJ, CASTIGLIONE CL, ASSAEL LA, LITT MD. Craniomaxillofacial trauma in the elderly. *J Oral Maxillofac Surg* 1988; **53**: 1145–1149.
 9. HIEBERT R, AHARONOFF GB, CAPLA EL, EGOL KA, ZUCKERMAN JD, KOVAL KJ. Temporal and geographic variation in hip fracture rates for people aged 65 or older, New York State, 1985–1996. *Am J Orthop* 2005; **34**: 252–255.
 10. HUI SL, SLEMENDA CW, JOHNSTON CC. Age and bone mass as predictors of fracture in a prospective study. *J Clin Invest* 1988; **81**: 1804–1809.
 11. IIDA S, REUTHER T, KOGO M, MATSUYA T, MÜHLING J. Retrospective analysis of facial fractures related to falls in 260 Japanese patients. *Mund Kiefer Gesichtschir* 2002; **6**: 421–426.
 12. KHAN R, FERNANDEZ C, KASHIFL F, SHEDDEN R, DIGGORY P. Combined orthogeriatric care in the management of hip fractures: a prospective study. *Ann R Coll Surg Engl* 2002; **84**: 122–124.
 13. KLOSS FR, GASSNER R. Bone and aging: effects on the maxillofacial skeleton. *Exp Gerontol* 2006; **41**: 123–129.
 14. LONNER JH, KOVAL KJ. Polytrauma in the elderly. *Clin Orthop* 1995; **318**: 136–143.
 15. MANDAVIA D, NEWTON K. Geriatric trauma. *Emerg Med Clin North Am* 1998; **6**: 367–373.
 16. MOSENTHAL AC, LIVINGSTON DH, ELCAVAGE J, MERRITT S, STUCKER S. Falls: Epidemiology and strategies for prevention. *J Trauma* 1995; **38**: 753–756.
 17. TINETTI ME, WILLIAMS CS. Falls, injuries due to falls, and risk of admission to a nursing home. *N Engl J Med* 1997; **337**: 1279–1284.
 18. TULI T, HÄCHL O, HOHLRIEDER M, GRUBWIESER G, GASSNER R. Dentofacial trauma in sport accidents. *Gen Dent* 2002; **50**: 274–279.
 19. TULI T, HÄCHL O, RASSE M, KLOSS FR, GASSNER R. Dentoalveolar trauma. Analysis of 4763 patients with 6237 injuries in 10 years. *Mund Kiefer Gesichtschir* 2005; **9**: 324–329.
 20. US Bureau of the Census: Current Population Reports, Series P-25, No. 952, Projections of the population of the United States, by age, sex and race: 1983 to 2080. US Government Printing Office, Washington, DC, 1984.
 21. WANG X, SHEN X, LI X, AGARWAL CM. Age related changes in the collagen network and toughness of bone. *Bone* 2002; **31**: 1–7.
 22. ZIOUPOS P, CURREY JD, HAMER AJ. The role of collagen in the declining mechanical properties of aging human cortical bone. *J Biomed Mater Res* 1999; **45**: 108–116.

Address:

Frank Rudolf Kloss
 Department of Cranio-Maxillofacial and
 Oral Surgery
 University Hospital of Innsbruck
 Maximilianstr. 10
 6020 Innsbruck
 Austria
 Tel: +43 512 504 24373
 E-mail: frank.kloss@uibk.ac.at