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# Prevalence of cervical spine injuries in patients with facial trauma

Wolfgang Hackl, MD,[a] Karin Hausberger, MD,[a] Romed Sailer, MD,[a] Hanno Ulmer, PhD,[b] and Robert Gassner, MD, DMD, PhD,[c,d] Innsbruck, Austria, and Pittsburgh, Pa
UNIVERSITY OF INNSBRUCK AND UNIVERSITY OF PITTSBURGH

***Objective.*** Injuries to the spine may accompany facial trauma. By using a large computerized database the goal of this case control study was to assess the association between facial and cervical spine injuries among patients sustaining facial trauma.
***Study design.*** During a period of 4 years (1995 to 1998) 3083 patients, 10 years or older, with facial injuries were admitted to the University Hospital of Innsbruck's Department of Oral and Maxillofacial Surgery for facial trauma. Records were analyzed for cause of injury, age and gender distribution, frequency and type of injury, and frequency of cervical spine injuries in relation to facial trauma and concomitant injuries. Two hundred six (6.7%) of these patients had experienced a concomitant cervical spine injury (case group). All other patients (2877) were assigned to the control group of facial trauma only.
***Results.*** Facial trauma patients with concomitant cervical spine injuries were significantly older (mean age, 42 vs 34 years); no difference existed for the female/male ratio of 30:70. Sports trauma was the main cause of facial trauma in the control group (37.4%), yet traffic accidents accounted for 43.7% of combined facial and cervical spine injuries in the case group. Central mid face fractures dominated in the case group and lateral mid face fractures in the control group. In the case group cervical spine fractures and dislocations occurred in 19.2%. None of them showed evidence of paralysis. Concomitant brain injuries occurred in 21.6% of the case group and 8.8% of the control group. For patients sustaining facial trauma, logistic regression analysis revealed reduced risks for additional cervical spine injuries in younger patients, female patients, absence of brain injury, and in patients with facial soft tissue lesions alone (58.2%) or dental trauma alone (77.5%).
***Conclusion.*** The results of this study underline the importance of proper clinical and computed tomographic evaluation in cases of facial fractures for recognition of additional cervical spine trauma. Detection of cervical spine trauma can be missed, especially when pain or symptoms from other parts of the body dominate. The typical patient with concomitant neck and facial trauma is male, 40 years old, and usually involved in a traffic accident.
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Concomitant injuries in patients with facial trauma are not uncommon and involve the head and the neighboring neck region.[1-3] The association between facial and cervical spine injuries has been frequently reported.[4-6] Two essential criteria are required for final assessment, an evaluation of the patient by a trauma surgeon and maxillofacial surgeon and an exact description of the individual injuries. These criteria are important in spine trauma because injuries such as whiplash are often neglected in the overall assessment. Without these criteria, the incidence of associated neck traumas in facial injuries varies between 1% and 6%.[3,6-8]

Because of the differences in the mechanisms of injury for both regions, most often high velocity trauma to the head or face is suspect for a combined occurrence.[6,9-11] Therefore, the cervical spine has to absorb the appearing energy in relation to the trunk. Corresponding to that, traffic accidents are responsible for the vast majority of causes.[1,3,6,12] Injuries even of minor impact in either region can lead to long-term disabilities eventually connected with a social and psychological burden such as loss of frontal teeth and dreadful scars.

This case control study reviews a large number of patients with facial injuries including facial bone fractures, dentoalveolar trauma, and soft tissue injuries and investigates their relationship with mild and severe

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[a]Department of Trauma Surgery, University of Innsbruck, Austria.
[b]Institute of Biostatistics, University of Innsbruck, Austria.
[c]Department of Oral and Maxillofacial Surgery, University of Innsbruck, Austria.
[d]Department of Oral and Maxillofacial Surgery, University of Pittsburgh, Pa.
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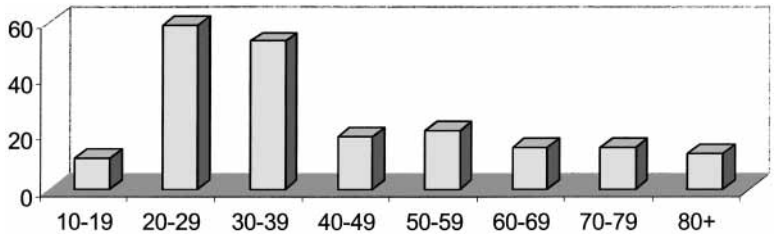


Fig 1. Age distribution of the study group.

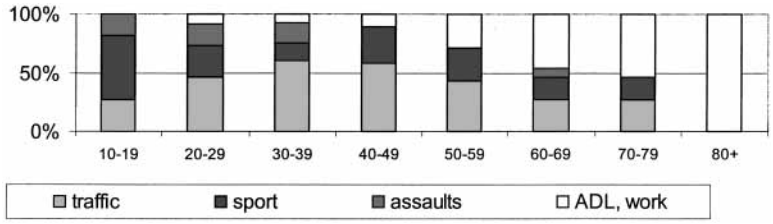


Fig 2. Cause of injury according to age.

forms of cervical spine trauma. In addition, patients with combined facial and cervical spine injuries are compared with a patient collective with isolated facial trauma to assess the statistical patterns of combined facial trauma and cervical spine injury.

## PATIENTS AND METHODS

Between January 1, 1995, and December 31, 1998, 206 patients with a combination of cervical spine and facial trauma were registered at the Departments of Trauma Surgery and Oral and Maxillofacial Surgery in the University Hospital of Innsbruck. Trauma surgeons evaluated patients reporting symptoms or displaying signs of cervical spine trauma including all unconscious patients clinically at entry for cervical spine injury and also assessed radiographs and computed tomographic (CT) images of head and neck together with radiologists. Oral and maxillofacial surgeons performed clinical and radiologic assessment and treatment of patients' facial trauma.

The records of these 206 patients were studied according to their frequency of this type of combined injury as well as to their age and gender distribution, cause of accidents, and concomitant injuries. This group of patients (study group) was compared to patients, 10 years and older, registered at the Department of Oral and Maxillofacial Surgery with facial trauma lacking cervical spine injuries (2877 patients, control group) with respect to age, gender, type of laceration, and cause of injury. Of the 3971 trauma patients, all 888 children younger than 10 years of age with dental trauma alone were excluded from the analysis for homogeneous groups in the statistical assessment.

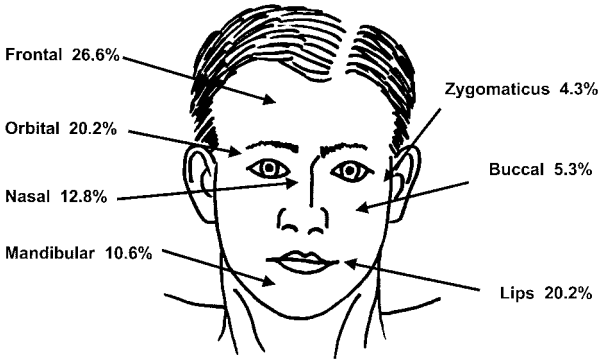


Fig 3. Location of wound lacerations.

Patient characteristics were analyzed with descriptive statistics. Comparisons between study and control groups were performed with chi-square tests, Fisher exact test, and Mann-Whitney *U* test as appropriate. This was followed by a logistic regression analysis determining independent factors for the occurrence of cervical spine injuries. The final regression model included age, gender, and type of facial trauma and concomitant brain injury. Odds ratios and their 95% confidence intervals were calculated to represent the relative risk of the variables.

## RESULTS

### Age

Ages represented in the study group varied from 11 to 103 years; the mean age was 42.0 ± 19.9 years (Fig 1). In the control group, age distribution peaked in the second and third decades. The mean age was younger

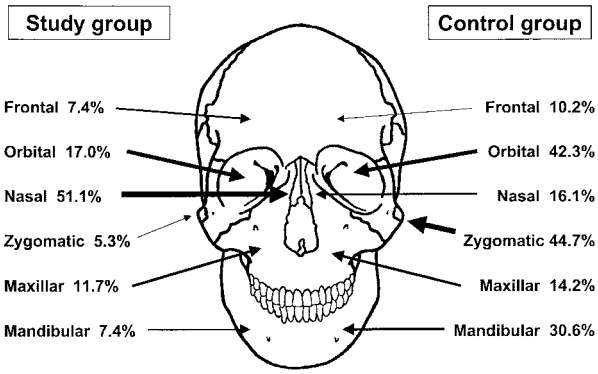


Fig 4. Facial fracture site comparing both groups.

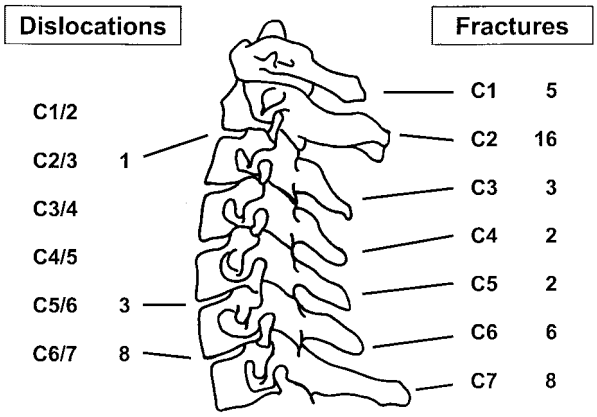


Fig 5. Site of dislocations and fractures of the cervical spine.

(33.9 ± 18.4 years) than in the study group; the difference was statistically significant ($P < .001$).

## Gender

In the study group, the male patients were dominant (70.9% vs 29.1% female) with a mean age of 41.4 ± 19.3 years, whereas the mean age in women was higher at 43.3 ± 21.7 years. In the control group, gender distribution showed 30.6% female to 69.4% male. This was not significantly different as compared to the study group ($P = .696$).

## Cause of injury

In the study group, traffic accidents were the major cause of injury in 43.7%, followed by sport injuries (23.3%), activities of daily life (ADL)/work (21.8%), and assaults (11.2%). In correlation to age, sport injuries decrease as the age increases whereas the rate of simple falls (ADL) increases with higher age. Yet, the occurrence of sport injuries peaked in the fourth and fifth decades (Fig 2). The main cause for sport accidents was skiing (62.7%); car accidents dominated in 73.3% of traffic accidents, followed by bicycle crashes in 15.6%.

In the control group, traffic accidents were responsible for only 19.9% of all cases, whereas sport injuries accounted for 37.4% followed by ADL/work in 27.4%.

Statistically significant differences existed between both groups for traffic accidents and sports trauma ($P < .001$ for each type of cause).

**Table I.** Study group: 206 patients with 238 facial injuries

| *Type* | *No. of patients* | *Percent* | *Severity* |
|---|---|---|---|
| Soft tissue | 141 | 68.3 | Mild |
| Bone fracture | 79 | 38.5 | Severe |
| Dental injury | 16 | 7.7 | Severe |

**Table II.** Study group: 206 patients with cervical spine trauma

| *Type* | *No. of patients* | *Percent* | *Severity* |
|---|---|---|---|
| Sprain | 166 | 80.8 | Mild |
| Bone fracture | 31 | 14.9 | Severe |
| Dislocation | 9 | 4.8 | Severe |

**Table III.** Study group: combinations of facial and spinal injuries

| *Type* | *No. of patients* | *Percent* |
|---|---|---|
| Spine mild/facial mild | 98 | 48.1 |
| Spine severe/facial mild | 17 | 8.2 |
| Spine mild/facial severe | 68 | 32.7 |
| Spine severe/facial severe | 23 | 11 |
| Total | 206 | 100 |

## Facial injuries

The study group consisted of 206 patients with 238 incidents. Soft tissue injuries accounted for 68.3% of all injuries, including lacerations, concussions, hematoma, and excoriations (Fig 3); 38.3% sustained fractures; and 7.8% displayed dentoalveolar trauma. Bone fractures and severe trauma to 2 teeth and more were considered severe injuries (Table I). Seventy-six patients had 94 facial bone fractures; nasal bone fractures (Fig 4) affecting the central mid face dominated. Fifteen patients had multiple facial fractures. Sixteen patients had 23 dentoalveolar traumas, mainly upper frontal incisors (73.9%).

In the control group, 73.8% had soft tissue lesions; 33.0% of all patients had bony fractures followed by dentoalveolar traumas in 32.2%. This injury pattern was not statistically different from the study group.

Fractures to the zygomatic bone were most frequent in 44.7% of patients followed by fractures to the orbital

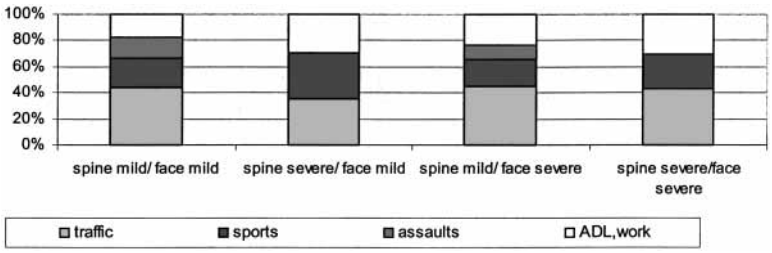


Fig 6. Injury pattern according to the trauma mechanism.

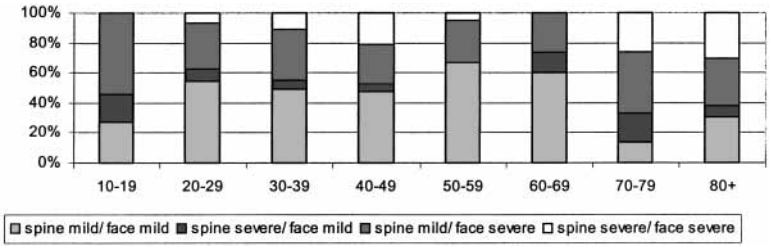


Fig 7. Injury pattern according to age.

**Table IV.** Associated cervical spine injury

| | *Cervical spine injury* | | *Significance, crude* | *Odds ratio adjusted* | *Odds ratio 95% CI* | *Significance, adjusted* |
|---|---|---|---|---|---|---|
| | *Case group* | *Control group* | | | | |
| Age | 42.0 ± 19.9 y | 33.9 ± 18.4 y | $P < .001$ | 1.017 | 1.010-1.024 | $P < .001$ |
| Traffic accident | 90/206 (43.7%) | 573/2877 (19.9%) | $P < .001$ | 2.978 | 2.202-4.028 | $P < .001$ |
| Dentoalveolar | 16/206 (7.8%) | 927/2877 (32.2%) | $P < .001$ | 0.225 | 0.133-0.380 | $P < .001$ |
| Brain injury | 45/206 (21.8%) | 253/2877 (8.8%) | $P < .001$ | 1.932 | 1.334-2.799 | $P < .001$ |

wall, both affecting the lateral mid face (Fig 4). These fracture patterns were statistically different to those fractures in the study group ($P < .001$).

## Cervical spine injuries

The vast majority of all patients in the study group (80.8%) had a minor type of injury (neck sprain, whiplash injury). Thirty-one patients had 42 fractures peaking at vertebra C2 in 16 cases. Nine patients had 11 dislocations (Fig 5). These types of injuries were termed as severe (Table II). None of them showed evidence of paralysis.

## Combination of facial and cervical spine injuries

One hundred eight patients had sustained at least 1 severe trauma to the face or neck (Table III). Twenty-three of them had fractures/dislocations in both regions. For all possible combinations of trauma (severe and mild), traffic accidents were the main cause (Fig 6). The combination of mild facial and spine injuries was dominant in the ages of 20 to 69 years; the combination of severe facial and spine injuries was noted beginning from ages 20 through 80+ years except for the age group of 50 to 59 years (Fig 7).

## Polytrauma and additional injuries

In the study group, 91 patients (44.2%) had additional injuries located outside the head or neck; 11 of them were considered polytraumas (5.3%). Forty-five patients (21.8%) had additional brain injuries; the incidence here increased as the severity increased (52.1% for concomitant brain injuries in patients with combined severe facial and spine trauma).

In the control group 627 patients had injuries at the trunk or extremities (21.8%); polytraumas were seen in 68 people (2.4%). Only 8.8% had additional brain lesions. This was also statistically different for both regions ($P < .001$).

## Regression analysis

The risk to sustain additional cervical spine injury in facial trauma increases with every year by 1.7%. The risk to sustain a combined cervical spine and facial trauma in traffic accidents is 3-fold compared with

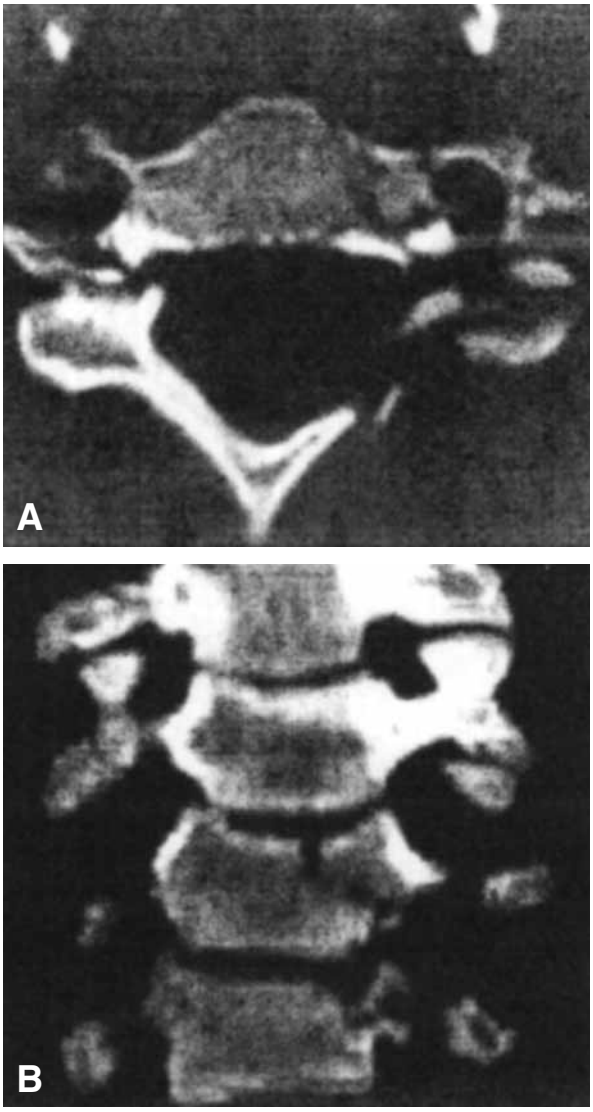



Fig 8. CT scan images of a 26-year-old man sustaining a complex C6-fracture during mountain-biking. He also had a zygomatic fracture on the right side and a fracture of the nose. Transversal sectioning of the neck (**A**) and then secondary reconstruction of the frontal (**B**) and lateral planes (**C**) are shown.

nontraffic accidents. If there is an additional brain lesion in combination with a facial trauma, there is a 2-fold risk to experience a concomitant cervical spine injury. An apparent facial soft tissue lesion alone implicates a risk reduction of 58.2% to sustain cervical spine trauma as well when compared with patients with facial bone fractures. Dental trauma alone revealed a risk reduction of 77.5% for sustaining additional cervical spine trauma (Table IV).

## DISCUSSION

Concomitant cervical spine injuries in facial trauma patients is reported in less than 10% of all facial trauma cases.[3,7-9,13] The main reason for this is that minor lesions to the cervical spine are often neglected as a concomitant injury to other body regions. But the importance of this type of injury should not be underestimated from the economic point of view.[14] Minor injuries to the face and neck are very common; therefore, sustaining a combined occurrence of injuries is also frequent. In contrast, our study revealed that a combination of severe injuries to both regions is rare.

There is no common agreement about an injury pattern concerning facial fractures.[4,15-19] Independent from the cause of injury, all kinds of regions are discussed to be the most common fracture site. The reason for this may be manifold. One possibility is that nasal bone fractures are more commonly seen by the ear, nose, and throat doctor. The control group of this study represented the fracture pattern from a department of oral and maxillofacial surgery. Fractures of the zygomatic bone were dominant, followed by fractures of the orbital wall. In contrast, fractures to the nasal bone were clearly dominant in the group of combined facial and cervical spine trauma, followed by fractures of the orbital wall and the maxilla. Sixteen percent of patients with fractures had multiple fractures. This injury pattern between both groups was statistically different.

In the assessment of the overall type of facial injuries, there is agreement that soft tissue lacerations account for the vast majority.[4,7,17-23] This is independent from the patient's age or the cause of injury mech-

anism. This type is then followed by fractures or dentoalveolar trauma, according to the anatomic regions. In both groups of this series we had similar results except that the percentage of dentoalveolar trauma was higher in the control group.

Age in our series was an important factor because the mean age of the study group was significantly older than in the control group. Yet, age did not seem to have a real effect on the injury pattern in patients younger than 40 years, whereas in elderly patients dentoalveolar trauma decreased.

The gender distribution preferred the male sex with a ratio of more than 2.5:1 for both groups. This contrasted to our previous findings in a case control study on facial and cervical spine injuries based on cervical spine injuries as the control group.[24] There was a significant difference ($P < .05$) in gender distribution between the 2 groups. Male patients predominated in the study group (75.2% male vs 24.8% female), whereas an almost equal distribution between male and female patients was found in the control group (50.9% vs 49.1%).

The cause of injury can differ in accordance to age and gender. Assault against women and children plays an important role in facial trauma, and the number of unregistered cases is probably high.[17,20,25] In patients sustaining a combination of neck and facial trauma, assaults do not play an important role. Sports as the cause of injury peaked in the second and third life decades of patients in our study group. In patients between 20 and 59 years of age, traffic accident was the main injury mechanism. This can be explained because their participation in traffic accidents is increased compared with other age groups. This changes in patients older than 60 years in whom injury in ADL, such as simple falls, predominated.

Additional brain injuries are very common in facial trauma and can increase to 38%.[9] But it is remarkable that this percentage increases dramatically with an additional cervical spine trauma. If there was a fracture present in the face and neck, this percentage of additional brain injuries increased to more than 50% in our study. On the other hand, regression analysis showed that there is a 2.87-fold risk to sustain an additional cervical spine trauma in patients with combined brain and facial injures.

The typical patient with concomitant neck and facial trauma is male, 40 years of age, and usually involved in a traffic accident. It is important to note that facial bone fractures present with swelling and hematoma, whereas spinal trauma does not always display obvious symptoms. Cervical spine trauma can be missed, especially when pain from other parts of the body dominates. Neurologic evaluation of the spinal cord is important because lesions of the lower cervical spine are frequent. Therefore, we evaluate all patients with facial bone fractures by using CT for cervical spine trauma too. Besides exact diagnosis and severity of fractures, therapy regimens can be started. Additional developing brain lesions will be discovered too. In the same setting the cervical spine is also evaluated. The value of CT scans in cases of facial fractures for recognition of additional spine trauma is already described.[26]

Scanning of head and neck lasts less than 10 minutes. We use a high speed multislice CT scanner (QX/i; GE, Milwaukee, Wis). Images of the head are sliced first into 2 to 5 mm and immediately transformed for bone algorithm. Then the spine is evaluated down to the third thoracic vertebra by using 1-mm slices in 2 planes (coronal and sagittal). The total examination within this procedure lasts 7 minutes including reconstructed images of head and neck (Fig 8). The results of this study emphasize the importance of proper clinical and radiologic evaluation of patients with facial fractures to recognize additional cervical spine trauma even when pain or symptoms from other parts of the body dominate.

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*Reprint requests:*
Robert J. Gassner, MD, DMD, PhD
Associate Professor
Department of Oral and Maxillofacial Surgery
University of Innsbruck
Maximilianstraße 10
A-6020 Innsbruck, Austria
Maxillofaziale-Chirurgie@uibk.ac.at