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Co-occurrence of craniofacial injuries with cervical spine injuries

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ABSTRACT

In their daily practice, both doctors and dentists can come into contact with patients who have suffered craniofacial trauma as a consequence of traffic accidents, assaults or falls. This creates a risk of life threatening complications, such as impaired airway patency or hemorrhagic shock. The aim of the study was to discuss the connections and dependency between the type and location of facial trauma and possible traumatic changes that occur in the cervical spine. The knowledge of these information allows dotors to conduct precise examination of the patient and take appropriate action, such as implementing proper therapeutic procedures, reducing the risk of misdiagnosis or misdiagnosis omissions. The pediatric population should also be taken into consideration since such injuries are less common in them than in adults, however, neurological recovery potential seems to be better. The following literature review provides an extensive discussion of the association between craniofacial injuries and cervical spine injuries. In August 2023, an extensive research of major electronic databases was carried out (PubMed, Google Scholar) in order to identify relevant studies published on this subject. It is necessary to pay special attention to the possible occurrence of concomitant damage to the cervical spine, especially in patients with fractures of the mandible, nose or zygomatic-maxillary-orbital area. It is also important to implement appropriate procedures that will minimize the risk of failure in treatment, or negative health consequences for the patient.

***Keywords*:** fracture, spine, head, mandible, vertebrae, skull

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1. INTRODUCTION

In everyday practice, both doctors and dentists may encounter patients who have suffered craniofacial trauma. These injuries are associated with a high risk of concomitant injury to the cervical spine or spinal cord [1-3].

Traffic accidents, assaults and falls are considered to be the cause of their most common etiology [4-6]. It is estimated that concomitant maxillofacial and cervical spine injuries occur in 0,8–12 % of cases [7]. The vast majority of them are men who were diagnosed at the age from 50 to 65 years and women aged over 80 years [7].

Sharp and blunt trauma to the head may lead to unsuspected comorbidity of the cervical spine [8-10]. Severe maxillofacial and neck trauma exposes patients to life-threatening complications such as airway compromise and hemorrhagic shock. Possible symptoms of cervical spine injury include local headache, occipital tenderness on palpation, Horner syndrome, cranial nerve impairments, and brain(stem) infarction [11]. The patients with an initial GCS score of 8 or less are mostly at risk of coexisting damage to the cervical spine and, consequently, an increased risk of death [12].

Therefore, an insightful examination of the patient and correct diagnosis determining the extent of the injury are very important. This will help to avoid serious complications. It is particularly important to take a classic X-ray or computed tomography for diagnosis in case of cervical spine injuries. Typical X-ray of cervical spine after the injury is shown in the **Figure 1** and **Figure 2**.

In cases when there is no clear reason indicating damage to the cervical spine, patients should still be examined for this injury. These examinations are responsible for increasing the chance of obtaining positive treatment results and minimizing the risk of error in ailing treatment.

2. PURPOSE

The aim of this study is to discuss the connection between craniofacial injuries and cervical spine injuries occurrence, as well as the dependence between each type of facial injury and the consequence of damage to the cervical spine.

As a result of finding this correlation, it is possible to reduce the misdiagnosis probability, avoid undiagnosed co-occurring injuries and severe complications, and also take appropriate action, such as implementation of proper therapeutic procedures. The latest reports on this subject are presented in this article.

3. MATERIALS AND METHODS

The study was conducted on the basis of reviewing and analyis of the latest available literature, especially articles on facial and cervical spine injuries found in the PubMed or Google Scholar databases.

Multiple search terms were used, including: "maxillofacial injuries", "fractures, bone", "skull", "cervical vertebrae". All selected articles were the most relevant articles available for this review.

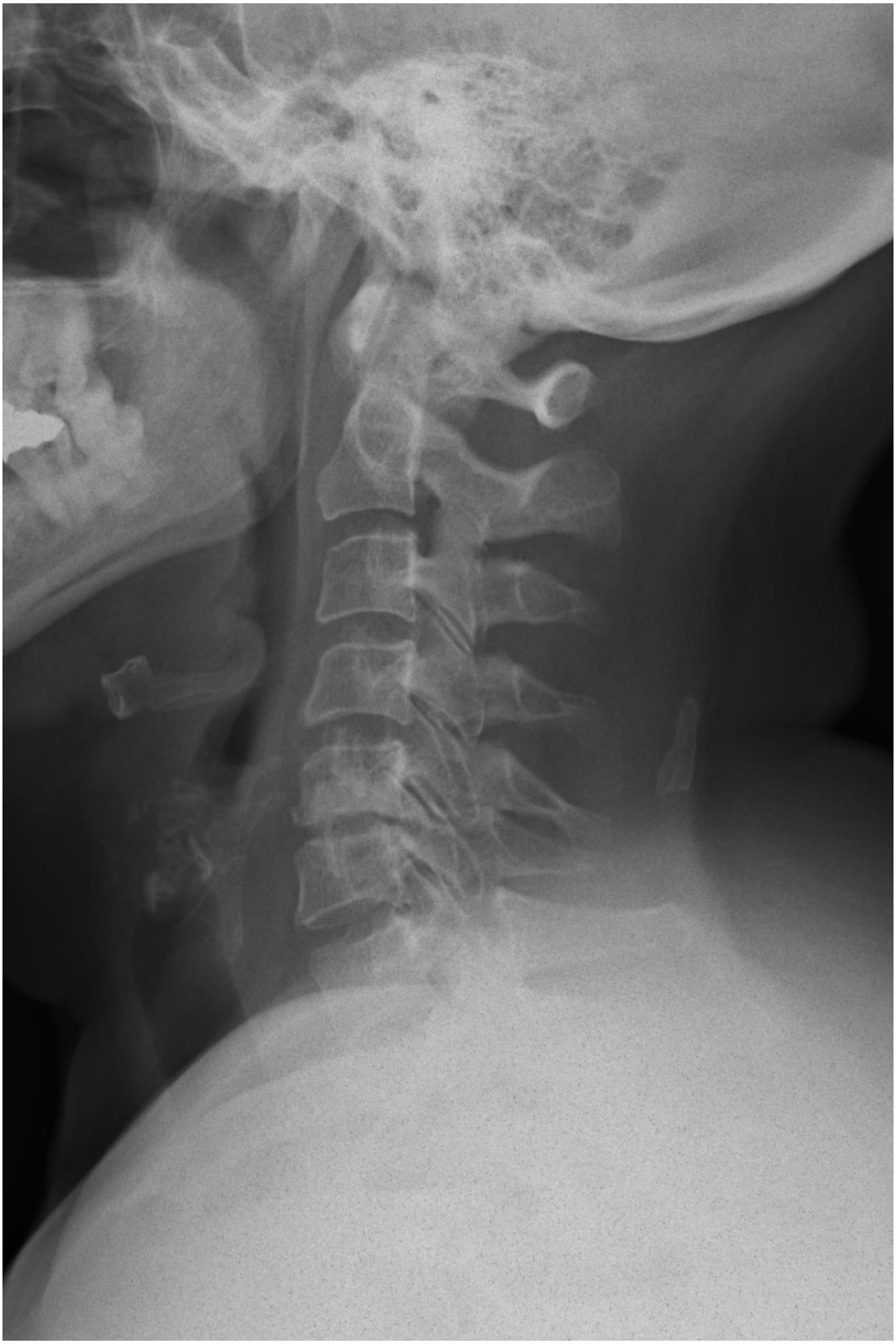

Figure 1. Typical X-ray of cervical spine (lateral view)

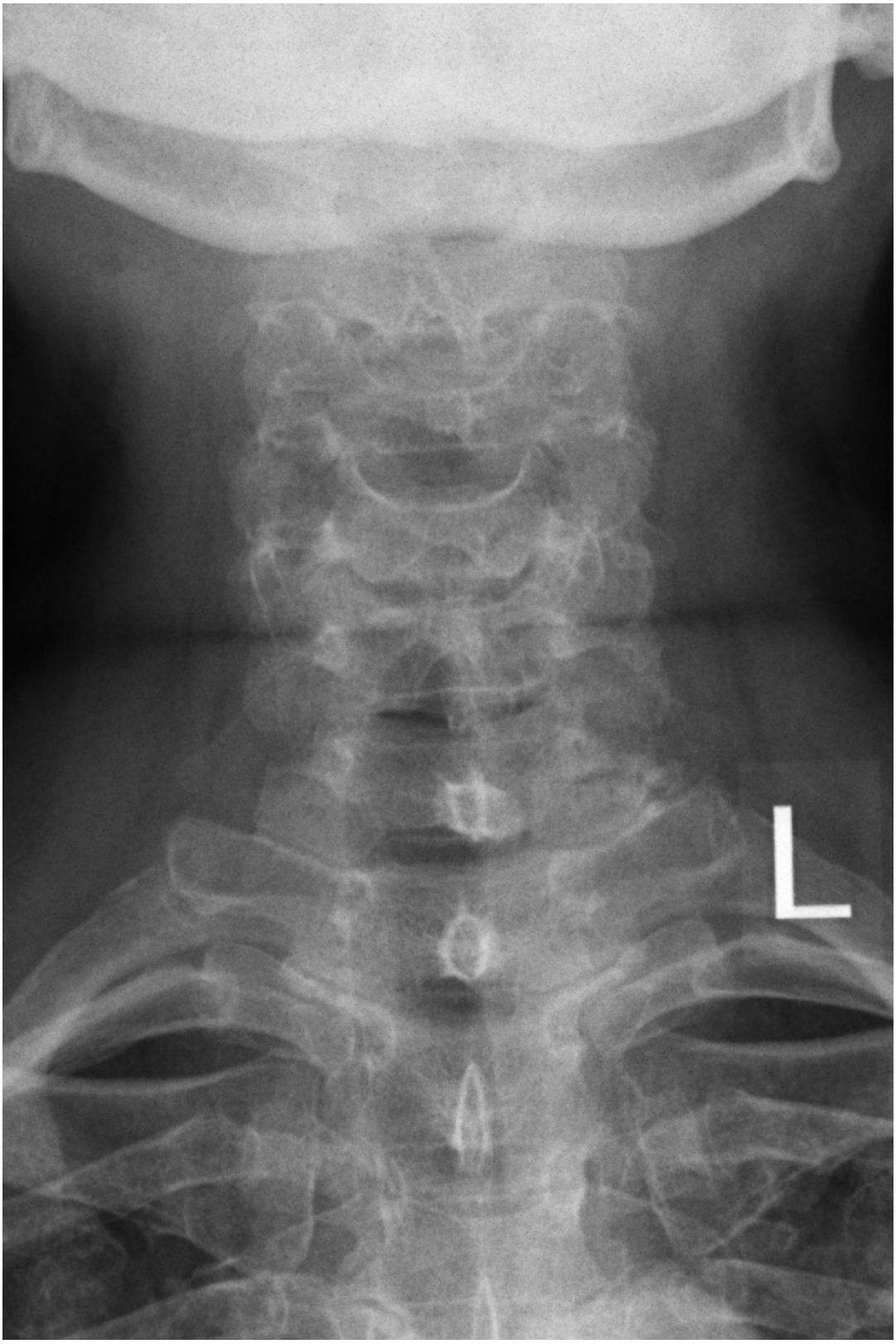

Figure 2. Typical X-ray of cervical spine (AP view)

4. RESULTS AND DISCUSSION

As the most common areas of the facial skeleton whose trauma correlates with cervical spine damage Bicsák et al. recognized areas near the midline of the body, such as: forehead, nose, Le Fort levels I and II and lateral areas of the face: zygomatic bone, inferior wall of the orbit, condyles of the mandible.

Conclusions were drawn on the basis of retrospective study of patients treated at the Dortmund General Hospital from January 1, 2007 to December 31, 2017 due to injuries of the maxillofacial area and the cervical spine. The study group involved 7,708 patients with craniofacial injuries, including 173 with a diagnosed cervical spine segment injury. [7].

In the research conducted by Halsey et al., attention is paid to the special correlation between a mandibular fracture and a cervical vertebra injury - C2 and a certain correlation between fractures included in the Le Fort classification including palate injuries and damage to the C1 vertebra. The C1 vertebra was damaged in 4 patients, C2 in 2 patients, vertebrae C3 to C7 in 4 patients. 285 patients met the inclusion criteria for the study [13]. Typical mandibular fracture is shown in the **Figure 3**.

Also in another study it was found that the most common cervical spine injury location was at the C2, followed by the C5 cervical spines. The most common location of a maxillofacial fracture resulting in a cervical spine injuries was the mandible. Conclusions were drawn based on a study of 1 407 750 patients, of which 115 997 patient had maxillofacial fractures with an associated cervical spine injuries [14].

Mulligan and Mahabir found that in the case of an isolated mandible bone fracture, inferior wall of the orbit, nose, zygomatic/maxillary bone or parietal/frontal bone cervical spine injury rates ranged from 4,9 to 8,0 percent. However, in the case of two or more facial bone fractures co-occurrence, cervical spine injury occurred at an incidence of 7,0 to 10,8 percent. This study constitutes the most accurate description of the incidence of cervical spine injuries and/or head injuries associated with cranio-maxillofacial fractures in trauma centers in the United States. The data used for the analysis were obtained from the National Trauma Data Bank from 2002–2006. They included over 1.3 million trauma patients from the United States and Puerto Rico [15].

The reviewed works also note that fractures of the upper parts of the facial skeleton may result in injuries to the middle and lower sections of cervical spine, serious intracranial injuries and increased mortality. In the middle part of face injuries, force is transferred to the base of skull. On the other hand, unilateral jaw injuries are associated with increased damage probability to the upper third of the cervical spine. These results were obtained from a retrospective review of 4786 patients. Of all patients with facial fractures, 461 (9.7%) had also cervical spine injuries, and 2,175 (45.5%) had associated head injuries [16].

Also in their work, the Harounian et al. determined the correlation between jaw and cervical spine injuries. To create the database they used the International Classification of Diseases (ICD-10), on the basis of which 5568 patients were included in the study. Researchers have shown that pediatric patients with subcondylar fractures of the mandible were almost twice as likely to suffer fracture of the cervical spine, probably because in the pediatric population the mandible is more proximal to cervical spine than in the adult population. Another reason is the limited space for its shifting in the case of dislocation. It was also found that in the case of bilateral subcondylar fractures of the mandible, fractures of the cervical spine occur more often than in unilateral cases [17].

Figure 3. Fracture of the mandibule

It was also emphasized that among pediatric patients, infants precisely, facial fractures are observed the least frequently and their incidence increases with age, which is caused by the lack of teeth in the maxilla and mandible, and greater facial bone structures flexibility and underpneumatized paranasal sinuses in younger children [17]. Typical view of the mandible after the surgery is shown in the **Figure 4**.

Figure 4. Mandible after surgical procedure

Puolakkainen et al. in their study for the Journal of Cranio-Maxillo-Facial Surgery noted, however, that cervical spine injuries caused by isolated mandibular fractures in the cohort he studied occurred in only 6 of 868 patients [18].

In the cases of correlated craniofacial and brain injuries, the exposure to spine trauma is 4 times more frequent than in isolated facial skeleton injuries [18]. A nasal bone fracture had the highest risk of cervical spine injury (zygomatic-maxillary-orbital fractures were also statistically significant) [18]. In turn, Färkkilä's retrospective cohort study, in addition to a nasal bone fracture, lists an orbital fracture, chest injuries, age, injury severity score, and traffic accidents or fall as the etiology [19].

Falls from height or stairs, injuries caused by car accidents and injuries caused by bicycle accidents are the mechanisms in which these symptoms coexisted most often. Based on the data presented by Puolakkainen et al., it can be stated that there is no clear correlation between the location of cervical spine injuries and a type of facial fracture. Injury to the upper cervical spine appeared more often with isolated nasal bone fracture, and low-grade trauma energy most often manifested itself through damage to the middle part of the cervical spine [18].

The reviewed papers showed a more frequent statistical occurrence of craniofacial injuries and accompanying cervical spine injuries in men than in women [7,18] .

In the research conducted by Hackl et al. it was found that the 20- to 30-year old male age group is a population at risk for the combination of craniofacial and cervical spine injuries.

Conclusions are drawn based on 4907 patients with cervical spine injuries which were treated at their hospital [20].

Elahi et. al. in their study noticed that the patients with cervical spinal injuries and craniomaxillofacial fractures also had other associated injuries. The most common associated injuries involved facial soft-tissue injuries (83 percent), upper and lower extremity injuries (72 percent), and chest wall and/or chest cavity injuries (63 percent). Conclusions were drawn on the basis of retrospective study of patients treated at the St. Michael's Regional Trauma Center, Toronto, Ontario, Canada from January 1, 1994 to December 31, 2003. A total of 3356 patients were identified in the 10-year study period as having craniomaxillofacial fractures [21].

In studies involving pediatric patients, this difference was also worth taking into consideration. According to Xun et al., the ratio of injuries in boys to injuries in girls is 6 to 1. Cervical spine injuries in pediatric patients with craniomaxillofacial trauma fracture are rare (frequency, 0.169%); this is considerably lower than the reported ranges in adults (3.69 to 24%) [22].

In the pediatric population is important to know that traumatic spinal cord injury have different mechanisms of injury and neurological recovery potential seems to be better when compared to adults [23].

In the article of spinal cord injury in youth, the level of injury differed based on the age category with C2 lesions occurring in the pre-teen groups, C4 lesions occurring in the teen group, and C4–C5 lesions occurring in the adult group. To identify special characteristics of the pediatric spinal cord-injured population, the database of 1,770 traumatic patients was analyzed [24].

Goodenough et al. database demonstrated a 5.7% incidence of pediatric cervical spine injuries in patients with maxillofacial trauma. All patients 18 or younger who presented to the emergency department between 2006 and 2015 were included. There were 1274 patients who were admitted with maxillofacial trauma during the study period.

In the article it was stated that cervical spine injuries were associated with concomitant traumatic brain injuries and skull fractures. Factors associated with cervical spine injuries include older age and penetrating mechanism [25]

An article from Prehospital and Disaster Medicine highlighted the correlation of gunshot injuries to the head with injuries to the cervical spine.

It has been shown that facial and brain skulls gunshot injuries do not show much co-occurrence correlation with cervical spine injuries - less than 4% of the study cohort had a cervical spine injury [26].

The incidence of cervical spine fracture was 5 times higher in matters not related to self-inflicted shooting [26].

In the review of cervical spine injury associated with facial trauma, it was stated that as many as 67% of patients with facial injuries develop an intervertebral disc hernia and spinal cord injury. It was also shown that the largest incidence of injuries to the cervical spine and facial skeleton is observed in patients involved in road accidents, which reflects dependency between the severity of the impact and the probability of cervical spine injury. [27].

Also, according to Jamal et al. the most common cause of craniofacial and cervical spine injuries were traffic accidents (45.5%), followed by falls (36.4%) [6]. Among the pediatric population, motor vehicle trauma (32.6%) are also the leading cause of these injuries, but the second place is interpersonal violence (18.8%), and then falls (13.5%). Conclusions were drawn based on retrospective cohort study. A total of 32,952 patients were included in this study [28].

In tertiary referral trauma centre in Frenchay Hospital in Bristol a retrospective analysis was conducted. Of the 714 maxillofacial fracture patients, 2.2% had associated cervical spine injury including a fracture, cord contusion or disc herniation. In comparison, 1.0% of patients without maxillofacial trauma sustained a cervical spine injury [5].

Holly et al. said that approximately one in 20 patients with moderate and severe head injury will sustain a cervical spine injury. Patients involved in vehicular-related accidents and those with an initial GCS score of 8 or less are at highest risk for concomitant cervical spine injury. The most of injuries are mechanically unstable and involve an spinal cord injuries [12].

According to Deepak Bhiman, in cases when there is no clear reason indicating damage to the cervical spine, patients should still be examined for this injury because an unstable cervical spine injury may cause deterioration of neurological condition.

For diagnosis in case of cervical spine injuries, it is particularly important to take a classic X-ray or computed tomography. It states that the CT scan detects 99.3% of cervical spine injuries in patients with blunt trauma, therefore CT is first-line method in a patient after trauma.

However, MRI is indicated for assessment of neurological deficits and ligament damage. MRI has advantages over CT in demonstrating spinal cord pathology, intervertebral disc hernia and ligament ruptures. If the initial CT scan is negative and the patient has no neurological abnormalities, MRI is not necessary.

In his work from the Journal of Head Neck and Spine Surgery, Deepak Bhiman also describes detailed recommendations for taking an X-ray, e.g. in the case of a probable injury to the C1 vertebrae, C2, and indicates that the best visibility of a possible injury can be obtained by taking a photo with the opened oral cavity [29].

5. CONCLUSIONS

In emergency medicine, due to the high probability of injuries occurring simultaneously, attention should be paid to the possible occurrence of cervical spine injury when patients with nose, mandible, zygomatic-maxillary-orbital area fractures are admitted. Upper parts of the facial skeleton fractures are more likely to be connected with lower sections of the cervical spine damage, while jaw fractures predispose to injuries of the upper cervical spine. Patients in critical age groups with a high-energy injury are more likely to sufer both, maxillofacial injuries and cervical spine injuries.

Consequences of facial bones fractures may also include spinal cord injuries or intervertebral disc hernia. All maxillofacial injuries are directly life threatening due to the proximity to the respiratory tract and the brain and the risk of hemorrhagic shock. Tthe pediatric population shall not be forgotten, in which such injuries are less common than in adults, but neurological recovery potential seems to be better.

A proper initial assessment of the patient at the accident site and in the emergency room allows the initiation of adequate therapy, and if required, surgical therapy to decrease overall complications. It should be remeberd to take care to stabilize the cervical spine in any patient with facial fractures, especially during work up and diagnostic maneuvers performed before spinal injuries are ruled out. Since severe cervical spine injuries can also be asymptomatic, it is important to perform an emergency radiologic assessment The injuries discussed in the review highlight how important it is to take X-rays or computer tomography to ensure accurate diagnosis and appropriate treatment for patients.

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