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Craniofacial Injuries Resulting from Polytrauma: Mechanisms, Imaging, and Complications

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Abstract:
Purpose: This literature review aims to identify and analyse the most common mechanisms causing injuries in the craniofacial region their diagnosis and possible sequelae.
Methods: The study analysed publications from the Medline database made available in PubMed and Google Scholar considering the following keywords "maxillofacial injuries" and/or "maxillofacial trauma" and/or "maxillofacial fractures".
Results: Craniofacial injuries in polytrauma patients are often complicated by their heterogeneous nature and coexistence with other injuries. Their incidence and mechanisms vary depending on the country of investigation. Diagnosis includes advanced imaging techniques such as CT scans. Treatment often requires multidisciplinary collaboration.
Conclusions: Craniofacial injuries in polytraumatic patients require a complex diagnostic and therapeutic approach. Interdisciplinary collaboration is crucial to achieve the best clinical outcome. The most common causes include road traffic collisions, assaults, falls and sports-related injuries. Despite properly applied treatment protocols, they generate changes in the stomatognathic system, sensory disturbances, blindness and, in extreme cases, can lead to death.
Keywords: Craniofacial injuries, craniofacial trauma, polytrauma patients, literature review, maxillofacial trauma, craniofacial fractures.

Introduction:

Craniofacial injuries include a wide range of injuries to the upper, middle and lower facial floors(Kryst, 1999), are a common component of polytraumatic injuries. These injuries, can result from a variety of mechanisms, such as motor vehicle accidents, accidents acquired during sports, falls, interpersonal violence or accidents occurring during work (Alvi et al., 2003; Gassner et al., 2003; Naveen Shankar et al., 2012; Van Hout et al., 2013).

Unfortunately, these are not always the main focus of attention when treating a multitrauma patient, but they can have serious consequences for patient mortality if not properly diagnosed and subsequently treated (McGoldrick et al., 2018).

The craniofacial region is unique due to its complex anatomy and the presence of vital systems: visual, respiratory, digestive and stomatognathic(Shah, 2015), making this area particularly susceptible to trauma-related complications. However, craniofacial trauma can generate functional and cosmetic abnormalities, and these can affect the quality of life of accident victims (Hull et al., 2003; Kishore et al., 2020).

Objective:

The aim of this paper is to analyse the available literature describing craniofacial trauma in the context of polytrauma. The incidence and mechanisms of these injuries are investigated, above which imaging modalities and potential sequelae are discussed.

Methods:

This study analysed Medline publications from PubMed and Google Scholar with the following keywords "maxillofacial injuries" and/or "maxillofacial trauma" and/or "maxillofacial fractures". Due to the interdisciplinary nature of the topic, papers on surgery and orthopaedics outside the above-mentioned databases were also included. The focus was on clinical studies, systematic reviews and meta-analyses on craniofacial trauma in the context of polytrauma.

Frequency and mechanisms causing craniofacial injuries.

Geographical region, socioeconomic trends, road traffic accidents, alcohol and drug abuse, and seasons of the year most influence the incidence and demographic distribution of craniofacial fractures (Banks, 2015). The most common mechanisms causing craniofacial injuries include:

- Road accidents

  They still constitute for the largest proportion of injuries, mainly in developing countries. According to Boffano et al. (Boffano et al., 2014) Asia and Africa have the highest incidence of craniofacial injuries caused by road traffic collisions (Gandhi et al. 2011; Subhashraj, Nandakumar, and Ravindran 2007). In contrast, a progressive decreasing trend has been observed in European countries and in North America and Brazil (Boffano et al., 2015; Van Den Bergh et al., 2012). The above analysis provides information, on the positive results of the introduction and subsequent enforcement of stricter laws and regulations on alcohol consumption and speed limits. (Chrcanovic, 2012). The undeniable life-saving role played by motorbike helmets when driving motorbikes and seatbelts when driving two-wheelers should be mentioned here. As reported by Liu et al. (Liu et al., 2008)motorbike helmets save lives. A 2008 study proved the appropriate use of a certified helmet on the road can reduce the risk of mortality by 40% and the risk of head injury by 70%. In the context of seatbelt use, it has been proven that there is a significant decrease in mortality in people with a normal BMI, but also in overweight and obese people(Elkbuli et al., 2019).

- Assaults

  Since the modification and tightening of traffic laws in industrialised countries, assaults are the main cause of craniofacial injuries (Boffano et al., 2015). Interpersonal violence can be defined as harm to another individual that violates his or her autonomy, physical or psychological integrity, and most often occurs through the use of excessive force (Ferreira et al., 2014). Assaults are facilitated by alcohol and drug use. Based on a study conducted in Amsterdam from 2000 to 2010, assaults under the influence of alcohol accounted for 74% of all recorded(Van Den Bergh et al., 2012) According to Lee. et al. (Lee et al., 2007) there is a direct correlation, between the amount of alcohol consumed and the increase in interpersonal violence. Assaults mostly involved predominantly male individuals, regardless of age (Eggensperger et al., 2007; Pillai et al., 2023).

- Falls

  They are the second (after assaults) cause of injuries in the area in developed countries according to the EURAT Project (Boffano et al., 2015). Craniofacial fractures resulting from falls are the result of a coincidence of factors such as: biological factors (age, sex) (Roccia et al., 2014), behavioural factors (use of drugs or alcohol abuse) (Hino et al., 2020; Ito et al., 2020)environmental factors (slippery surfaces and falls down stairs)(Rowbotham et al., 2018; Yamamoto et al., 2010) and socioeconomic risk factors. Craniofacial injuries resulting from falls on a flat surface account for the majority of injuries associated with falls in general. The main causes are the aftermath of slipping or tripping and dizziness (Yamamoto et al., 2010). However, it is falls from stairs that generate more complex and extensive injuries, including multisystem injuries, compared to those arising on a flat surface (Rowbotham et al., 2018).

  Mostly men are affected, however, this trend changes once they reach around 60 years of age (Roccia et al., 2014), this is related to changes in women's hormonal balance due to menopause, this in turn leads to progressive osteoporosis, which generates a greater susceptibility to injuries related to, among other things, falls (Atisha et al., 2016; Nogami et al., 2019). As demonstrated on 180 patients by Hino et al. (Hino et al., 2020) alcohol-induced falls generate a higher incidence of craniofacial injuries, compared to falls without the influence of alcohol.

- Sports-related injuries

  Sports activities account for a large proportion of admissions to traumatology departments. Craniofacial injuries resulting from sports activities account for between 6 - 35 % depending on the region (Boffano et al., 2014). The most traumatic sports are football, skiing, horse riding, motocross and cycling, including mountain biking. Injuries can occur through 3 mechanisms, which include:

  1. Contact with another player
  2. Contact with the ground

3. Contact with playing instruments (e.g. hockey stick or football) (Roccia et al., 2008)

It was noted that, depending on the region surveyed, different sports lead the way in the most traumatic category. In Germany, France and Italy it is football, in Switzerland and Austria it is skiing, while in Finland it is hocke (Elhammali et al., 2010) y. Based on an analysis of craniofacial fractures conducted by Bojino et al. in 2020 in Italy on 432 patients (Bojino et al., 2020) it was proven that fractures of the zygomatic-orbital-maxillary complex are the most common, followed by fractures of the lower face, i.e. the mandible, with the third most common fracture being of the nasal bone. This study is in line with studies brought in other countries (Elhammali et al., 2010; Murphy et al., 2015). Injuries are more common in young men, mainly as a result of a more aggressive playing style, higher levels of physical activity and greater muscle mass (Bojino et al., 2020; Chrcanovic, 2012).

Imaging in craniofacial trauma

Imaging in craniofacial trauma is a key component to making a correct diagnosis and planning treatment, often surgical. Interpreting images of a trauma patient can be challenging due to the complex anatomy of the head. The overlap of numerous bony structures can create obstacles to accurate interpretation of head injuries (Laine F; Coway W; Laskin D, 1993)

Computed tomography (CT) has become the standard for imaging maxillofacial injuries, and it also allows the patient to be qualified for potential surgery (Dreizin et al., 2016; Maurya et al., n.d.). When describing the image obtained from a CT scan, the face is divided into five regions: nasal, orbital, zygomatic, maxillary and mandibular. This allows the injury to be categorised as an injury to one area, different areas or multiple, adjacent areas (Avery et al., 2011).

Cone beam computed tomography (CBCT) uses cone-shaped X-rays travelling around the patient's head in 360st. (Kaasalainen et al., 2021). This examination has a lower radiation dose and the cost of the machine itself is cheaper than CT (Ludlow et al., 2006), but the amount of noise in the image is higher compared to CT (Boeddinghaus & Whyte, 2008). Diagnosis of craniofacial trauma using CBCT may be useful in outpatient centres, but will not serve its purpose in polytraumatic patients (Meara, 2019).

Magnetic resonance imaging (MRI) is rarely used for diagnostic purposes of maxillofacial injuries, it only images soft tissues. Possible indications may include:

- Soft tissue entrapment e.g. of the rectus inferioris muscle in orbital floor fractures
- Cervical-cavernous fistula
- Cerebrospinal fluid leakage in skull base fracture (Meara, 2019)

The temporomandibular joint and the position of the articular disc in this joint in mandibular condylar process fractures can be described using MRI (Boeddinghaus & Whyte, 2008). The disadvantages of MRI include its lesser availability compared to CT scans in traumatology departments. Advantages, on the other hand, include the lack of use of ionising radiation and soft tissue imaging is better than with CT(Meara, 2019).

Consequences of craniofacial trauma

Due to the varying extent of craniofacial trauma in the course of multi-organ trauma, the range of both physical and psychological consequences can be wide. One of the sequelae of trauma in this body region is damage to or complete loss of teeth and subsequent prosthetic rehabilitation. In a study conducted by Zhou et al. (Zhou et al., 2013) almost 42% of patients suffered dental trauma in the course of craniofacial trauma. Falling from a height represented the highest risk of dental trauma, while the teeth most frequently injured were the medial incisors in both the maxilla and mandible. Total tooth dislocation was the most common type of injury (47.4%). Bite abnormalities, maxillary bite and altered facial contour were the complications that occurred in patients in the first 3 months after injury in the study by Petersen et al. (Petersen et al., 2021). In the same study, some patients were found to have blindness or double vision, but they represented a small proportion of the injured patients. Sensory disturbances of the infraorbital and chin nerve were complications of orbital floor fracture and mandibular fracture, respectively. The facial nerve was also paralysed in a central or peripheral mechanism. However, the symptoms of paralysis diminished over time (Petersen et al., 2021). Functional and aesthetic complications are a well-known consequence of craniofacial trauma and have been proven to affect patients' subsequent quality of life and mental health (Conforte et al., 2016).

Conclusions

Craniofacial injuries in polytraumatic patients require special care due to the anatomical complexity in this region. The most common causes causing this type of injury include road traffic accidents, assaults, falls on a flat surface and those from a height, and injuries generated during sporting activities. These include injuries to the upper, middle and lower face, dental injuries and soft tissue injuries. These injuries can lead to serious functional, aesthetic and, in extreme circumstances, even fatal consequences. Diagnosis and subsequent treatment among polytraumatic patients require interdisciplinary collaboration and a holistic approach from specialists in traumatology, maxillofacial surgery, neurology, otolaryngology and ophthalmology. Diagnosis usually includes advanced imaging techniques, such as computed tomography (CT), which allows an accurate assessment of the extent and nature of damage. Psychological and psychiatric support for craniofacial trauma patients should not be overlooked, as these affect wellbeing and quality of life.

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The authors report no disclosures.

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Conceptualization, supervision and project administration:
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Methodology:
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Software, validation, formal analysis, investigation, resources, writing original draft preparation:

Agnieszka Porwolik, Dominik Rabstein
Writing, review, editing and visualization:
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