Epidemiology of Facial and orbital injuries in Quebec, Canada

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Abstract

Facial trauma can involve soft tissue injuries such as burns, lacerations, and bruises, or fractures of the facial bones. It causes orbital floor fractures, nasal fractures, and fractures of the jaw, zygomatic arch fractures, Le Fort type I, II, or III mid-face fractures, as well as trauma such as eye injuries. Orbital and facial skeletal fractures are a typical result of facial trauma. However, their frequencies vary a lot depending on demographics and socioeconomic conditions. The goal of treatment of orbital and facial skeletal fractures is to maintain or restore the best possible physiologic function and aesthetic appearance to the area of injury. A conservative approach may be warranted in some instances, whereas more invasive intervention may be necessary for other situations. The indications and timing for fracture repair are debatable in the literature.

The principal objectives of the study will be to 1) determine the prevalence of facial injuries, orbital fracture and other facial skeletal fractures following facial trauma who visited one of the hospitals in Quebec, 2) to identify the most common cause for facial and orbital injuries, 3) to describe the difference and trend in facial and orbital injuries according to age, gender, and socioeconomic status, 4) to describe the surgical and pharmacological treatment strategies used and to assess the associated clinical outcomes, complications, morbidities, mortality of the different treatment strategies and what is the best approach to treat each patient.

This thesis is a nine years retrospective observational study using data from the Quebec Trauma Registry (QTR), Med-Echo hospitalization data, and medical and pharmaceutical

services from the Régie de l'assurance maladie du Québec (RAMQ). All the patients who sustained a facial trauma between 1994 and 2002 selected from the QTR. Patients with orbital fractures and other facial skeletal fractures identified with the primary and secondary diagnosis ICD-9 and AIS codes for the respective fractures. The selected patients were followed for one year from the occurrence of the fracture by reviewing their QTR records, hospitalization data, and medical and pharmaceutical services. A one-year medical history before the event of the injury will be sought in the administrative database for every patient to adjust the statistical models and avoid confounding bias.

This study will provide population-based information on the frequency of orbital and facial skeletal injuries following facial trauma, on surgical and pharmacological treatment strategies used and on the associated clinical outcomes, complications, morbidities, and mortality issued from the different treatment strategies. These results will be essential to identify the most suitable indications and timing for fracture repair in the province of Quebec and any elsewhere.

Résumé

Les traumatismes du visage peuvent impliquer des lésions des tissus mous telles que des brûlures, des lacérations et des ecchymoses, ou des fractures des os du visage telles que des fractures du plancher orbitaire, des fractures du nez et des fractures de la mâchoire, des fractures de l'arc zygomatique, Le Fort type I, II ou III au milieu. Fractures du visage, ainsi que des traumatismes tels que des blessures aux yeux. Les fractures squelettiques orbitales et faciales sont un résultat typique d'un traumatisme facial, mais leur fréquence varie beaucoup en fonction de la démographie et des conditions socio-économiques. L'objectif du traitement des fractures orbitales et faciales du squelette est de maintenir ou de restaurer la meilleure fonction physiologique et l'aspect esthétique possibles de la zone de la blessure. Une approche conservatrice peut être justifiée dans certains cas, tandis qu'une intervention plus invasive peut être nécessaire dans d'autres situations. Les indications et le moment choisi pour la réparation d'une fracture sont discutables dans la littérature.

Les principaux objectifs de l'étude seront de 1) déterminer la prévalence des blessures au visage, des fractures orbitales et d'autres fractures du squelette du visage consécutives à un traumatisme au visage qui s'est rendu dans un des hôpitaux du Québec, 2) afin d'identifier la cause la plus courante de blessures au visage et à l'orbite. , 3) décrire la différence et la tendance des lésions faciales et orbitales en fonction de l'âge, du sexe et du statut socio-économique, 4) décrire les stratégies de traitement chirurgical et pharmacologique utilisées et évaluer les résultats cliniques associés, les complications, les morbidités, la mortalité du patient différentes stratégies de traitement et quelle est la meilleure approche pour traiter chaque patient.

Cette thèse est une étude d'observation rétrospective de neuf ans qui utilise des données du Registre des traumatismes du Québec (RQT), des données d'hospitalisation Med-Echo et des services médicaux et pharmaceutiques de la Régie de la maladie du Québec (RAMQ). Tous les patients ayant subi un traumatisme au visage entre 1994 et 2002 ont été sélectionnés à partir du QTR. Patients présentant une fracture orbitale ou une autre fracture du squelette facial associées aux codes de diagnostic primaire et secondaire, CIM-9 et AIS, pour les fractures respectives. Les patients sélectionnés ont été suivis pendant un an après la survenue de la fracture en examinant leurs dossiers QTR, leurs données d'hospitalisation et leurs services médicaux et pharmaceutiques. Un historique médical d'un an avant l'événement de la lésion sera recherché dans la base de données administrative pour que chaque patient puisse ajuster les modèles statistiques et éviter les biais de confusion.

Cette étude fournira des informations en population sur la fréquence des lésions orbitales et faciales au squelette consécutives à un traumatisme au visage, sur les stratégies de traitement chirurgicales et pharmacologiques utilisées et sur les résultats cliniques, les complications, les morbidités et la mortalité associés issus des différentes stratégies de traitement. Ces résultats seront essentiels pour identifier les indications et le moment les plus appropriés pour la réparation d'une fracture dans la province de Québec et ailleurs.

Introduction

Any wound or shock produced by a sudden bodily injury resulting from violence or an accident is the definition of physical trauma to the human body. Trauma accounts for 10% of all mortality worldwide. In North America, it is the fifth leading cause of death among individuals under 45 years of age. Blunt trauma is one of the most common causes of traumatic death in North America. The majority of dull trauma cases caused by motor vehicle accidents, followed by falls. Both locally and globally, trauma is a severe public health problem with high social and economic costs (1).

Facial trauma is one of the most common forms of trauma, including any injury or physical damage to the face. It was reported in several studies to range from 34% in North America Database on Trauma (2), to 15% in Liverpool (3), and 25% in London (4). Blunt or penetrating trauma can cause harm to the area of the face. Common causes of injury to the face include motor vehicle accidents, penetrating injuries, physical violence, sports injuries, blow from fists or objects, and workplace injuries. Facial trauma may result in soft tissue injuries such as burns, lacerations, abrasions, and bruises, as well as fractures of the facial bones and eye injuries (1).

The incidence and demographic distribution of these injuries vary depending on the season, geographical area, socioeconomic determinants, frequency of road traffic accidents, and prevalence of alcohol and drug abuse.

There are currently no published studies from Quebec regarding facial and orbital injuries secondary to any cause of facial trauma. Data published in Ontario has focused on the treatment of this type of trauma and the associated fractures. There are also few studies focused on the etiology and epidemiology of facial and orbital trauma (5-8).

This thesis will focus on facial injuries, and fractures of the facial bones, including, the frontal bone, maxilla, mandible, zygomatic bone, nasal bone, and orbit. A subset of mid-face fractures previously described by Rene Le Fort accounts for about 10-20% of facial fractures. These fractures categorized into three types: Le-Fort type I, Le-Fort type II, and Le-Fort type III. The most common type of fracture is a mandibular fracture (9). Facial and orbital fractures affect a significant proportion of trauma patients. It occurs in around 5 - 35% of patients who had trauma (1). It found that 45% of the facial and orbital fractures involved the mandible, and 43% the zygomatico-orbital bones (10, 11). The zygomatic fracture can occur as an isolated fracture or in combination with the zygomatic arch, the body of the zygoma, and especially infra-orbital rim fracture. The orbital trauma frequently associated with zygomatic fracture and up to one third associated with ocular injuries and 16.6% with concomitant orbital fractures (11, 12).

Epidemiological studies of facial trauma are critical in guiding the development of more efficient care delivery systems, improvement of the quality of care, and prevention of this type of injury by providing information to the public and health care professionals. We, therefore, assessed the epidemiology and management of facial trauma and fractures in Quebec.

Our goals were to describe the prevalence of facial trauma by evaluation data of patients with facial and orbital bone fractures and to describe the most common causes of facial and orbital injuries in Quebec. We also aim to describe the management of these injuries.

Literature review

Trauma

History and Cause

In western countries, the median age of the population has increased progressively in the last two decades. It estimated that within the next decades, 25% of the Canadian would be over 65 years of age (13, 14). Based on the published data in the field, around 5 to 33% of patients have experienced severe trauma (15-17). Due to the increase in life expectancy and a growing elderly population, this change will result in more facial trauma (18, 19). In elderly patients, the annual occurrence of traumatic injury reported as 29% (19). Facial trauma is a burden to the health care system in addition to the patients and their families as their time spent in the hospital, and treatment is expensive. There is also associated with a psychological problem and severe morbidity (20). It is the fifth leading cause of death, and it increases the probability of severe disability. Several factors can contribute to the increase of this type of trauma in elderly patients, including; chronic illness causing weaknesses and a lake of general physical activity, visual changes, unsteady gait, and decrease cognitive functions (21, 22).

There are currently no published data on facial injuries in Quebec. Studies conducted in Ontario have focused on the treatment of this type of trauma and associated fractures (5-8). One study focused on mandibular fractures. It found that the median age of patients who sustained a mandibular fracture is a range between 21-30 years, with a male to female ratio of 5:1. The leading cause of fractures was violent assault (54%), followed by falls (22%), and then sports activities - almost half of all patients treated by open reduction. The postoperative complications occurred in 5.3% of patients, which is lower than the results from another studies report. The most frequent complication was an infection. (9, 23-25).

Another study of facial trauma conducted in Ontario showed that falls were the leading cause of facial and orbital fractures, and it is the leading cause of in-hospital deaths. The MVC is the second cause of in-hospital mortality. They also conclude that rural areas have a higher incidence of fractures (26).

In the last five decades, a regionalized trauma care system with level I (tertiary) trauma centers has been developed to provide the best definitive care for patients with life-threatening trauma and injuries. There is strong evidence in the literature supporting the efficacy of regionalized trauma care systems in minimizing the mortality of secondary trauma injuries, particularly in urban areas (27-33). The regionalized trauma system provides a continuum of services encompassing four phases of care: pre-hospital care, in-hospital care, rehabilitation, and research-driven quality assurance. The ultimate goal of these systems is to ensure that patients with severe injuries receive definitive and appropriate care promptly.

In 1992, the regional trauma care system officially was implemented in the province of Quebec, and it led to an increase in patient volume at the level I trauma centers (32, 34). These trauma centers were designated to receive and treat patients with significant injuries (34-36). There are currently three Level I trauma centers and twenty-nine Level II (secondary) trauma centers in the province of Quebec, serving a population of approximately 10 million. Data from the Quebec trauma registry (QTR) have shown that the mortality rate from serious injuries decreased from 52 % in 1992 to 13% in 2005 as a result of implementing the Quebec Regionalized Trauma system (34).

Epidemiological studies on the occurrence of orbital and facial injuries have conducted in various countries around the world. Most of the published studies have been retrospective. The information is as diverse as the countries and their populations; however, traffic accidents and assault are the most common causes of facial injuries globally (37). Earlier studies from the United States (38), Europe (39), and the Middle East (40) found that traffic accidents were the most common cause of facial fractures. Other studies from Scotland determined that assault was the most common cause of facial fractures according to the data collected in these regions (41).

Facial and orbital fractures affect a significant proportion of trauma patients (42). It is occurring in 5-33% of patients who had a severe trauma. It can develop as an isolated injury or associated with other severe injuries (43-45). This type of trauma can cause facial bone fractures. The most common type of fractures is mandibular fractures, followed by

zygomatic fractures (5, 24, 46, 47). It is account for 36% to 59% of all facial and orbital fractures (24).

In 2006, a study from Brazil found the prevalence of facial and orbital fractures are: mandible (41.3%), ZMC (38.9%), nasal bone (22.2%), maxilla (6%), with lower facial fractures are more frequently than midfacial fractures. The most common cause of fractures was MVA (45%), followed by assaults (22.6%), falls (17.9%), sports accidents (8%), and work accidents (4.5%). Almost half of the patients were treated conservatively (48%) and the rest with surgery. Complications observed in 7.4% of the patients due to infection and malocclusion (47).

In Korea, another study showed that more frequent fractures are in the midface with 86.2%, 12.2% in the mandible, and 1.6% simultaneously occurring in the midface and mandible. The most frequent fracture in that study was nasal bone fracture (65.0%), followed by the orbital fractures (29.2%), maxillary fractures (15.3%), zygomatic arch (13.2%), Zygomatic (9.8%), and mandible (9.1%). This type of fracture is due to the low mechanical strength and thinness increase the risk of fracture, compared to areas where greater force must be applied to increase the risk of fractures such as the mandible or Zygomatic. Furthermore, these results are in agreement with other research showing that nasal bone fractures are the most common, as the nose is the most exposed facial area (48). The symphysis of the mandible is the most frequent fractures (33.9%), the angle (30.6%), condyle (25.4%), and body (10.1%). This conclusion is quite different from the results of other studies. Some studies reported the incidence of fractures based on the site of mandibular fractures. The condyle (33.6%), angle (21.7%), and symphysis (16.7%) (49). While other studies reported that fractures were more common in the angle (50, 51). In other words, the literature showed

slightly different results, which could explain concerning social, economic, cultural, conventional, and regional differences.

Determinants of the incidence and etiology of facial injuries include social, cultural, and environmental factors. A detailed analysis of the epidemiological features of facial trauma in Quebec will enable healthcare and policy workers to take action in the prevention of these injuries.

Definitions:

Facial Trauma

Trauma to the face includes facial bone fractures, dentoalveolar injury, and soft tissue injuries, as well as any associated injuries of the eye, head, and neck (52). Facial trauma can occur in isolation or combination with other serious injuries, including spinal, upper body, and lower body injuries (53, 54).

Facial Fractures

Facial fractures are a common component of multiple trauma cases resulting from different causes, including motor vehicle accidents, workplace accidents, sporting injuries, and physical violence. Facial fractures may accompany other serious injuries, including cranial, spinal, upper body, and lower body injuries (53, 54).

Epidemiology of Facial Injuries:

The distribution of orbital and facial fractures varies in terms of cause, severity, and type,

depending on the study population (55, 56). Differences in the origins of facial fractures between communities may be the result of risk factors and cultural differences between countries and are likely to influence injury severity. Several studies found motor vehicle accidents were the most common cause of fractures, whereas in other assaults were the most common cause. However, the falls were increasing, whereas sports accidents where the object in more than 10% of the facial trauma (24, 47).

In all studies, the number of men exceeds the number of women with a male to female ratio of 2:1. In African studies, motor vehicle accidents remain the most common cause of facial and orbital fractures with a progressive reduction in the last 20 years. The second common cause of injury is Assault, whereas falls and sports accidents were more sporadic than other causes. The male to female ratio is 4:1 or more. In Asia, the male to female ratio is variable and ranges between 2:1 and 20:1, maybe because of the developmental changes in economics among countries. The leading cause of injuries remains motor vehicle accidents, which account for 40-45 %, followed by an assault, which mentioned in 2 studies as an essential cause of fractures (57, 58). In North America and Brazil, the motor vehicle accident is the most common cause in almost all studies, and the number remained stable. Assault is the second most common cause of the fracture and is still progressing. The male to female ratio 2:1 and 4.3:1 retrospectively. In Europe, the male to female ratio remains stable in the last three decades, with a ratio of 1.8:1 and 6.6: 1. The car accident remains the most common cause of fractures in most of the studies followed by Assaults, which described in 5 reviews as a primary cause of fractures. Finally, in Oceania, the assaults

were the most common cause of fractures, followed by car accidents. The male to female ratio is 4:1 (20).

Patients affected by facial fractures have worse outcomes than patients with less severe facial injuries. There is a relationship between facial injury severity and the development of working disabilities (55).

The cause of facial injuries varies by location. Motor vehicle collisions and crush injuries are more common causes of injury among rural populations. In contrast, the assault incident is higher in urban than in rural areas (59).

In this study, we will access and utilize data from the trauma registry in Quebec. Our scope is to evaluate data on patients with facial and orbital injuries in Quebec.

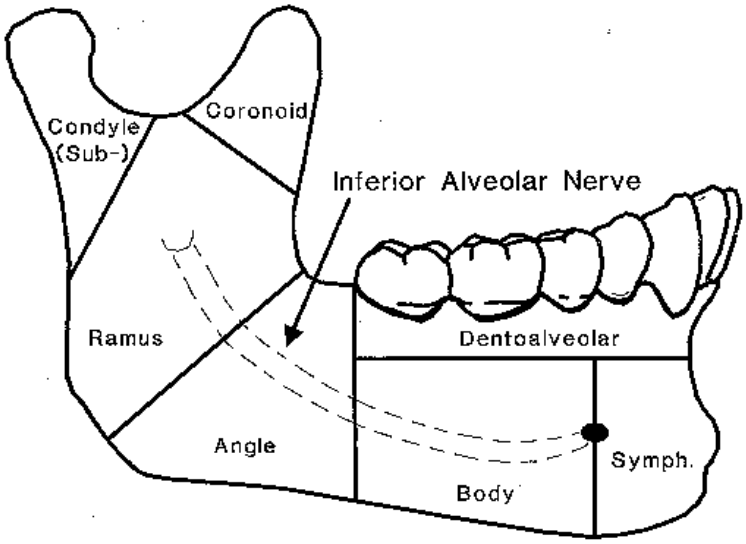
There are different types of fractures:

A. Mandibular fractures

Fractures of the mandible can locate it in the symphysis, body, angle, ramus, condyle, or sub-condyle regions (Fig. 1). The location of the fracture is related to the cause of the injury. Motor vehicle collisions tend to cause fractures of the condylar and symphysis regions. The force usually is directed against the symphysis, commonly resulting in a combination of fractures in the symphysis and one or both condylar regions. The high-

velocity impact tends to generate comminution and multiple region fractures. Injuries sustained in physical altercations and assaults are more commonly located in the mandibular angle region, especially on the left side, in the more common case that a right-handed aggressor has struck the blow.

Figure 1: Mandibular fractures



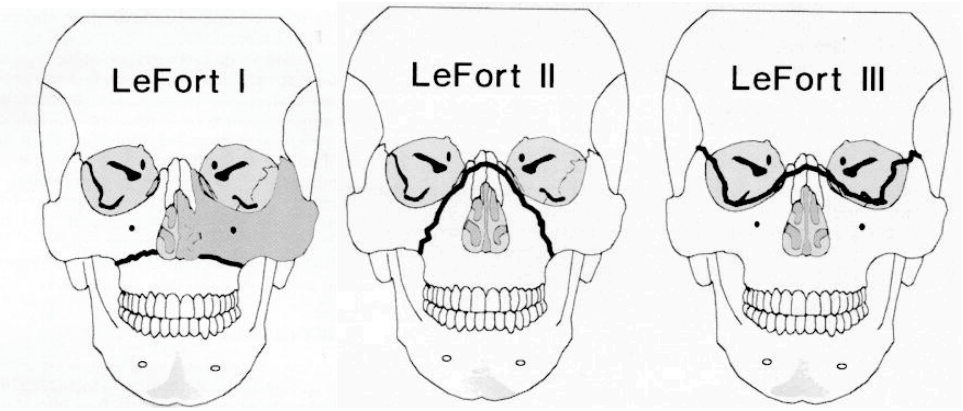
Injuries to the mandible can occur through both indirect and direct forces. As previously mentioned, a condyle fracture can be the result of a blow to the symphysis, which fractures the symphysis directly and pushes the mandible posteriorly, resulting in an indirect condylar injury. At least half of mandibular fracture cases are multiple fractures. In the case of violence and assault, multiple fractures commonly occur at the mandibular angle on the side of impact (direct), and the contralateral mandibular symphysis or body (indirect).

A particular aspect of the management of the mandibular fracture is that the mandible supports the tongue, and some fractures of the mandible can cause loss of this supporting role. Bilateral mandibular fractures, especially bilateral condylar plus symphysis fractures, can cause damage of tongue support, allowing posterior displacement of the tongue (60). Mandibular fractures caused by gunshot wounds with comminution can also create a situation in which the mandible cannot support the tongue. The airway must be maintained in such cases, using airway aids (61). The rate of postoperative complications is around 5%, and it is very low. The most common complication is infections, followed by malocclusion and malunion (23, 62, 63).

B. **Maxillary fractures**

Maxillary fractures are less common than those of the mandible. When they occur, they are usually associated with other midfacial fractures. Almost all maxillary fractures involve dental occlusion, although a few are fractures of the anterior wall of the maxilla above the level of the teeth. These do not usually warrant treatment. Classically, maxillary fractures are categorized according to the Le Fort classification (Fig. 2)

Figure 2: Le Fort classification



The Le Fort I fracture is a horizontal fracture above the roots of the teeth, extending from the piriform aperture of the nose to the pterygomaxillary fissure, separating the maxillary tuberosity from the pterygoid plates. The mobile maxillary fragment is similar to a loose denture, containing the teeth and palate. It can be a single fragment or in multiple segments. This fracture is commonly the result of a horizontal force applied to the anterior maxilla.

In a Le Fort II fracture, the maxilla and its approximating nasal complex together are separated from the orbital and zygomatic structures. Instead of the fracture running along the anterior maxilla extending from the pterygomaxillary fissure into the piriform aperture, as it does in the Le Fort I fracture, it courses upward through the infraorbital rim, over the medial orbit and nasal bones. Because of this pattern, it is also called a pyramidal fracture.

Le Fort III fractures have also been termed craniofacial separation, because the maxilla, naso-orbito-ethmoid (NOE) complex, and zygomas separated from the cranial base.

It is sporadic for a midfacial fracture to cause airway obstruction; however, the significant blood supply to the midface can result in life-threatening hemorrhage. In the case of severe bleeding, a nasal packing can be lifesaving.

C. Nasal fractures

Fractures of the nose are common and often go undiagnosed, with many patients choosing not to present for evaluation. Patients often undergo some traumatic event, resulting in a bloody nose, and do not seek attention once the nose stops bleeding. Isolated fractures of the nasal bones alone are very rare. The entire nasal complex usually is involved, and there is often damage to the underlying bones and cartilages. Frequently, there is an extension to the frontal and ethmoid bones. Fracture of the nasal septum usually is associated with nasal fractures and may produce a nasal airway obstruction (48).

An essential difference between the adult and pediatric nasal fractures is that the nasal bones not fused in children until adolescence; therefore, fractures in young patients occur in each bone. Furthermore, injuries to the nose and nasal septum can result in growth dysplasia(48).

Most injuries to the nose occur from the side, which dislocates both nasal bones and the nasal septum to the opposite side. Patients who do not seek treatment or receive poor treatment often complain of nasal airway obstruction secondary to a deviated nasal septum.

Fractures of the NOE are a more severe injury. They include not only the nasal bones but also the nasal processes of the frontal bone and the frontal process of the maxilla. The bones involved in NOE injuries are at the "anatomic crossroads" among the cranial, orbital, and nasal cavities. In such fractures, the orbital rim and nasal pyramid frequently become displaced posteriorly. The thin middle segment of the orbital wall and nasal septum crumbles, absorbing the shock and sparing the posterior portion from more severe displacement.

In addition to the disorganization of the skeletal framework produced by the backward displacement of the bony structures into the interorbital space, fractures involving the cribriform plate and anterior cranial fossa can result in cerebrospinal rhinorrhea and brain damage. Fractures of the medial orbital rim cause displacement of the medial canthal tendon, lacrimal apparatus, and suspensory ligaments of the eyelids and globe.

A direct blow to the midface can result in fractures of the bony NOE complex and injury to the adjacent soft tissues. A common source of such damages is rapid deceleration of an unrestrained subject whose nasal bridge strikes the steering wheel or dashboard of a car. These injuries can be confined to the NOE complex. However, frequently, they are associated with other facial fractures and are often complicated by multisystem trauma (48).

Simple nasal fractures frequently require no immediate intervention unless epistaxis is problematic. Bleeding from the nose that continues beyond several minutes after the injury could require the insertion of nasal packing or commercially available hemostatic balloons or other devices.

CSF rhinorrhea is common after NOE fractures (64). The bone of the anterior skull base is thin, with densely adherent dura. The T-shaped mass of the crista Galli and the cribriform plate is robust. It moves as a unit in response to a significant blow to the nasal bridge, creating fractures in the medial fovea ethmoidalis (65). The presence of CSF rhinorrhea is not diagnostic for an NOE injury, however, because this can accompany frontal sinus, orbital roof, and Le Fort fractures. On the other hand, its absence is not evidenced against an NOE fracture, because many patients with NOE fractures do not experience CSF rhinorrhea.

Trauma to the anterior cranial fossa must disrupt the arachnoid to cause CSF rhinorrhea. It also can be caused by a tear in the dura and a fracture of bone (as well as a tear through the periosteum and mucosa). The incidence of meningitis varies widely from one study to another but is quite low (from 4%-10%) in those who have CSF fistula (64, 66). Whether one should administer antibiotics for CSF rhinorrhea, and if so which antibiotics, is usually a decision made by the neurosurgeon (67).

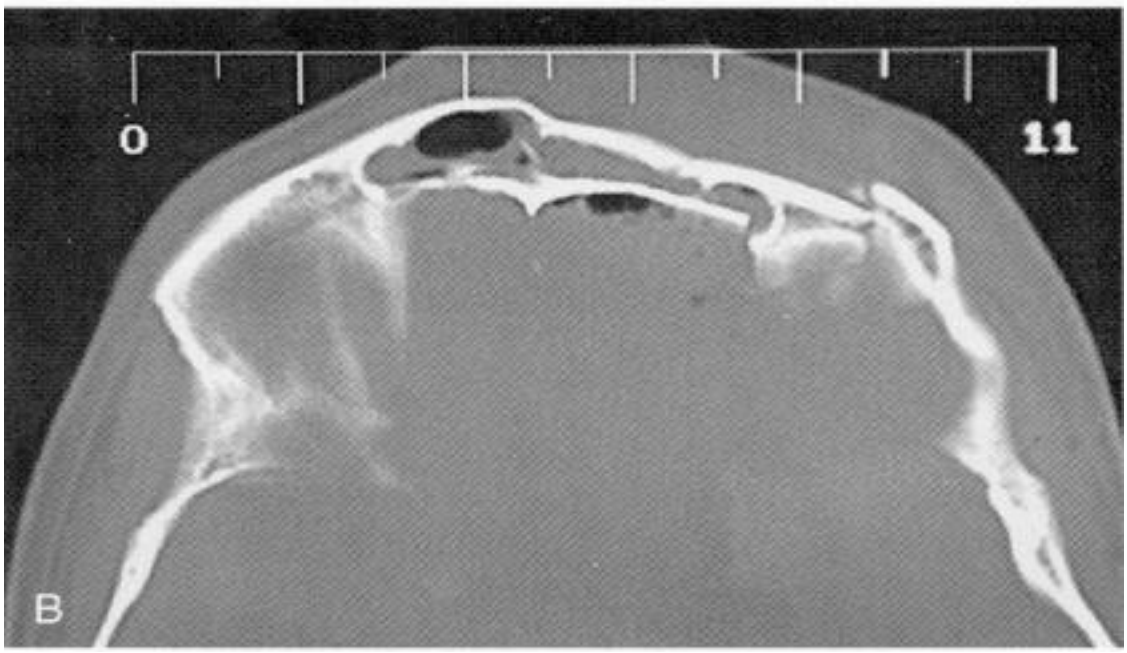
D. Frontal bone and sinus fractures

Frontal bone and sinus fractures are uncommon compared to the other facial fractures. Due to the anatomical closeness to the orbit, nose, and brain, they can cause severe morbidity. The floor of the frontal sinus consists of the orbital part of the frontal bone, which can overlie the optic nerve in extensively pneumatised sinuses. Anteriorly, the floor of the frontal sinus overlies the ethmoid sinuses and nasal cavity. The frontal sinus drains into the middle meatus of the nose by the nasofrontal ducts or Ostia. The patency of the drainage system is extremely important to ascertain when making decisions about whether to treat a

fractured frontal sinus and which treatment is necessary. Some frontal sinus injuries are apparent, but most are not.

Like other facial fractures, frontal sinus fractures usually are not medical emergencies, although the presence of CSF rhinorrhea can be a life-threatening condition if meningitis develops. Neurosurgical consultation is generally warranted if CSF rhinorrhea or posterior table fractures are present. The decision to begin administration of prophylactic antibiotics and the choice of antibiotic is up to the discretion of the neurosurgeon. A thorough ophthalmologic examination must also be performed on all patients with frontal sinus fractures. One study documented that 89% of patients with frontal sinus fractures had associated eye injuries (68).

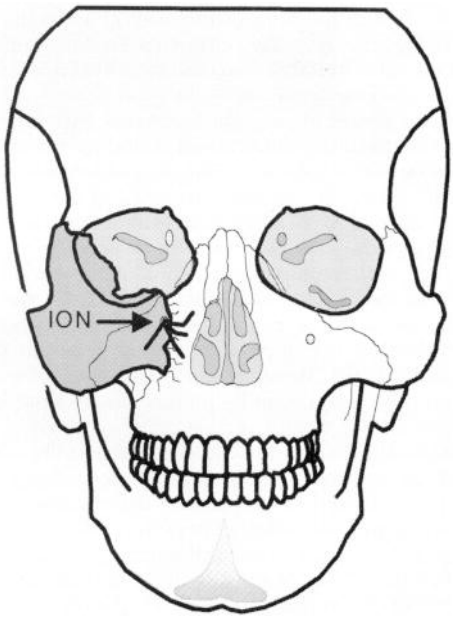
Figure 3: Frontal bone fracture



E. Zygomatic bone fractures

The zygoma is a prominent bone in the facial skeleton, making it prone to fracture. It articulates extensively with the maxilla along the anterior maxilla, infraorbital rim, and orbital floor; the frontal bone at the frontozygomatic suture of the lateral orbit; the temporal bone at the zygomatic arch; and the sphenoid along the lateral wall of the orbit (Fig. 4). The zygoma forms a large part of the lateral and inferior walls of the orbit, as well as a portion of the roof and lateral wall of the maxillary sinus.

Figure 4: Zygomatic fracture



Because the zygoma is thick, and fractures of this region occur in areas where support is weakest, it is rare to have an isolated fracture of the zygoma in which the fracture lines are entirely within this bone or only through the structures surrounding it. Instead, the fracture

lines commonly extend through adjacent bones, which are thinner. Zygomatic fractures are orbital fractures because the internal orbit can sustain disruption during the displacement of the zygomatic body. For this reason, fractures of the lateral midface are sometimes called as zygomatico-orbital fractures. They are also sometimes called malar fractures, or zygomaticomaxillary complex (ZMC) fractures, which indicates that the injury involves the zygoma and adjacent bones. In all such cases, at least one fracture through the zygomatic arch occurs. ZMC fractures must be distinguished from those of the zygomatic arch only, whereby the zygomatic body is intact, and only the arch extending from the body of the zygoma to the temporal bone is disrupted.

The zygoma has numerous muscles attached to it, including the masseter. A combination of the direction of the disrupting force direction (usually posterior and medial) and the pull of the masseter muscle causes inferior and posterior displacement of the usual ZMC fracture. Because of its involvement with the internal orbit, complications of the orbit are not uncommon.

F. Orbital fractures

The bony orbit is made of seven bones of varying thickness. Superiorly, the supraorbital rim and orbital roof are formed by the thick frontal bone. Inferiorly, the floor and infra-orbital rim are formed by the zygoma and maxilla. The lateral wall is thick and is made of the greater wing of the sphenoid and the zygoma. Medially, the orbit is formed primarily by the lamina papyracea of the ethmoid. The bony orbit has solid buttresses anteriorly along the infraorbital rim and posteriorly at the apex. In between is a large area of anatomic weakness, especially in those areas where the bones are fragile. The floor of the orbit is also

weakened by the groove for the infraorbital nerve, which traverses through it.

Fractures of the orbit can be either pure, whereby the internal orbit is disrupted without a disruption of the orbital rims, or impure, whereby a fracture of the orbital rim is also involved with the internal orbital fracture. A ZMC fracture is classified as an impure orbital fracture because the disruption is both internal and along the rim. The term blowout fracture refers to a pure internal orbital fracture created by a sudden increase in intraorbital pressure by compression of the orbital contents against a volumetrically constrained orbital socket. The force creates fractures of the internal orbit in areas where the bone is thinnest (i.e., along the floor and medial wall), which then causes bone displacement into the air spaces of the ethmoid and maxillary sinuses. Intraorbital soft tissue contents also herniate into the maxillary and ethmoid sinuses.

Ocular injuries, such as; global rupture or laceration, hyphema, vitreous hemorrhage, severance of the optic nerve, and corneal abrasions, were found in 4% of patients with midfacial trauma by Turvey (69) and in 5% of zygomatico-orbital fractures by Livingston and colleagues (70). Ophthalmologic consultation was deemed necessary in approximately 5% of 2,067 cases of zygomatico-orbital injuries reported by Ellis and colleagues (65). Ioannides et al. found significant ocular/adnexal injuries in 26% of orbital fractures (71). Al-Qurainy et al. prospectively performed ophthalmologic examinations in 363 patients who had sustained midfacial fractures (72). Minor or transient eye injuries, such as corneal abrasion, chemosis, mild impairment of the accommodation and visual acuity, and orbital emphysema, were found in 63% of patients. Moderate injuries, such as conjunctival

abrasion, traumatic pupillary changes, iridodialysis, lens damage, macular edema, moderate-to-severe impairment of the accommodation, and visual acuity, were noted in 16% of patients. Severe ophthalmic disorders, such as gross proptosis, retro-bulbar hemorrhage, corneal laceration, hyphema, angle recession, severe reduction/loss of vision, visual field loss, choroidal tear involving the macula, and optic nerve injuries, were found in 12% of patients. One-third of all patients with comminuted ZMC fractures suffered a severe ocular disorder. Therefore, if there are any significant or questionable findings in patients with midfacial fractures, ophthalmologic consultation should be obtained.

The evaluation and management of orbital and skeletal facial fractures is well described, but there are still some areas of controversy. One such unresolved question is the need for immediate versus delayed surgery (ORIF) (73).

Not many published studies have focused on facial and orbital fractures, especially in Quebec. This report is the first large study employing data from the QTR. Multiple studies on the prevalence and treatment of facial and orbital injuries have published. However, these conducted outside Canada in other countries, including Australia, the United States of America, and some countries in the Middle East. None of the previous publications have discussed facial fractures of all types together. This study will include a broad scope of all facial fractures, provide information about each fracture, and describe the incidence, cause, severity, and risk factors for Quebec patients who sustained a facial and orbital injury.

Objective

The overall objective of this work is to describe the prevalence of facial and orbital injuries in Quebec. The study will assess the causes, demographics, treatment, follow-up, and outcomes of facial and orbital injuries from different treatment centers in Quebec for eight years.

The specific objectives are:

1. Describe the frequency of facial and orbital trauma,
2. Describe the frequency of orbital and facial skeletal fractures,
3. Describe the most common cause and sites,
4. Describe the surgical and pharmacological treatment strategies,
5. Assess timing for fracture repair,
6. Compare the clinical outcomes, complication, morbidity, and mortality associated with different treatments, and
7. Determine whether specialized centers will be required to better treat facial fractures in Quebec.

The outcome of this study will be to determine the optimal care system for facial injuries in Quebec. Our findings can be extrapolated to other provinces and complement the existing literature on care systems worldwide.

An improved understanding of the prevalence, causes, and severity of the facial and orbital injuries will lead to the development of more effective treatments and preventative measures. Long-term data collection is critical because it allows clinicians to obtain sufficient data to develop protective measurements and more effective therapies (5).

Methodology

Study design and participants

This report is a retrospective, descriptive, observational study employing data from the Quebec Trauma Registry (QTR), Med-Echo hospitalization data, and medical and pharmaceutical services from the Régie de l'assurance maladie du Québec (RAMQ). The QTR database contains clinical, administrative, and demographic data. All the patients who sustained a facial trauma between 1994 and 2002 selected from the QTR. Patients with orbital fracture and other facial skeletal fractures identified with the primary and secondary diagnosis of International Statistical Classification of Disease (ICD-9-CA) and Abbreviated Injury Scale (AIS) codes and for the respective fractures. The ICD and AIS are the general classifications used in the Canadian Hospital system to document symptoms, diagnosis, problems, and any other related conditions needed by health care providers.

The selected patients were followed for one year from the occurrence of the injury by reviewing their QTR records, hospitalization data, and medical and pharmaceutical services. A one-year medical history before the event of the fracture has been sought in the

administrative database for every patient to adjust the statistical models and avoid confounding bias. The obtained data include age, sex, cause of injury, single or multiple fractures, clinical presentation, management of each patient, and complication of treatment (if any).

Source of data

In this study, the data collected from the Quebec Trauma Registry (QTR), Med-Echo hospitalization data, and medical and pharmaceutical services from the Régie de l'assurance maladie du Québec (RAMQ). The QTR is a regional trauma registry for the province of Quebec in Canada that was established in 1992 and has since collected data from 99 Quebec hospitals. The following documented data obtained from different health care centers for the patients who had visited or admitted to any hospital in Quebec due to facial trauma. These data include the patient's demographic information, including gender, age, and geographical region of residence. It also contains the case description, including the time of arrival to the hospital, length of stay, and discharge or admission information.

The data retained included age, gender, cause of fracture, date of admission and date of discharge, type of injury (including single or multiple fractures), length of stay in the hospital, complications, and follow up.

Inclusion criteria

To be included in the analysis, the patients were required to meet these criteria:

1. Age of 18 years or over
2. Male or female
3. Discovery of isolated facial or orbital injury due to any cause
4. Event between 1994 through 2002

Exclusion criteria

1. Death of the patient before completion of the treatment
2. Combined fractures
3. Age under 18 years excluded

Data analysis

Data collected during nine years from 1994 to 2002 were analyzed using IBM SPSS 21.0 program (SPSS, Inc, Chicago, IL). The analysis included calculating the prevalence of facial and orbital injuries for the patients who presented or admitted to one of the hospitals in Quebec. Descriptive characteristics of patients have been described as well as hospital management, length of hospital stay, type of fracture, type of treatment, and complications. For the categorical variables: (classes of age, gender, causes of injury, type of injury (including single or multiple fractures), complications, and death. A Chi-square test was used to assess the difference among categories. For continuous variables (age and length of

hospital stay), T-test and ANOVA were used to determine differences among groups. The assumptions of homogeneity of variances before doing T-test and ANOVA were tested with Levene's test. The analysis also included the association between the predictors and outcomes. We considered the age, gender, causes of trauma, and type of treatments as predictors and the mortality, complications, and length of stay are outcomes. The multivariate analyses were also done by logistic regression for mortality and linear regression for the length of hospital stay. In the first model, death was tested as a binominal dependent variable in a binominal regression. In the second model, the length of hospital stay was tested as a continuous variable in linear regression. In both models, the independent variables (predictors) are age (as continuous), gender (binominal), and causes of trauma (categorical). Type of treatment, coded in three categories (medical, surgical, and both), was also added in the model as a control variable.

Ethics

There is no contact with the patients required during this study. No identifying information on the patients is available. Because of its retrospective nature, follow-up with patients not required. The study had obtained ethics approval from the Montreal General Hospital, McGill University, and the University of Montreal as a part of a long-term program evaluation trauma causes in Quebec.

Results

Descriptive statistics of the patients

From 1994 through 2002, thirteen thousand three hundred ten patients (13,310) presented to one of the trauma centers in Quebec with a facial or orbital injury.

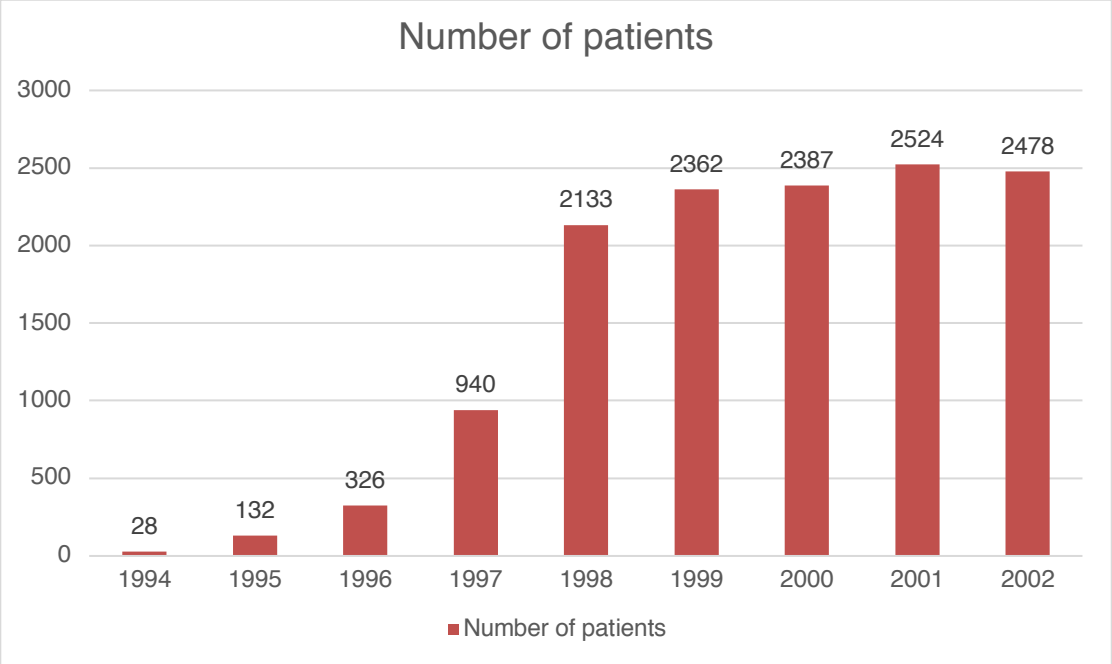
Overall, the majority of the patients were male in 8834 (66.5%), with a male-to-female ratio of 2:1. The highest prevalence of injuries for females occurs in the age category more than 75; the peak of injuries for males occurs in the 18-35 class of age. Table 1 shows the distribution of patients according to age and gender.

Table 1: Distribution of patients according to classes of age and gender

	Female		**Male**		**Total**	
Age category	**N.**	**%**	**N.**	**%**	**N. 13310**	**%**
18-≤35 years	913	20.4	3234	36.6	4147	32.8
>35-≤55 years	984	22.0	2948	33.4	3932	29.5
>55-≤65 years	441	9.9	1021	11.6	1462	11
>65-≤75 years	619	13.8	827	9.4	1446	10.9
>75 years	1518	33.9	803	9.1	2321	17.4
Total	4476	100	8834	100	13310	100.0

The number of patients doubled from 1997 to 1998, and since 1998, it has always been over 2000 cases (Figure 5). In 1998, MVC and falls increased, and this could explain the increases in patient numbers. In 1997, the increases in patient numbers were because at that time and after, trauma patients were transported or transferred to trauma centers that participated in the QTR.

Figure 5: Distribution of patients with facial and orbital trauma across years



Causes of facial trauma

The analysis showed that urban areas had a higher number of patients who had injuries compared to rural areas (70% vs. 30%). Motor vehicle collisions (MVC) were the most common cause of facial trauma that led to facial and orbital fractures. Overall, the three leading causes were motor vehicle collision, falls, and injury by blunt objects, respectively (Table 2). It showed that the prevalence of falls among women is higher than men with a statistically significant P-value of <0.001. It also showed that the prevalence of other causes of trauma is statically significant, as shown in Table 2.

Table 2: Causes of facial/orbital trauma according to gender

Causes of trauma	Female		Male		Total	
	N.	%	N.	%	N.	%
MVC	1975	44.1	4058	45.9	6033	45.3
Fall*	2214	49.5	2745	31.1	4959	37.3
Firearm*	9	0.2	93	1.1	102	0.8
White weapon*	18	0.4	79	0.9	97	0.7
Blunt object*	144	3.2	1129	12.8	1273	9.6
Cutting object*	11	0.2	94	1.1	105	0.8
Other*	105	2.3	636	7.2	741	5.6
Total	4476	100	8834	100	13310	100

*=p<0.05

The prevalence of falls among causes of facial trauma seems to increase according to age; on the contrary, the prevalence of facial injuries due to motor-vehicle collision appears to diminish. These are, respectively, the most common causes of facial traumas among the oldest and the youngest (Table 3).

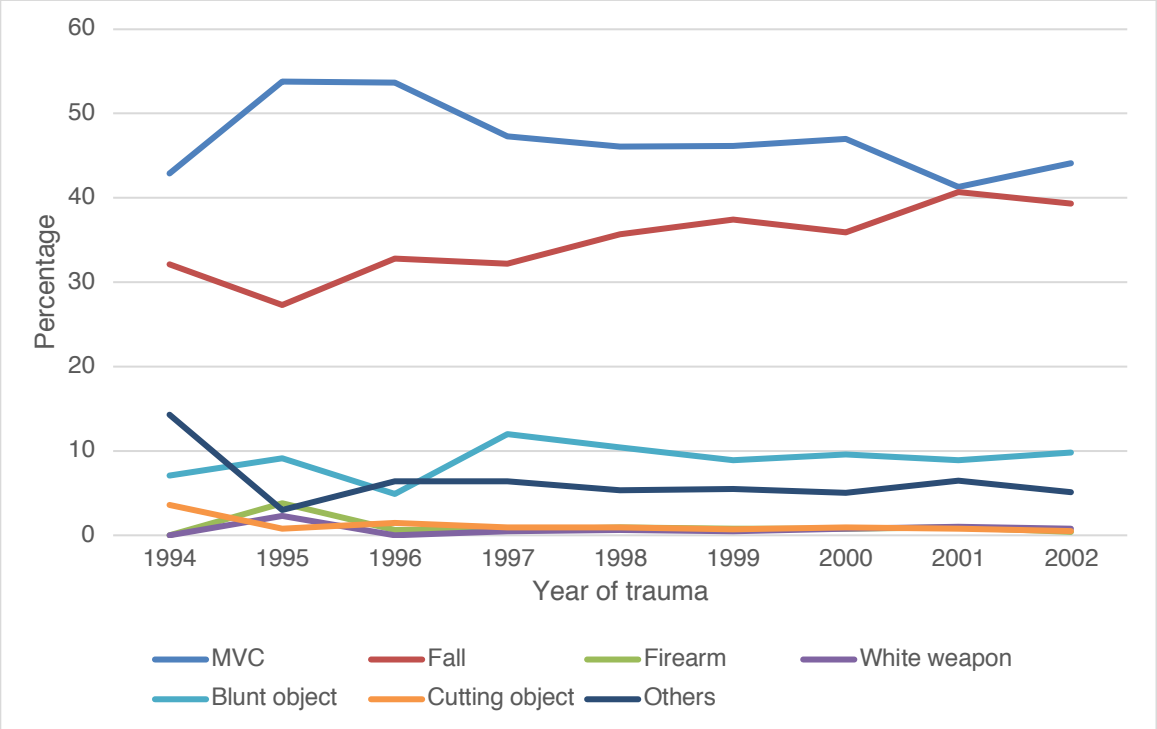
Table 3: Causes of facial trauma according to classes of age

Causes of trauma	18-≤35 years		>35-≤55 years		>55-≤65 years		>65-≤75 years		>75 years		Total	
	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
MVC*	2620	63.2	1947	49.5	565	38.6	487	33.7	414	17.8	6033	45.3
Fall*	521	12.6	1108	28.8	675	46.2	824	57.3	1831	78.9	4959	37.3
Firearm*	42	1.0	37	1.0	14	1.0	7	0.4	2	0.0	102	0.8
White weapon*	56	1.4	26	0.7	7	0.3	4	0.3	4	0.1	97	0.7
Blunt object*	575	13.9	481	12.1	112	7.7	73	5.0	32	1.4	1273	9.6
Cutting object*	45	1.1	43	1.0	12	0.7	4	0.3	4	0.0	105	0.8
Other*	289	7.0	291	7.3	77	5.3	47	3.3	47	1.7	741	5.6
Total	4149	100	3932	100	1292	100	1313	100	2157	100	13310	100

*=$p<0.05$

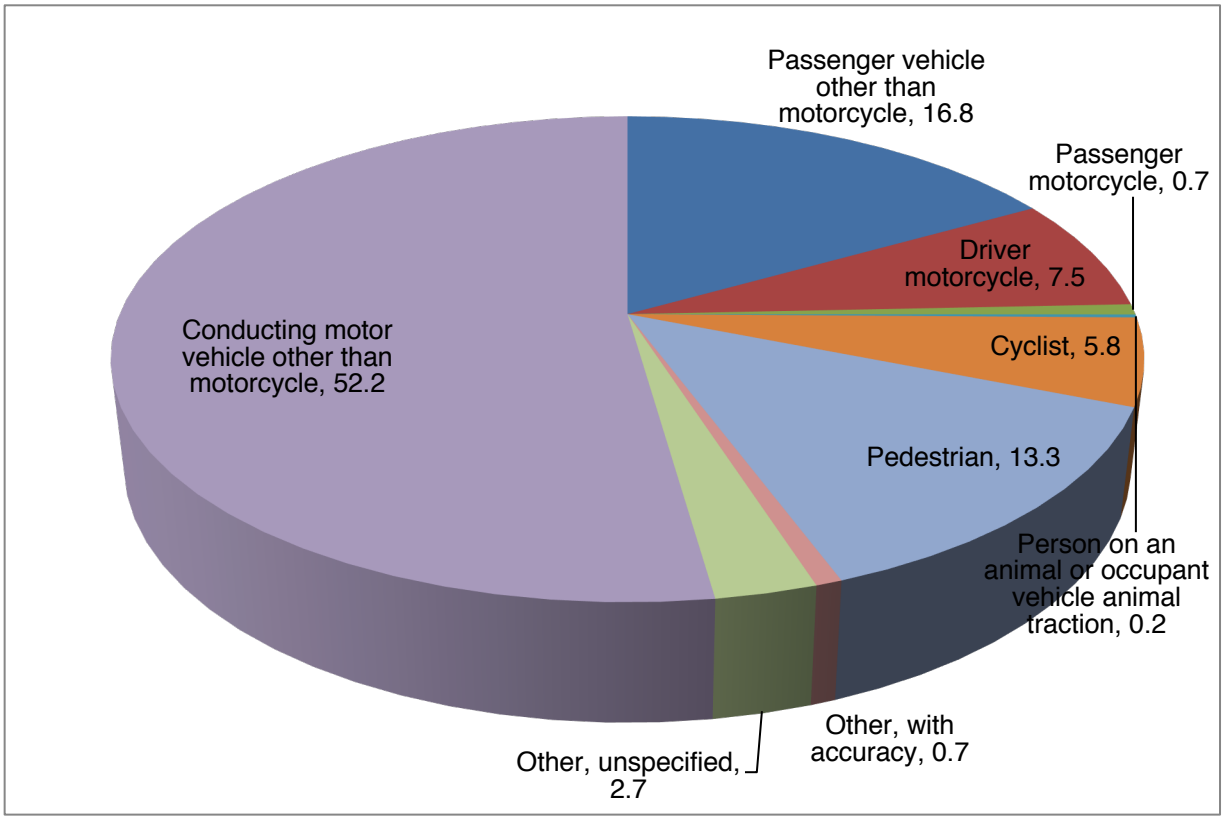
Figure 6 shows the trend of causes of facial trauma across time. It seems that MVC is decreasing across time by using more safety precautions and follow instructions, while facial injuries due to falls are increasing. Nevertheless, MVC has always been the primary cause of facial trauma.

Figure 6: Causes of facial trauma across years



Among motor vehicle collisions, the most frequent facial trauma was being a driver of a motor vehicle other than a motorcycle, which accounted for more than 50% of cases (Figure 7).

Figure 7: Causes of motor vehicle collisions (the values are in percentages)



Among the patients with facial traumas, 67.6% had head injuries.

Mortality rate

The mortality rates were 17.5% for female patients and 9.1% for male patients. The difference in mortality rate between females and the male patient is statistically significant, with a P-value of <0.001. Comparing the different causes of trauma, it seems that falls are the most common and frequent cause of death. 23.2% of the patients died. However, it should not be underestimated that the high prevalence of death in total because of it mostly due to the higher mortality rate in the older age category (Table 4).

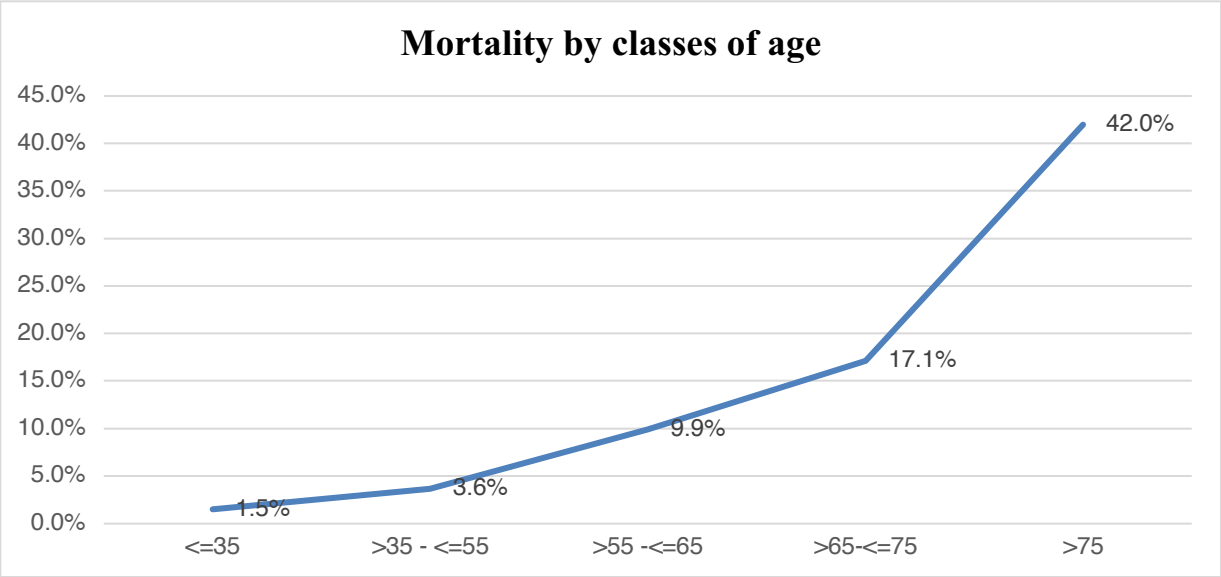
Table 4: **Mortality rate by causes and age of facial trauma**

	Causes of trauma	Death				
		Yes		No		Total
		N.	%	N.	%	N.
18-≤35 years						
	MVC	38	1,5%	2492	98,5%	2530
	Fall	5	1,0%	503	99,0%	508
	Firearm	2	4,8%	40	95,2%	42
	White weapon	2	3,6%	54	96,4%	56
	Blunt object	10	1,8%	558	98,2%	568
	Cutting object	1	2,2%	44	97,8%	45
	Others	2	0,7%	282	99,3%	284
>35-≤55 years						
	MVC	56	3,0%	1812	97,0%	1868
	Fall	51	4,7%	1024	95,3%	1075
	Firearm	1	2,8%	35	97,2%	36
	White weapon	0	0,0%	25	100,0%	25
	Blunt object	23	4,9%	449	95,1%	472
	Cutting object	0	0,0%	42	100,0%	42
	Others	7	2,5%	278	97,5%	285
	Total	138	3,5%	3667	96,4%	3805
>55-≤65 years						
	MVC	46	8,3%	505	91,7%	551
	Fall	72	10,9%	590	89,1%	662
	Firearm	2	14,3%	12	85,7%	14
	White weapon	2	28,6%	5	71,4%	7
	Blunt object	8	7,3%	102	92,7%	110
	Cutting object	2	16,7%	10	83,3%	12
	Others	10	13,2%	66	86,8%	76
	Total	142	9,9%	1290	90,1%	1432
>65-≤75 years						
	MVC	54	11,3%	425	88,7%	479
	Fall	169	20,8%	644	79,2%	813
	Firearm	2	28,6%	5	71,4%	7
	White weapon	0	0,0%	4	100,0%	4

	Blunt object	11	15,1%	62	84,9%	73
	Cutting object	0	0,0%	4	100,0%	4
	Others	8	17,0%	39	83,0%	47
	Total	244	17,1%	1183	82,9%	1427
>75 years						
	MVC	108	26,1%	306	73,9%	414
	Fall	835	45,6%	995	54,4%	1830
	Firearm	2	100,0%	0	0,0%	2
	White weapon	1	25,0%	3	75,0%	4
	Blunt object	13	40,6%	19	59,4%	32
	Cutting object	0	0,0%	1	100,0%	1
	Others	15	40,5%	22	59,5%	37
	Total	974	42,0%	1346	58,0%	2320
Total						
	MVC	302	5.2%	5542	94,8%	5844
	Fall	1132	23.2%	3756	76,8%	4888
	Firearm	9	8,9%	92	91,1%	101
	White weapon	5	5,2%	91	94,8%	96
	Blunt object	65	5,2%	1190	94,8%	1255
	Cutting object	3	2,9%	101	97,1%	104
	Others	42	5,8%	687	94,2%	729
	Total	1558	12%	11459	88,0%	13017

Moreover, mortality rates increase with older age of patients, as evident from Table 4 and Figure 8. This increase could be due to other causes, including comorbidities, which could explain the higher mortality rate in this group compared to younger patients.

Figure 8: Mortality rate by classes of age (the values are in percentages)



The number of people who died is significantly differencing across age ($p < 0.001$). While the death prevalence among those who are less or equal to 35 is 1.5, it goes to 42% in the class of age >75 (Figure 8).

There is a statistically significant difference comparing different types of treatment and mortality rates. Those who received just medical treatment have a higher rate of mortality (15.6%) in respect to those who received both treatments (mortality rate = 9.4%), and those who received just surgical treatment (mortality rate = 9.1%) with a P-value of <0.001.

Table 5: Mortality rate by causes of trauma

	Death					
Causes of trauma	**Yes n. 1558**		**No n.11459**		**Total n.13017**	
	N.	**%**	**N.**	**%**	**N.**	**%**
MVA*	302	5.2	5542	94.8	5844	100
Fall*	1132	23.2	3756	76.8	4888	100
Firearm	9	8.9	92	91.1	101	100
White weapon (knifes &blades) *	5	5.2	91	94.8	96	100
Blunt object*	65	5.2	1190	94.8	1255	100
Cutting object*	3	2.9	101	97.1	104	100
Other*	42	5.8	687	94.2	729	100
Total	1558	100	11459	100	13017	100

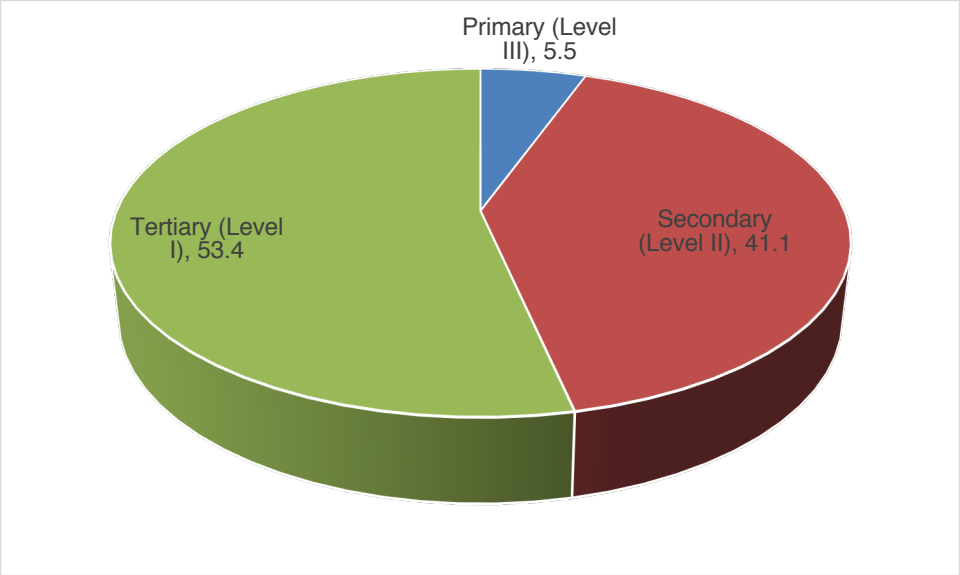
*=$p<0.05$

As shown in Table 5, some causes of trauma are more associated with death. It is statistically significant for MVA, falls, white weapons, blunt objects, cutting objects, and other injuries.

In-Hospital Management and Treatment

There were 8114 (61%) patients brought to the hospital by other methods, and 5169 (39%) patients were transported to the hospital by ambulance. Among those patients, 7108 (53.4%) presented to tertiary (Level I) centers, 5471 (41.1%) to secondary (Level II) centers, and 731 (5.5%) presented to a primary (Level III) center (figure 9).

Figure 9: Prevalence of access to hospital by the level of the hospital (the values are in percentages)



The minimum length of stay in the hospital was 0 days, and the maximum was 394 days, with a mean of 14.34 days (sd = 18.05). The length of stay increases with the age of patients (Table 6). The differences between the length of stay in the different groups are significant (P-value <0.001).

The length of stay in hospital is significantly different between females (mean= 15,8; sd 19,0), and men (mean 13,6; sd 17,5) with a p value <0.001.

Table 6: Length of stay by classes of age

Classes of age	Mean	s.d.	Min	Max
18-≤35 years	11.1	14.2	0	171
>35-≤55 years	12.9	16.9	0	369
>55-≤65 years	15.3	19.0	0	202
>65-≤75 years	17.1	20.2	0	315
>75 years	20.2	21.9	0	394

Trauma caused by firearms has the most extended length of stay mean (19.3 days), while injuries due to sharp objects have the shortest (6.2 days) (Table 7). The mean length of stay is significantly different across the different causes of trauma ($F= 44.246$, $P<0.001$).

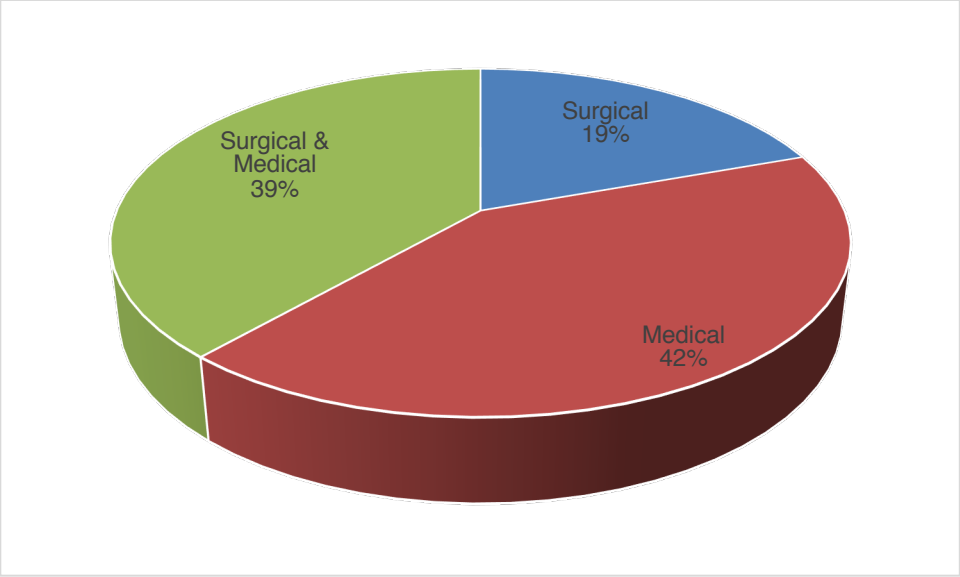
Table 7: Length of stay by causes of trauma

Causes of trauma	Mean	s.d.	Min	Max
MVC	15	18.2	0	369
Fall	15.9	19.5	0	394
Firearm	19.3	18.6	0	88
White weapon (Knifes &blades)	8.8	9.3	0	61
Blunt object	9.1	12.7	0	138
Cutting object	6.2	14.0	0	142
Others	8.7	12	0	134

The majority of patients (5593, 42%) required medical treatment, while 38.5% (n. 5121) needed both surgical and medical intervention (Figure 10).

There is no statistically significant difference concerning the length of stay and treatment received. The mean (in days) for those who underwent surgical procedures= 14.8 days, for those who received medical treatment= 14.1 days, and for those who received both treatments = 14.4 days with a P-value (p=0.269).

Figure 10: **Distribution of treatments**



The majority of patients who had facial trauma had no fractures (Table 8).

Table 8: Number of patients with facial trauma

	N.	%
No Fracture	8538	64.1
Single Fracture	2589	19.5
Multiple Fracture	2183	16.4
Total	13310	100.0

Complications

The total number of complications reported for patients admitted to the hospital was 2649. The most common complications in the hospital were urinary infections (34.5%) followed by pneumonia (32.1%), as evident in table 9.

Table 9: patient's complications

Complication*	N.	%
Renal insufficiency	75	2.8
Shock	53	2
Cardiac arrest	23	1
Myocardial Infarction	31	1.2
Coagulopathy	141	5.4
Lung Shock	95	3.6
Pulmonary embolism	63	2.4
Wound infection	188	7.5
Urinary infection	915	34.5
Pneumonia	850	32.1
Intra-abdominal abscess	14	0.5
Other abscesses	41	1.5
Empyema	12	0.5
Septicemia	143	5.4
Pseudo-septic syndrome	0	0
Fungal septicemia	5	0.2
Total	2649	

*In this table, the total represents the total number of complications and not patients. Patients could have had no complications or more than one.

Table 10: patient's complications by age category

	Age category					
Complications	**18- <=35 n.4148**	**>35 - <=55 n.3933**	**>55 -<=65 n.1462**	**>65-<=75 n.1446**	**>75 n.2321**	**Total n.13310**
Kidney failure*	13	19	10	15	17	74
	0.3%	0.5%	0.7%	1.0%	0.7%	0.6%
Shock	13	17	6	3	10	49
	0.3%	0.4%	0.4%	0.2%	0.4%	0.4%
Cardiac arrest	2	7	4	3	3	19
	0.0%	0.2%	0.3%	0.2%	0.1%	0.1%
Myocardial infarction*	0	1	6	7	17	31
	0.0%	0.0%	0.4%	0.5%	0.7%	0.2%
Coagulopathy	34	38	20	18	14	124
	0.8%	1.0%	1.4%	1.2%	0.6%	0.9%
Lung Shock	27	27	14	12	6	86
	0.7%	0.7%	1.0%	0.8%	0.3%	0.6%
Pulmonary embolism*	4	28	10	4	13	59
	0.1%	0.7%	0.7%	0.3%	0.6%	0.4%
Wound infection*	56	57	25	12	15	165
	1.4%	1.4%	1.7%	0.8%	0.6%	1.2%
Urinary infection	168	187	115	129	249	848
	4.1%	4.8%	7.9%	8.9%	10.7%	6.4%
Pneumonia	248	211	106	93	123	781
	6.0%	5.4%	7.3%	6.4%	5.3%	5.9%
Intra-abdominal abscess	7	4	1	0	0	12
	0.2%	0.1%	0.1%	0.0%	0.0%	0.1%
Other abscesses	11	15	5	3	2	36
	0.3%	0.4%	0.3%	0.2%	0.1%	0.3%
Empyema	4	3	2	1	1	11
	0.1%	0.1%	0.1%	0.1%	0.0%	0.1%
Septicemia	38	40	16	14	26	134
	0.9%	1.0%	1.1%	1.0%	1.1%	1.0%
Pseudo-septic syndrome	0	0	0	0	0	0
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Fungal septicemia	1	3	0	0	0	4
	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
Total	626	657	340	314	496	2433
	25.7%	27.0%	13.9%	12.9%	20.4%	100.0%

*=p<0.05

As shown in Table 10, for several complications, the number of people with complications is higher in older patients. It is statistically significant for kidney failure, myocardial infarction, pulmonary embolism, and wound infection.

Table 11: Patients' complications by gender

	Gender			
Complication	**Female n. 4476**		**Male n.8834**	
	N.	**%**	**N.**	**%**
Kidney insufficiency*	15	0.3	59	0.7
Shock	13	0.3	36	0.4
Cardiac arrest	6	0.1	13	0.1
Myocardial infarction	12	0.3	19	0.2
Coagulopathy	32	0.7	92	1.0
Lung Shock	23	0.5	63	0.7
Pulmonary embolism	20	0.4	39	0.4
Wound infection	46	1.0	119	1.3
Urinary infection*	454	10.1	394	4.5
Pneumonia*	176	3.9	605	6.8
Intra-abdominal abscess	3	0.1	9	0.1
Other abscesses	8	0.2	28	0.3
Empyema	3	0.1	8	0.1

Septicemia*	34	0.8	100	1.1
Pseudo-septic syndrome	0	0.0	0	0.0
Fungal septicemia	0	0.0	4	0.0
Total N=2433	845	34.7	1588	65.3

*=p<0.05

As shown in Table 11, some complications are associated with a specific gender. We find that males are more affected than females. The difference between males and females is statistically significant for kidney failure, urinary infection, pneumonia, and septicemia.

Table 12: Complications by causes of trauma

	Causes of trauma						
Complications	**MVA**	**Falls**	**Firearm**	**White weapon**	**Blunt object**	**Cutting object**	**Other**
Kidney insufficiency	38	27	0	1	4	1	3
% within trauma cause	0.6	0.5	0.0	1.0	0.3	1.0	0.4
Shock	28	9*	3*	3*	4	1	1
% within trauma cause	0.5	0.2	2.9	3.1	0.3	1.0	0.1
Cardiac arrest	9	6	2*	1*	1	0	0
% within trauma cause	0.1	0.1	2.0	1.0	0.1	0.0	0.0
Myocardial infarction	9	20*	0	0	2	0	0
% within trauma cause	0.1	0.4	0.0	0.0	0.2	0.0	0.0
Coagulopathy	81*	32*	4*	4*	3*	0	0
% within trauma cause	1.3	0.6	3.9	4.1	0.2	0.0	0.0
Pulmonary shock	59*	17*	1	2	3*	0	4
% within trauma cause	1.0	0.3	1.0	2.1	0.2	0.0	0.5
Pulmonary embolism	36*	19	0	0	4	0	0
% within trauma cause	0.6	0.4	0.0	0.0	0.3	0.0	0.0
Wound infection	116*	29*	3	1	9*	2	5
% within trauma cause	1.9	0.6	2.9	1.0	0.7	1.9	0.7

Urinary infection	411	388*	2*	5	26*	2*	14*
% within trauma cause	6.8	7.8	2.0	5.2	2.0	1.9	1.9
Pneumonia	437*	269*	9	5	36	0	25*
% within trauma cause	7.2	5.4	8.8	5.2	2.8	0.0	3.4
Intra-abdominal abscess	7	0	1*	2*	1	1*	0
% within trauma cause	0.1	0.0	1.0	2.1	0.1	0.1	0.0
Other abscesses	23	7*	3	0	2	1	0
% within trauma cause	0.4	0.1	2.9	0.0	0.2	1.0	0.0
Empyema	6	4	0	0	0	0	1
% within trauma cause	0.1	0.1	0.0	0.0	0.0	0.0	0.1
Septicemia	67	48	4	2	8	0	5
% within trauma cause	1.1	1.0	3.9	2.1	0.6	0.0	0.7
Pseudo-septicemia	0	0	0	0	0	0	0
% within trauma cause	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fungal septicemia	3	1	0	0	0	0	0
% within trauma cause	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*=$p<0.05$

In this table, we are reporting only those who had a definite complication among those who had trauma causes. For example, 38 cases in the first line, represent those who had kidney insufficiency and MVA. The percentages refer to the total number of positive trauma causes (i.e., among all the subjects who had MVA, 0.6% of them had kidney insufficiency). The results with a * are statistically significant ($p<0.05$); there is a statistically significant difference in having coagulopathy among those who had MVA and those who had not.

Table 13: Complications by the type of treatment

Complication	Type of treatment: Surgical		Medical		Both (surgical and medical treatments)	
	N.	**%**	**N.**	**%**	**N.**	**%**
Kidney insufficiency	15	20.3	32	43.2	27	36.5
% within treatment provided		0.6		0.6		0.5
Shock	12	24.5	17	34.7	20	40.8
% within treatment provided		0.5		0.3		0.4
Cardiac arrest	4	21.1	5	26.3	10	52.6
% within treatment provided		0.2		0.1		0.2
Myocardial infarction	7	22.6	10	32.3	14	45.2
% within treatment provided		0.3		0.2		0.3
Coagulopathy*	28	22.6	20	16.1	76	61.3
% within treatment provided		1.1		0.4		1.5
Pulmonary shock	23	26.7	26	30.2	37	43.0
% within treatment provided		0.9		0.5		0.7
Pulmonary embolism*	17	28.8	15	25.4	27	45.8
% within treatment provided		0.7		0.3		0.5
Wound infection*	71	43.0	28	17	66	40.0
% within treatment provided		2.7		0.5		1.3
Urinary infection*	209	24.6	297	35.0	342	40.3
% within treatment provided		8.1		5.3		6.7
Pneumonia*	214	27.4	300	38.4	267	34.2
% within treatment provided		8.2		5.4		5.2
Intra-abdominal abscess*	5	27.4	6	50.0	1	8.3
% within treatment provided		0.2		0.1		0.0
Other abscesses	3	8.3	15	41.7	18	50.0
% within treatment provided		0.1		0.3		0.4
Empyema	2	18.2	5	45.5	4	36.4
% within treatment provided		0.1		0.1		0.1
Septicemia*	40	29.9	33	24.6	61	45.5
% within treatment provided		1.5		0.6		1.2
Pseudo-septicemia	0	0.0	0	0.0	0	0.0
% within treatment provided		0.0		0.0		0.0
Fungal septicemia*	3	75.0	0	0.0	1	25
% within treatment provided		0.1		0.0		0.0

*=$p<0.05$

This table shows that the type of treatment is associated with a higher prevalence of some complications. It is statistically significant for coagulopathy, pulmonary embolism, wound infection, urinary infection, pneumonia, and septicemia.

Multivariate analysis

Table 14: Logistic Regression for Death (Mortality)

							95% C.I. for EXP(B)	
	B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
Age	0.073	0.002	1074.270	1	0.000	1.076	1.071	1.080
Gender	0.362	0.067	28.842	1	0.000	1.436	1.258	1.638
MVA	-0.200	0.183	1.196	1	0.274	0.818	0.572	1.172
Fall	0.353	0.179	3.921	1	0.048	1.424	1.004	2.021
Firearm	0.602	0.417	2.086	1	0.149	1.826	0.806	4.135
White weapon	0.358	0.522	0.469	1	0.494	1.430	0.514	3.980
Blunt object	0.162	0.219	0.550	1	0.458	1.176	0.766	1.805
Cutting object	-0.330	0.628	0.275	1	0.600	0.719	0.210	2.464
Treatment type	-0.151	0.055	7.433	1	0.006	0.860	0.771	0.958
Constant	-6.910	0.260	708.795	1	0.000	0.001		

First model interpretation: The odds ratio of having a death increase of 8% increasing age of one year (OR=1.08, CI 1.07-1.08), the odds ratio of having a mortality rate is higher for males than for females (OR 1.44; CI 1.26-1.64). The model was adjusted for causes of trauma and treatment provided.

Table 15: Linear Regression for Length of stay

	Unstandardized Coefficients		Standardized Coefficients			95,0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	0.252	0.724		0.348	0.727	-1.168	1.673
Age	0.150	0.008	0.180	18.333	0.000	0.134	0.166
Gender	0.367	0.333	0.010	1.104	0.270	-0.285	1.020
Treatment provided	-4.497	0.248	-0.184	-18.114	0.000	-4.984	-4.011
Fall	-1.661	0.370	-0.044	-4.483	0.000	-2.387	-0.934
Firearm	3.856	1.703	0.019	2.264	0.024	0.517	7.194
White weapon	-4.420	1.746	-0.021	-2.532	0.011	-7.842	-0.998
Blunt object	-4.133	0.533	-0.067	-7.753	0.000	-5.178	-3.088
Cutting object	-6.144	1.681	-0.030	-3.655	0.000	-9.439	-2.849
Other trauma	-4.516	0.669	-0.057	-6.751	0.000	-5.826	-3.205

Age has a significant impact on the length of stay. For a 1-year increase in the age of trauma, length of stay increases of 0.15 days (B coefficient=0.15, C.I.: 0.13-0.17).

The firearm injury is associated with a higher length of hospital stay. While falls, white weapons, blunt objects, cutting objects, and other trauma are associated with a lower length of hospital stay.

Discussion

This study reports the number of facial and orbital injuries observed in the province of Quebec between 1994 and 2002. These estimates will help the clinician, health provider, policy manufacturer, and planner in the health systems to know the burden and issues with facial and orbital fractures secondary to facial trauma, especially in Quebec province. This study will help to evaluate and develop a management program to help the people in Quebec and the Canadian in general.

In this study, we found that the three most common causes of facial injuries in Quebec are motor vehicle collision (MVC) (45.5%), falls (36.9%), and trauma by blunt objects (6.9%). Motor vehicle collision and falls are the leading cause of facial injury, which lead to facial and orbital fractures.

The facial and orbital injuries occurred more frequently in younger age (18-35) compared to older individuals. Increasing the risk of a motor vehicle collision in younger ages and not using the seat belt while driving could explain this observation.

On the other hand, the male gender was also a significant risk factor for facial and orbital trauma. This result is supported by previously published data in the literature, which is consistent with the same effect of a higher male incident of specifically facial and orbital injuries (6, 16, 74-78). The higher rate of MVA and falls in the males compared to females could be explained by that male patients usually report the incidence. Also, this result could be interpreted as it was mentioned in the literature that MVA and falls are more frequent in

males (22). There are some studies they correlated the high number of MVA and falls due to several smokers and alcoholic in men compared to women (22).

The results of Epidemiological studies tend to vary with socioeconomic status, geographic region, culture, type of centers were patients treated, and era in time (10, 39). Most studies in the literature conclude that male gender relatively consistent finding in almost all the studies (38-40, 79-81). Most studies show that females have a lower incidence of facial and orbital trauma. In our study, the male to female ratio is 2:1. This ratio is almost similar to the reported rate from other countries (74:26 in the United States, 75: 25 in England, France, and the middle east) (20, 82).

The age of the majority of the patients ranged from 18 and 35 years. The incidence of the injuries increased from 1994 to 2002 and almost the same in those four years (1999 until 2002) compared to 1994 until 1997 (Figure and Table 6). Many studies reported similar results regarding age (11, 83-85). The could be explained that younger individuals have a high tendency to drive cars carelessly, involved in a risky exercise and sports, and do more violence (86). There is more susceptibility of an accident with a higher rate of mobility, which can lead to a high rate of facial and orbital injuries (10, 46).

Motor vehicle accidents, falls, sports, assaults, industrial accidents, and hard objects commonly cause facial and orbital injuries. In our study, a motor vehicle accident was the most common cause of facial and orbital injuries in Quebec, which account for 45.5% of the cause of fractures. The fall is the second cause of facial injury in Quebec, which

accounts for 36.9 % of the causes of facial and orbital injuries. The third most common cause is injuries caused by blunt objects accounts for 9.6%.

Analysis in Scotland from 1977 to 1985 showed that fall was the second most common cause of facial fractures after the assault (81). In Japan, they reported that the most common cause of facial fracture was traffic accidents and accidental falls (87). The traffic car accidents remain a significant cause of facial and orbital fractures in the united states and England, which accounted for 40% and 24.7%, respectively (39, 88). In France, the most common cause of facial and orbital fractures is a motor vehicle accident, which accounted for 48% (89). In African studies, motor vehicle accidents remain the most common cause of facial and orbital fractures with a progressive reduction in the last 20 years. The second common cause of fracture is Assault, whereas falls and sports accidents were more sporadic causes of fractures. In Asia, the leading cause of fractures remains motor vehicle accidents, which account for 40-45 %, followed by an assault, which mentioned in 2 studies as an essential cause of fractures (57, 58). In North America and Brazil, the motor vehicle accident is the most common cause in almost all studies, and the number remained stable. Assault is the second most common cause of the fracture and is still progressing. In Europe, the car accident remains the most common cause of fractures in most of the studies followed by Assaults described in 5 reviews as a primary cause of fractures. Finally, in Oceania, the assaults were the most common cause of fractures, followed by car accidents. The male to female ratio is 4:1 (20).

Using more precaution and legislative measures, including using seat belts and a reduction in drunk driving, has significantly decreased the incidence of facial and orbital fractures. Also, enforcement of legislation about crash helmets, speed control, restrictions about drunk driving, the use of surveillance cameras in the streets, and the development of other transportation, can reduce the number of MVC (90, 91).

The incidence and causes of facial and orbital fractures vary from country to country due to cultural, social, environmental factors (38). A successful preventing facial and orbital fracture requires the application of precaution and prevention measurements.

In North America, this type of fractures treated by multiple different specialty services. So, there may be bias in the reports of aetiologies.

In the last 20 years, the management of facial trauma has evolved and changed by the development of new materials and technology (92). Also, treatment varies from surgeon to surgeon and sometimes depends on the available material (93). Our study showed that the majority of the patients treated with medical therapy (42%), surgical treatment (19%), or both treatments (39%). It also showed that the most common complications are infection and pneumonia. This result is similar to the previous studies in facial and orbital trauma (47).

There are a few reported data from Ontario, Canada, and there is none from Quebec. This study presents the prevalence, patient demographics, single or multiple injuries, management, and treatment complications.

Our finding has implications and supports the previous studies in the epidemiology of this type of fractures.

Limitation

One of the limitations of this study is in a retrospective format. These databases are deficient and lack of some factors like substance abuse, alcohol use. Another limitation could be an error in coding the fracture by different hospitals and the emergency department in Quebec. The number of complications was also one of the limitations because we do not have the exact number of patients who had complications. Finally, the data reported are almost 20 years old. However, the result of this study can be used as a bench-mark to support the most recent data; with respect to patient profiles and outcomes.

Summary and Conclusion

Orbital and facial fractures are prevalent in Quebec. Most fractures are moderate to severe and survival.

The results of this study compared to similar studies from different published data in the literature supported that the prevalence and causes of fractures vary from country to country.

This study stressed the health impression of facial and orbital fractures, offering Quebec agencies an essential epidemiological data, which is necessary to optimize and create protective measures to minimize and help the Canadian, especially in Quebec, from facial trauma and associated injuries. Future direction will be to develop prevention programs and strategies targeted at the high-risk group, including younger ages, mainly male.

Applying this type of study will help in the future to create a prevention program to prevent and minimize facial and orbital trauma. This study will also lead to a focus on the people with high risk like a young male, which should be a priority in public health programs.

In the end, this is nine years retrospective observational study described the detailed information about the patients who visit or admitted to one of the hospitals in Quebec, and the only conducted research in Quebec, Canada.

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