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## Maxillofacial Fractures in the Province of Terni (Umbria, Italy) in the Last 11 Years: Impact of COVID-19 Pandemic

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**Abstract:** The main purpose of this retrospective study is to analyze the main causes and the main anatomical structures involved in maxillofacial traumas in the province of Terni, Umbria. From January 2009 to July 2021, 603 patients were

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admitted with a maxillofacial trauma diagnosis and underwent surgery at “Santa Maria Hospital” in Terni, Italy. The collected data included sex, age, nationality, cause of trauma, type of fractures, comorbidities, clinical signs, symptoms, date of admission, and date of discharge from the hospital. Causes were divided into 5 categories: road traffic accidents, accidental falls, physical assault, sport accidents, and occupational injuries. Men were more involved than women, with a male:female ratio of 325:1. The mean age of the population was 41.7 years. The main cause of trauma were road traffic accidents (36%), followed by accidental falls (27%), an increasing phenomenon during the current SARS-CoV-2 global pandemic. The orbital floor was the most fractured anatomical site, followed by zygoma and nasal bones.

**Key Words:** Blow-out, facial injuries, maxillofacial fractures, maxillofacial trauma, trauma epidemiology, zygoma

In traumatology, a large proportion of the cases consists in maxillofacial fractures. The etiology depends on geographic area, population density, socioeconomic situation, cultural differences and lifestyle choices.<sup>1,2</sup> The large number of variables involved makes it difficult to determine an exact percentage of maxillofacial injuries in traumatology, even though the high incidence is universally acknowledged.

It can be associated with multiple injuries to the chest, cervical spine, abdomen, extremities, and cranium, that carries the significant potential for mortality and neurologic morbidity especially in young adults.<sup>3</sup>

The management of cranio-maxillofacial trauma includes treatment of facial bone fractures, dentoalveolar trauma, and soft tissue injuries, as well as associated injuries, mainly of the head and neck.<sup>4</sup> Alteration of the facial features of an individual may have functional, psychological, social and, not least, professional consequences, difficult to reverse over time. In this context, the management of maxillofacial fractures can be complex, involving a multidisciplinary approach and high costs.<sup>5</sup>

The distribution of fracture sites seems to be influenced by the cause of the injury, which is influenced by age, geographic location, local behavior, and socioeconomic trends.<sup>6,7</sup> Young adults, as they are physically and socially active, have a greater risk of being injured in motor vehicle accidents, assaults, and sports activities, whereas facial trauma in elderly patients is commonly associated to age-related changes and systemic pathologic conditions. However, increasing longevity and more active lifestyles lead to an increased frequency of maxillofacial injury in elderly population.<sup>8</sup>

In Europe the etiology, epidemiology and severity of maxillofacial fractures have been deeply analyzed over the last 2 decades,<sup>9</sup> while in the last few years, Italy has shown a larger interest in the study of maxillofacial fractures, in order to fully understand the etiology and to prevent these accidents.<sup>1,2,10,11</sup>

From January 2020 to January 2022, 10,953,342 people were diagnosed with COVID-19 and 745,354 people died.<sup>12</sup> The SARS-CoV-2 outbreak led to a national lockdown in Italy from March 9, 2020, to May 4, 2020, with further restriction in December 2020 and January 2021. All the outdoors activities were forbidden except for those activities that were strictly necessary for guaranteeing the nation's primary needs. During this period, most of the surgical activities (especially in maxillofacial units) were suspended to allow the hospital staff to be used in COVID-19 and as a form of prevention of the spreading of the SARS-CoV-2 outbreak.<sup>13</sup> Furthermore, a lot of patients decided not to get access to medical care due of the fear of being contracted

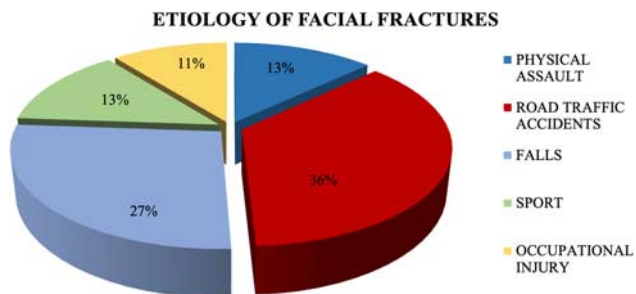


FIGURE 1. The chart shows the etiology of maxillofacial fractures, divided in: road traffic accidents, accidental falls, physical assault, and occupational injury.

with SARS-CoV-2 in the hospital environment.<sup>14</sup> The strict containment measures led to a peak of psychological and psychiatric disorders, like depression, panic attacks, suicide attempts and anxiety, especially in the younger portion of the population.<sup>15</sup> During the current SARS-CoV-2 pandemic, a slight change in the recurrence of maxillofacial injuries happened all over the world, especially during lockdown: the number of trauma referrals for dog-bites reduced—due to confinement at home; maxillofacial fractures related to self-harm increased, potentially reflecting the exacerbating nature of heightened social anxiety and the interruption to regular mental health services.<sup>16,17</sup>

This is the first epidemiologic study of maxillofacial fractures in Umbria, Italy, and one of few studies analyzing the impact of the COVID-19 pandemic on the epidemiology of maxillofacial

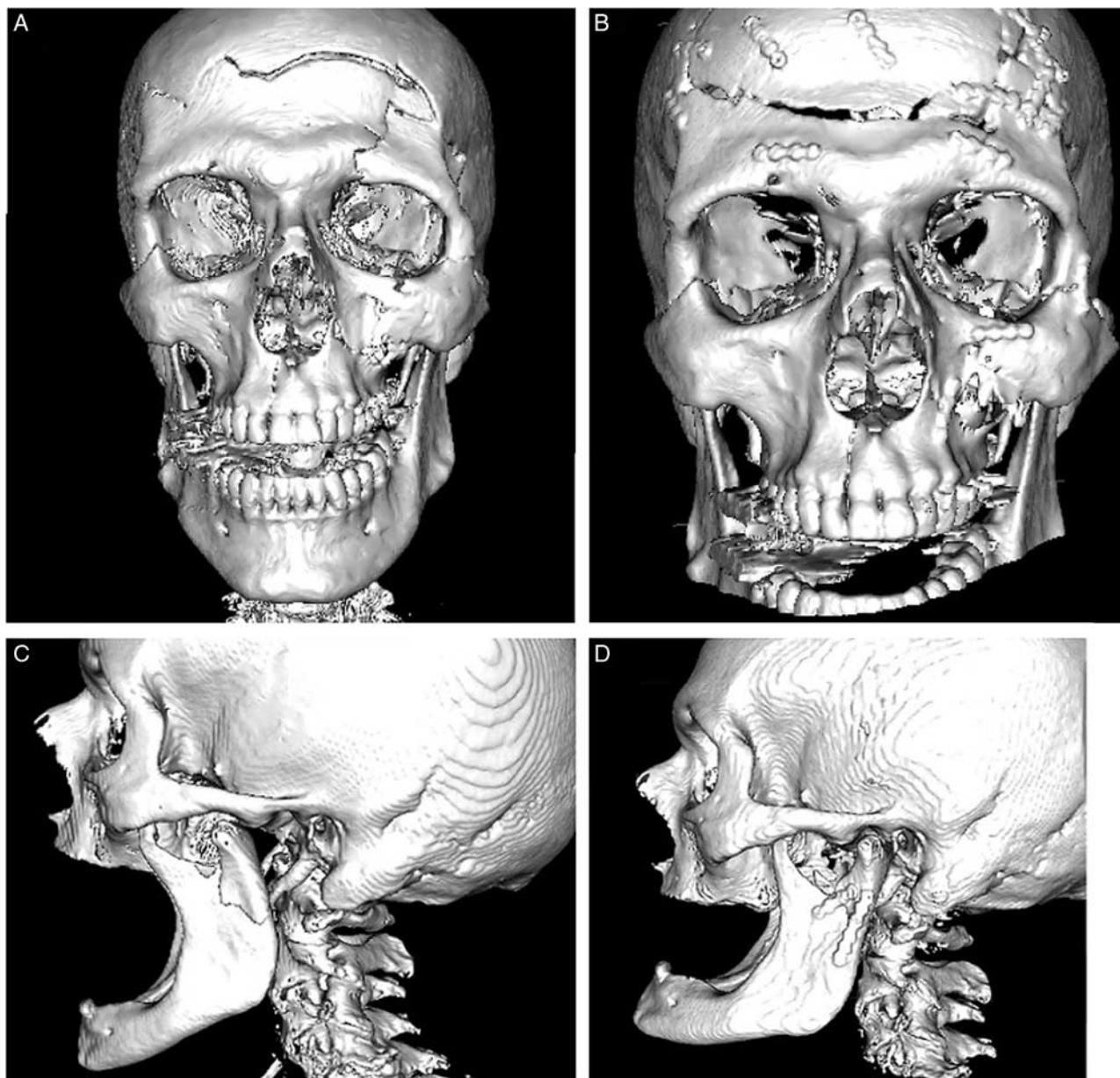


FIGURE 2. (A and B) Three-dimensional computed tomography preop and postop of a young male patient with a frontal fracture and a dislased left zygomatic after a fall. (C and D) Three-dimensional computed tomography preop and postop of an edentulous male patient with a left dislaced and dislocated subcondylar fracture.

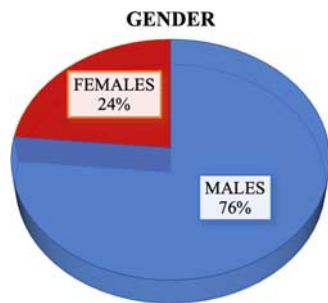


FIGURE 3. The chart shows the gender distribution of maxillofacial fractures in the province of Terni (Umbria, Italy) from January 2009 to July 2021.

traumas.<sup>16,18–24</sup> Umbria has 870,165 inhabitants,<sup>25</sup> an area of 8,456 km<sup>2</sup> and borders Lazio, Tuscany and Marche. It is well known for its picturesque medieval villages (like Gubbio and Assisi, the town of Saint Francesco) that attract tourism, mainly for religious purposes.

The main goal of this retrospective study is to analyze the maxillofacial injuries treated in a time span of 11 years (from 2009 to 2021) in “Santa Maria Hospital” in Terni, with a close eye on age, sex, fracture pattern, and surgical treatment and if SARS-CoV-2 pandemic changed the epidemiology and etiology of maxillofacial injuries. The authors discovered that the restriction of outdoor activities led to a decrease of maxillofacial traumas related to physical activities and road traffic accidents, reflecting a world-wide pattern. The Authors highlight the role of a smart working and distance learning regimen in reducing maxillofacial traumas, meanwhile the limitation of sports that involved physical contact led to a decrease of sport-related injuries.

### MATERIALS AND METHODS

From January 2009 to July 2021, 641 patients were admitted with maxillofacial fracture diagnosis at “Santa Maria Hospital” of Terni and underwent surgery. In all, 603 of them (94,1%) were included in this study; 38 of them were not included in the study because they did not fit the criteria (5.9%). Seven of them underwent a second surgery to remove fixation devices used in the first surgery (2 cases) or to resolve surgical complications (5 cases). One of the patients deceased due to the severity of the multiorgan injuries.

The authors collected data from the hospital’s medical records. These data included: sex, age, nationality, medical co-

morbidities, cause of trauma, type of fracture, symptoms, clinical signs, radiological exams, date of admission at the hospital, date of surgery, and date of discharge.

The number of days of presurgical and postsurgical hospitalization were analyzed in order to properly estimate the costs for National Health System. Some cases of maxillofacial fractures underwent a delayed treatment. The main reason behind therapeutical choice was the need to control internal bleeding and to ensure a patent airway.

The authors divided the patients in 8 age groups: patients under 15 years old, 15 to 24 years old, 25 to 34 years old, 35 to 44 years old, 45 to 54 years old, 55 to 64 years old, 65 to 74 years old, and over 75 years old (Fig. 1).

Six causes of trauma were considered: road traffic accidents, physical assault, accidental fall, work injuries, sports injuries, and other unspecified causes.

Fractures were classified in: zygomatic fractures (with a subcategorization in zygomatic arc fracture and zygomatic body fracture), maxillary fractures (using the Le Fort system), medial orbital wall fractures, blow-out fractures, nasal bones fractures, frontal bone fractures, and mandibular fractures (subcategorized basing on the involved anatomical structure: condyle, coronoid process, angle, ramus, body, and symphysis). Isolated nasal bones fractures were not included in the study because their surgical treatment is performed by otolaryngologists.

Zygomatic fractures were treated with a lower eyelid or transconjunctival and eyebrow approach, with a maxillary vestibular incision when needed. Plates and screws were used for the fixation. In case of isolated zygomatic arc fractures, a temporal approach was performed. The bone fragment is then repositioned through a zygoma elevator. Le Fort I fractures were approached with a maxillary vestibular incision from 1.6 to 2.6. The fracture was then exposed and fixated with Ø 1.5 diameter plates and screws. An intraoperative intermaxillary fixation was used when needed. Le Fort II fractures were approached with a maxillary vestibular and lower eyelid incision in order to achieve a better control of the fracture. The fragments were then fixated with Ø 2.0 or Ø 1.5 plates and screws. Intraoperative intermaxillary fixation was performed and then removed at the end of the surgery.

Medial orbital wall fractures were approached with transconjunctival incision and replacement of the displaced fragments. When this type of reconstruction was not easy to manage, a reconstruction with a collagen or bone membrane was performed. Orbital floor fractures were approached with a transconjunctival or, less frequently, a lower eyelid incision

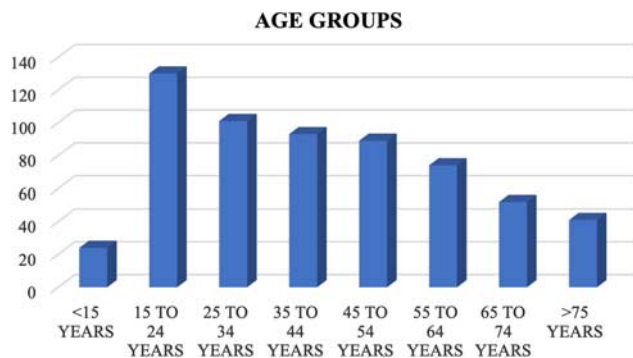


FIGURE 4. The chart shows the age distribution of maxillofacial fractures, divided in: under 15 years old, 15 to 24 years old, 25 to 34 years old, 35 to 44 years old, 45 to 54 years old, 55 to 64 years old, 65 to 74 years old, and over 75 years old.

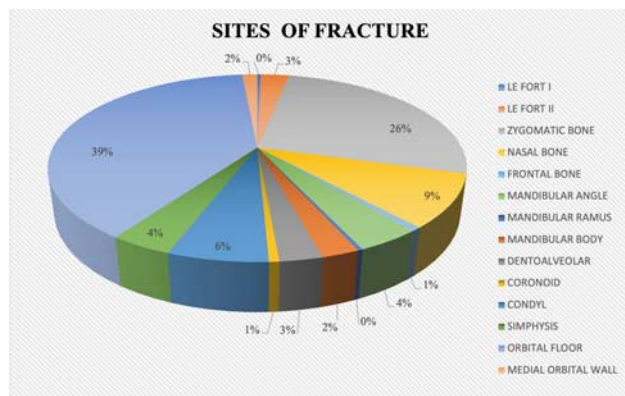


FIGURE 5. The chart shows the pattern of maxillofacial fractures.

followed by reconstruction with a collagen membrane. When the fracture was too big to be managed with this technique, a titanium mesh was placed with fixation to surrounding orbital rims, in order to achieve an adequate reconstruction.

Frontal bone fractures were approached with a coronal incision and reconstruction with plates and screws or a titanium mesh, based on the extent of the fracture (Figs. 2A, B). A frontal approach through a previous frontal wound is rarely used, mainly because of the unattractive result of the scar: usually the wound is not big enough to provide an adequate exposure of the fracture, therefore is often necessary an extension that results in a deforming scar.

Mandibular fractures were fixated with 2.0 plates and screws after an intraoperative intermaxillary fixation. The intermaxillary fixation was removed at the end of the surgery. A minimum of 2 plates were used, with at least 4 holes. Spiessl and Schroll classification was used to subcategorize condylar fractures. The main goal in condylar fractures was restoring mandibular height and mandibular functionality. Condylar fractures were treated with a preauricular pretragic approach, with open reduction and rigid fixation with plates and screws (Figs. 2C, D). Otherwise, an external fixator was used, with a pin applied on the condylar neck and a second pin applied on the mandibular angle after a transcuteaneous approach.<sup>26,27</sup> While all maxillofacial fractures undergo standard treatments, condylar fractures can be treated with intermaxillary fixation only. This approach can lead to an important loss of function during chewing movements.

This study respects the principles of the Declaration of Helsinki and was approved by the “Santa Maria Hospital” Ethical Committee (TRAUMAX).

## RESULTS

A large proportion of the population suffers maxillofacial injuries. From January 2009 to July 2021, 603 patients underwent maxillofacial surgery after a craniomaxillofacial injury in “Santa Maria Hospital” in Terni. Among these patients, 461 were males (76.4%) and 142 were females (23.6%) (Fig. 3). The mean age of population was 41.7 years (mean age for males: 38.8 y; mean age for females: 47.9 y). Men were more involved in maxillofacial fractures than women, with a male:female ratio of 3.25:1. The main causes of maxillofacial trauma among our patients were road traffic accidents (218 cases, 36%), followed by accidental falls (161 cases, 27%), sports (80 cases, 13%), physical assault (80 cases, 13%) and occupational causes (65 cases, 11%) (Fig. 4). The orbital floor was the most frequent facial bone involved in maxillofacial fractures (39%), followed by zygomatic bone (26%), mandible (20%: condylar process 6%, symphysis 4%, angle 4%, body 2%, coronoid process 1%), and nasal bone (9%) (Fig. 5, Supplementary Table 1, Supplemental Digital Content 1, <http://links.lww.com/SCS/E175>). A large proportion of zygomatic fractures were associated with orbital floor fractures, maxillary fractures, and nasal fractures. During 2020, only 25 patients were admitted with a maxillofacial fracture diagnosis. Among them, 11 patients (44%) suffered maxillofacial injury after an accidental fall, usually in the household; 9 patients underwent maxillofacial surgery after a road traffic accident (36%), 2 after an episode of physical assault (8%), 2 after a sport-related accident (8%), and only 1 patient after an occupational injury (4%).

## DISCUSSION

Maxillofacial fractures are a common injury in general population. They can occur isolated or associated with other in-

juries, like abdominal, chest, and head injuries. Trauma is the leading cause of death in the first 40 years of life. In addition, traumatic injury has been identified as the leading cause of lost productivity, causing more loss of working years than heart disease and cancer combined.<sup>28</sup>

Road traffic accidents are the main cause of maxillofacial injuries, followed by accidental falls. Among road traffic accidents, motorcycle, and bicycle accident are the most dangerous, due to the lack of protection of the maxillofacial region. It reflects a pattern shown in several studies in different countries, both in Europe<sup>29,30</sup> and in other continents, like China,<sup>31</sup> United Kingdom,<sup>32</sup> and Brazil.<sup>33</sup>

Males are exposed to a higher risk of maxillofacial traumas, especially in the third and fourth decade, because these decades represent the main period of activity in people's lives. Females are more involved in maxillofacial injuries after the sixth decade. The main cause of fractures in this age span are accidental falls, because of the fragility of the bone after menopause. During the current SARS-Cov-2 pandemic, the authors highlighted a reduced number of patients admitted with a maxillofacial fracture diagnosis (only 25 cases), a slight increase of the mean age of patients (42.1 versus 41.7 y) and an increased ratio of maxillofacial traumas caused by accidental falls (11 cases, 44%). This occurrence is explained by national lockdown, that limited all the outdoor activities. During the national lockdown (from March 9, 2020, to May 4, 2020), only 4 patients (3 males and 1 female) were admitted with maxillofacial injuries at “Santa Maria Hospital” in Terni. One of the maxillofacial fractures (a blowout fracture in a 60-year-old man) was due to a road traffic accident, 1 (a nasal fracture in a 16-year-old male) was due to an accidental fall, 1 (a dentoalveolar fracture in a young female patient) was due to a work-related accident and the last 1 (a mandibular fracture in a 20-year-old male) was due to a physical assault. In the first 7 months of 2021, 21 patients were treated for maxillofacial fractures. Most of them were male patients (16 patients, 76.2%), while only 5 patients were females (23.8%). The primary cause of maxillofacial fractures in the first 7 months of 2021 were accidental falls (9 cases), followed by physical assault (5 cases), road traffic accidents (4 cases), sport-related accidents (2 cases), and work-related injuries (1 case). The main reason of the increased number of maxillofacial injuries between January and July 2021 is ascribable to the loosening of national restriction, thanks to a general decrease of the SARS-CoV-2 outbreak and the drop of hospitalization in ICU all over the country, thanks to the vaccines against SARS-CoV-2, that first arrived in Italy on December 31, 2020.

The few Italian studies published in literature in the last 10 years<sup>1,10,11,34</sup> show a recurring pattern all over both in northern and southern Italy, with an increasing rate of maxillofacial fractures due to road traffic accidents in southern regions of the country. This can be caused by a general tendency to violate road traffic rules.

In 2014, in Italy, a total amount of 177,031 road traffic accidents, that lead to the death of 3,381 people (within the 30th day) and the injury of 251,147 people. The most serious and life-threatening accident occurred on highways (4.63 deaths every 100 accidents), while the death rate increases in accidents on urban roads (+5.4%).<sup>20</sup> On a national level, measures were taken to prevent road traffic accidents and, consequently, reduce the rate of maxillofacial fractures in conjunction with brain injuries: since 2006, it is mandatory to wear a seat belt, both on the front seats and the back seats; since 2002 it is mandatory for new cars to be equipped with airbags; since 2000 it is mandatory to wear a helmet while driving a motorcycle (an

improvement of a previous law promulgated in 1986). Despite these measures, road traffic accidents are still the major cause of death and life-threatening trauma. It is important to strengthen the penalties for road accidents, even if they do not lead to death (in 2016 a law was promulgated on street murder, which included reinforced penalties for people who cause accidents that lead to death while drunk driving or driving under the effects of drugs). Despite the epidemiological evidence coming from this study, it is important to highlight how a correct and constant use of protection devices and a more rooted anti-violence culture can prevent most of the maxillofacial injuries. Even though smart working and social distancing helped in the decrease of road traffic accidents, it has led to several psychological consequences. As these measures cannot be permanent, it is important to educate the population (especially young-aged) in order to prevent road traffic accidents.

The effect of the incidence of maxillofacial injuries on this cost it is calculated to be around 160 million euros. Most patients with such injuries undergo hospitalization and subsequent rehabilitation, and considerable resources are needed for treatment, thus placing an enormous burden on the health care system.<sup>1</sup> A constant study on maxillofacial injuries offers a continuous update on the main causes of trauma and can be an excellent indicator of how national measures work.

## CONCLUSION

This study shows that the main cause of maxillofacial injuries in Terni, Italy, are road traffic accidents. Men are more involved than women in the early stages of life, while women were more involved in the elder age, due to accidental falls and increased fragility of bones caused by menopause.

The severity and complexity of facial trauma not only requires interdisciplinary co-operation in the care of these patients but also asks for continued education of the lay public on the importance of preventive strategies. During the current SARS-CoV-2 pandemic, maxillofacial fractures caused by road traffic accidents have been reduced, thanks to national lockdown that forbade all the outdoor sports and the unnecessary travels, except for essential work activities.

Despite the national measures to prevent these events to happen (both the use of protection devices and the general penalties for road offenses), these data (and the studies that preceded this dissertation) show that they are not sufficient. A lot can be done to reduce road traffic accidents and, consequently, maxillofacial fractures. A decrease of road traffic accident would lead to a decrease of costs for our National Health System and, of course, to a decreased mortality rate in general population.

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## Surgical Management of Necrotizing Fasciitis of the Head and Neck

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**Objective:** The purpose of this study was to highlight risk factors and surgeries for necrotizing fasciitis (NF) of the head and neck in the literature. NF is rare but can rapidly progress.

**Materials and Methods:** A literature search was done using PubMed and SCOPUS. Articles that discussed NF of the head and neck and a specific surgical technique were included. A

bivariate Pearson correlation was conducted using an  $\alpha$  level of 0.05.

**Results:** The study included 31 articles encompassing 77 patients who presented with head and neck NF. Diabetes mellitus (23.4%) was the most common comorbidity observed. Surgical techniques, such as debridement (96.10%) and incision/exploration (97.40%), were common.

**Conclusion:** Immediate surgical intervention should be performed when treating patients presenting with NF of the head and neck.

**Key Words:** Head and neck reconstruction, hyperbaric oxygen, necrotizing fasciitis, risk factors, surgical interventions

Necrotizing fasciitis (NF) is a serious infection of the soft tissue, skin, and muscles. Staphylococci and streptococci invade the subcutaneous tissue and release toxins leading to necrosis and septic shock.<sup>1</sup> Necrotizing fasciitis quickly advances to deeper fascial planes at a rate of 2 to 3 cm per hour. Therefore, early diagnosis and treatment is pertinent when evaluating patients.<sup>2</sup> Necrotizing fasciitis typically presents with pain, skin changes, fever, diaphoresis, or altered mental status.<sup>3</sup> Within the next few days, patients may have swelling, rash, or necrosis.<sup>4</sup> If not treated appropriately, NF can rapidly progress to sepsis, carotid artery erosion, or pneumonia.<sup>3</sup>

Necrotizing fasciitis is relatively uncommon in the head and neck region. When present, it is usually due to an odontogenic infection in immunocompromised patients.<sup>5</sup> Furthermore, NF is seen commonly among patients with obesity, a history of substance misuse, or peripheral vascular disease.<sup>6</sup> In a study conducted by Lin et al,<sup>7</sup> many patients had a history of diabetes mellitus (72.3%) and systemic disease (89.4%).

Previous studies have discussed treatment guidelines, which includes debridement, antibiotics, and supportive care. Early diagnosis is important due to the rapid nature of this infection.<sup>2,7</sup> Bonne and Kadri<sup>8</sup> emphasized that surgical debridement should be used in the management of NF. Hyperbaric oxygen is used as an adjunct therapy in select cases. Some patients may require a split-thickness skin graft due to excessive skin loss.<sup>9</sup>

The purpose of this study was to review the literature for surgical treatments, identify risk factors that predispose patients to NF, and establish standardized treatments guidelines. The current literature lacks a review of surgical interventions used to treat NF. By understanding previous surgical approaches, we can make better recommendations to approach future NF cases.

### MATERIAL AND METHODS

The literature search was conducted on March 29, 2020 using PubMed and SCOPUS. The search included different combinations of the following terms: “head and neck necrotizing fasciitis”; “treatment”; “procedure”; “therapy.” Articles discussing a case (s) of necrotizing fasciitis in the head and neck and a surgical treatment were included for a full article review. Articles that did not discuss individual patients or a surgical treatment for NF were excluded. The following filters were applied: articles in the English language and within the last 10 years. Initially, there were 452 articles, after filters were applied there were 197 articles. After removing 56 duplicates and filtering by the inclusion and exclusion criteria, there were 31 articles meeting criteria head and neck NF (Fig. 1).

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