https://doi.org/10.1186/s13005-025-00489-7

Head & Face Medicine

RESEARCH

Open Access

Impact of the Covid-19 pandemic on odontogenic infections in maxillofacial surgery

Florian Dudde[1*], Oliver Schuck[1], Sven Duda[2] and Manfred Giese[1]

Abstract

Background This study investigates the impact of the COVID-19 pandemic on the distribution, characteristics, and treatment of odontogenic infections (OI) in a cranio-maxillofacial hospital, comparing data from pre-covid (PC) and intra-covid (IC) periods.

Materials and methods A retrospective analysis was conducted on 194 patients treated for OIs from February 2019 to January 2021. Patients were categorized into two cohorts: PC (02/2019 – 01/2020) and IC (02/2020 – 01/2021). Data collected included demographics, infection types, symptoms, pre-existing conditions, treatments, length of hospital stay, and time from symptom onset to treatment.

Results The IC cohort exhibited a significant increase in submandibular (13.9% to 26.7%) and floor of mouth abscesses (6.5% to 18.6%). Patients in the IC period were more likely to present with fever (69.8% vs. 36.1%, $p<0.001$) and dyspnea (48.8% vs. 33.3%, $p=0.029$). Additionally, there was an increase in multi-space infections (7.4% to 22.1%) and higher inflammatory markers, with leukocyte counts rising from 12.51×10^9/l to 15.41×10^9/l ($p<0.001$). The mean length of stay in the hospital also increased significantly from 3.24 days to 8.01 days ($p<0.001$).

Conclusion The COVID-19 pandemic has significantly altered the landscape of OIs in oral and maxillofacial surgery, leading to more severe presentations, prolonged treatment durations, and increased hospital admissions. These findings underscore the necessity for improved public health strategies to ensure timely access to dental care during health crises. Enhanced awareness and proactive management are essential to mitigate the long-term impact of the aforementioned disruptions on patient outcomes.

Keywords Covid-19, Pandemic, Maxillofacial, Infection, Abscess, Treatment

Introduction

Abscesses in oral and maxillofacial surgery are purulent collections caused by bacterial infections and often pose a serious clinical challenge [1]. These conditions can occur in various anatomical regions of the face and jaw and are often the result of untreated dental problems, such as an odontogenic infection (OI), trauma or postoperative complications [1, 2]. OI can be divided into abscesses of the maxilla and mandible [1]. The cheek abscess, the fossa canina abscess and the retromaxillary abscess are the most common OI of the maxilla [1, 3]. In the mandibular region, a distinction can be made between paramandibular, perimandibular, submandibular, pterygomandibular and floor of the mouth abscesses [1, 3, 4].

*Correspondence:
Florian Dudde
floriandudde@gmx.de
[1] Department of Oral and Maxillofacial Surgery, Army Hospital Hamburg, Lesserstraße 180, 22049 Hamburg, Germany
[2] Department of Neurosurgery, Army Hospital Hamburg, Hamburg, Germany

The symptoms, which range from pain and swelling to systemic reactions such as fever, require rapid and targeted diagnosis and appropriate therapeutic intervention [1–5]. Early detection and treatment are crucial to avoid serious complications and maintain the patient's quality of life [5]. The pillars of treatment for OI with abscess formation are surgical incision and drainage of the abscess, simultaneous and/or prompt treatment of the causative tooth and perioperative administration of targeted antibiotics [5–7]. Although a calculated antibiotic treatment is sufficient in most cases, intraoperative swab collection and culture of the pathogens can sometimes achieve a more targeted antibiotic treatment [7]. Abscesses in oral and maxillofacial surgery can lead to various complications if they are not recognized and treated in time [5]. These complications can be both local and systemic and range from mild discomfort to life-threatening conditions. Examples of local complications include osteomyelitis, fistula formation, spread as soft tissue infection (i.e. cellulitis), airway obstruction and tooth loss [5, 8]. Systemic complications include the development of lymphangitis, meningitis, facial thrombosis of the venous sinuses and the development of sepsis [8, 9]. Particularly in the case of such complications and courses, the above-mentioned therapies may lead for the new of extended interventions, for example with temporary tracheostomy to secure the airway or perioperative care in an intensive care unit (ICU) in the event of septic shock [5, 6, 9, 10].

The prominent swelling of the abscesses generally develops over the course of a few days during OI. The longer the OI lasts, the more likely it is that complications will occur, accompanied by a prolonged course, which can result in the treatment becoming more difficult, in ICU stays, higher inflammatory parameters and a longer length of stay in the hospital [11, 12].

The Covid-19 pandemic has had a profound impact on healthcare systems worldwide. In some cases, the pandemic led to overburdening of healthcare facilities due to the increase in patients infected with Covid-19, which led to work overload and resource shortages. This affected both staff and medical equipment [13].

Many healthcare systems have had to postpone routine treatments and elective procedures to free up resources for the treatment of Covid-19 patients [14]. This led to longer waiting periods for other medical services [14, 15]. The pandemic exacerbated existing inequalities in healthcare, with vulnerable groups often having poorer access to healthcare services [16, 17]. Studies have already shown that the Covid-19 pandemic led to patients only presenting to medical specialists at a much more advanced stage of the disease than before the pandemic [18, 19].

Overall, the Covid-19 pandemic has put the resilience and adaptability of healthcare systems to the test and at the same time provided important lessons for future crises. The impact of the Covid-19 pandemic has already been studied for facial fractures regarding maxillofacial surgery [20–22]. However, it remains unclear to what extent the Covid-19 pandemic affected emergency OI settings in maxillofacial surgery. Therefore, the aim of this study is to investigate the influence of the Covid-19 pandemic on the OI distributions, on the circumstances/patterns leading to OI, on the emergent treatment modalities and to compare these results with the data from the PreCovid era in a cranio-maxillofacial department.

Materials and methods

Study design and participants

This retrospective study evaluated patients presenting to the Department of Oral and Maxillofacial Surgery with odontogenic infections (OI) from February 2019 to January 2021. OI were defined as infections originating from dental structures or surrounding tissues, with clinical and/or radiographic evidence of:

- Acute infections extending beyond the tooth structure, such as those involving soft tissues or fascial spaces.
- Involvement of multiple anatomical spaces (e.g., submandibular, sublingual, or buccal spaces).
- Systemic signs of infection, including fever, significant swelling, trismus, or spreading cellulitis.

Patients were categorized into two cohorts based on their date of admission: PreCovid (PC) from February 2019 to January 2020, and IntraCovid (IC) from February 2020 to January 2021. Eligible participants were adults aged 18 years and older. Exclusion criteria included incomplete medical records, non-odontogenic infections, chronic periapical abscesses, patients treated non-surgically, and those under 18 years of age. A total of 194 patients were included in the analysis.

Clinical management

All patients underwent surgical incision (either intraoral or extraoral) and drainage of the abscess, accompanied by perioperative antibiotic therapy. Antibiotic regimens consisted of Ampicillin/Sulbactam 3 g administered three times daily for five days, or Clindamycin 600 mg three times daily for five days in cases of penicillin allergy.

Data collection

Data were extracted from patient medical records, including baseline demographic information (age and gender), clinical characteristics of the OI (type, location, symptoms, pre-existing conditions, laboratory inflammatory parameters), treatment details, and monthly incidence patterns. OI types were categorized based on anatomical location: maxillary infections (i.e., fossa canina, cheek, retromaxillary, temporal region) and mandibular infections (i.e., paramandibular, perimandibular, submandibular, pterygomandibular, floor of mouth). To ensure clarity, the anatomical spaces referenced in this study are defined based on their anatomical borders. These spaces are regions where odontogenic infections can spread and were identified through clinical and radiological assessments (Table 1).

Length of stay and timing

The length of hospital stay, as well as the duration from the onset of symptoms to emergency presentation and subsequent surgical intervention, were recorded for each patient.

Statistical analysis

Descriptive analysis was used to display patients baseline characteristics. Normally distributed continuous variables are presented as mean ± standard deviation and binary variables are using absolute and relative frequencies. Comparison of continuous variables was performed by Student's t-test. Chi- square test was used for analysis of binary variables. A p-value < 0.05 was considered statistically significant. All statistical analyses were performed using the SPSS version 28.0 statistical package (IBM, Markham, Canada).

Table 1 Definition of anatomical spaces

Anatomical Space	Description and Borders
Retromaxillary Space	Posterior to the maxilla - **Anteriorly:** Posterior wall of the maxilla. - **Superiorly:** Infratemporal fossa - **Posteriorly:** Lateral pterygoid muscle - **Inferiorly:** Pterygomandibular space and adjacent soft tissues
Perimandibular Space	Encompasses both lingual and vestibular tissue surrounding the mandible
Submandibular Space	Located below the mandible - **Superiorly:** Mylohyoid muscle - **Inferiorly:** Platysma and skin
Submental Space	Located beneath the anterior mandible - **Laterally:** Anterior bellies of the digastric muscles
Buccal Space	Facial soft tissue space - **Medially:** Buccinator muscle - **Laterally:** Masseter muscle and skin
Paramandibular Space	Soft tissue region vestibular to the mandible
Pterygomandibular Space	Defined by multiple anatomical structures: - **Lateral:** Medial surface of the ramus of the mandible - **Medial:** Medial pterygoid muscle - **Anterior:** Posterior aspect of the buccinator muscle - **Posterior:** Parotid gland and stylomandibular ligament - **Superior:** Lateral pterygoid muscle - **Inferior:** Attachment of the medial pterygoid muscle to the mandible

Table 2 Baseline characteristics

Variable	Total (n = 194)	PreCovid (02/2019—01/2020) (n = 108)	IntraCovid (02/2020—01/2021) (n = 86)	p—Value
Age (years)	55.25 (± 19.5)	52.94 (± 18.6)	58.15 (± 20.3)	0.065
Sex				0.166
Male	92 (47.4)	56 (51.9)	36 (41.9)	
Female	102 (52.6)	52 (48.1)	50 (58.1)	

Data presented as mean (SD) and/or absolute values (percentage)

Results

Baseline

A total of 194 patients were included in the present study. The mean age of the patients was 55.25 (± 19.54) years (Table 2). The male to female ratio was almost proportionate throughout the study (Table 2). The population was divided into two cohorts (PreCovid: $n = 108$ vs. IntraCovid: $n = 86$) based on the patients´ date of admission.

Circumstances, type and treatment of OI

Regarding the localization of OI, the only significant differences between the two periods were found for submandibular and floor of the mouth infections (Table 3, Fig. 1). The incidence of submandibular abscesses increased from 13.9% (PC) to 26.7% (IC) as well as the incidence of floor of the mouth abscesses from 6.5% (PC) to 18.6% (IC) (Table 3, Fig. 1). For all other localizations and types of OI, there were no significant differences between the two periods (Table 3, Fig. 1). Paramandibular abscesses were the most common locations of OI in both cohorts with a total of 26.8% (Table 3). Temporal abscess were the rarest OI throughout the study with a total of 1.5% (Table 3).

There were significant differences in patients' symptoms between the two periods (Table 3). Patients in the IC period were significantly more likely to present with fever (37.5 °C) than patients in the PC period (PC = 36.1% vs. IC = 69.8%, $p = < 0.001$) (Table 3). There were also significantly more patients with concomitant dyspnea in the IC period (PC = 33.3% vs. IC = 48.8%, $p = 0.029$) than in the PC period (Table 3). There were no significant differences between the two cohorts for the symptoms dysphagia, pain, swelling and trismus (Table 3).

In the IC period, there was a significant increase in multi-space (> 2 locations) from 7.4% (PC) to 22.1% (IC) (Table 3). At the same time, patients in the IC period showed significantly more often pre-existing diseases (diabetes mellitus type II, coronary heart disease) than patients in the PC period (Table 3). There were no significant differences between the two cohorts regarding smoking or patients aged > 60 years (Table 3).

Furthermore, patients in the IC period had significantly higher leukocyte counts than patients in the PC period (PC = 12.51 × 10^9/l vs. IC = 15.41 × 10^9/l, $p = < 0.001$) (Table 4). In addition, the C-reactive protein (CRP) was

Table 3 Type of OI

Variable	Total (n = 194)	PreCovid (02/2019—01/2020) (n = 108)	IntraCovid (02/2020—01/2021) (n = 86)	p—Value
Fossa canina	27 (13.9)	17 (15.7)	10 (11.6)	0.411
Cheek/Maxillary	33 (17.0)	21 (19.4)	12 (14.0)	0.312
Retromaxillary	7 (3.6)	2 (1.9)	5 (5.8)	0.142
Paramandibular	52 (26.8)	28 (25.9)	24 (27.9)	0.757
Perimandibular	39 (20.1)	20 (18.5)	19 (22.1)	0.537
Submandibular	38 (19.6)	15 (13.9)	23 (26.7)	**0.025**
Pterygomandibular	7 (3.6)	5 (4.6)	2 (2.3)	0.393
Floor of mouth	23 (11.9)	7 (6.5)	16 (18.6)	**0.009**
Temporal	3 (1.5)	1 (0.9)	2 (2.3)	0.433
Symptoms				
Fever	99 (51.0)	39 (36.1)	60 (69.8)	**< 0.001**
Dyspnoe	78 (40.2)	36 (33.3)	42 (48.8)	**0.029**
Dysphagia	104 (53.6)	56 (51.9)	48 (55.8)	0.583
Pain	193 (99.5)	107 (99.1)	86 (100.0)	0.371
Swelling	194 (100)	108 (100)	86 (100)	/*
Trismus	104 (53.6)	58 (50.0)	46 (53.5)	0.539
Single Space Infection	167 (86.1)	100 (92.6)	67 (77.9)	**0.003**
Multi-Space Infection	27 (13.9)	8 (7.4)	19 (22.1)	**0.003**
PreExisting Diseases	73 (37.6)	33 (30.6)	40 (46.5)	**0.023**
Diabetes mellitus type II	66 (34.0)	30 (27.8)	36 (41.9)	**0.040**
Cardiovascular Disease	78 (40.2)	34 (31.5)	44 (51.2)	**0.005**
Smoker	86 (44.3)	50 (46.3)	36 (41.9)	0.537
Age > 60	84 (43.3)	43 (39.8)	41 (47.7)	0.272

Data presented as absolute values (percentage)

OI Odontogenic Infection, * / = Statistical Test not applicable

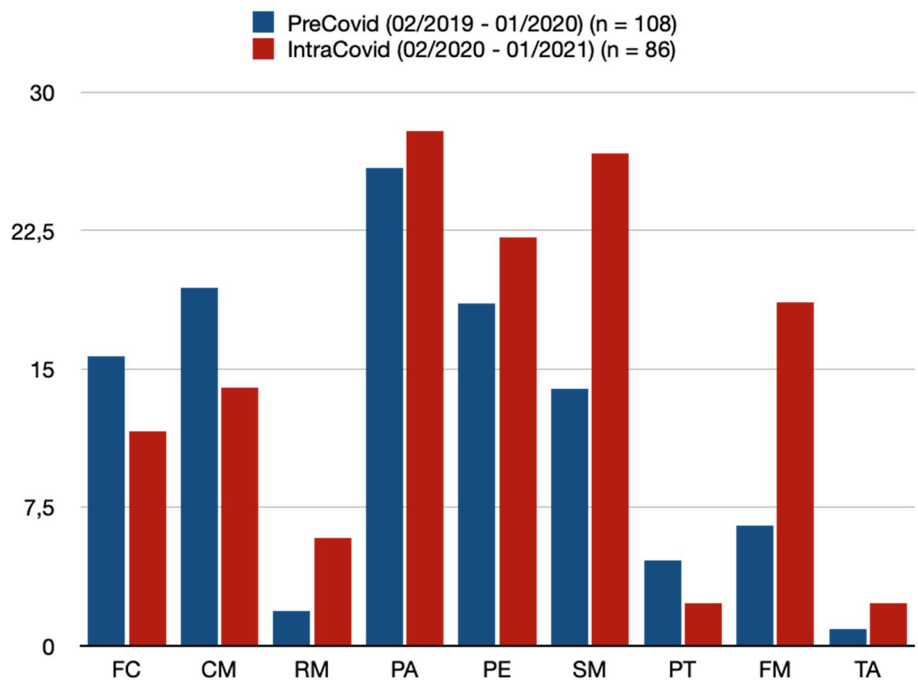

Fig. 1 Distribution of different OI

OI = Odontogenic Infections, FC = Fossa canina abscess, CM = Cheek/Maxillary abscess, RM = Retromaxillary abscess, PA = Paramandibular abscess, PE = Perimandibular abscess, SM = Submandibular abscess, PT = Pterygomandibular abscess, FM = Floor of mouth abscess, TA = Temporal abscess. Note: Data are presented in relative frequencies (%)

significantly increased in the IC cohort (PC = 59.83 mg/l vs. IC = 88.84 mg/l, $p = 0.005$) (Table 4). Consequently, the number of patients with a leukocyte count > 15 × 10^9/l or a CRP-level > 30 mg/l was also significantly increased in the IC period (Table 4). Regarding the distribution of weekday to weekend emergency presentations with OI or the daytime of presentation with OI (morning = 8 a.m.—4 p.m.; evening = 4 p.m.—12 p.m., night = 12 a.m.—8 a.m.), there were no differences between the two cohorts (Table 4). During the IC period, there was a significant reduction in outpatient treatment from 38.9% to 20.9% ($p = 0.007$) (Table 4).

At the same time, there was a significant increase in inpatient treatment in the intensive care unit (ICU) from 1.9% to 18.6% in the IC period ($p = < 0.001$) (Table 4). In addition, extraoral incision and drainage was significantly more frequent in the IC period than in the PC period (Table 4). Furthermore, there was a significant increase in tracheostomies in the IC period (PC = 1.9% vs. IC = 9.3%, $p = 0.020$) (Table 4). A significant decrease in intraoperative tooth extractions of the causative tooth for OI was observed in the IC period (PC = 20.4% vs. IC = 3.5%, $p = < 0.001$) (Table 4). Regarding the monthly distribution of OI, there were no significant differences between the two cohorts (Table 4). Overall, February, August and April were the months with the highest number of OI (Table 4).

Length of stay and timely distribution

Focusing on patients´ length of stay in the hospital, there was a significant increase in the IC period from 3.24 days (PC) to 8.01 days (IC) ($p = < 0.001$) (Table 5). Furthermore, a significant increase in the time from beginning of symptoms until emergency presentation (PC = 3.72 days vs. IC = 8.29 days, $p = < 0.001$) as well as the time from symptoms until operation (PC = 3.81 days vs. IC = 8.33 days, $p = < 0.001$) could be revealed (Table 5).

Discussion

The aim of the present study was to investigate the impact of the Covid-19 pandemic on the distributions and circumstances leading to OI. The findings from the present study revealed significant changes in infection characteristics, symptoms, treatment approaches, and overall management. These changes can be contextualized within the broader literature on health care during the COVID-19 pandemic.

In the IC period, there were no sex-specific differences and a slight increase in patients' age. The mean age of the

Table 4 Circumstances and treatment of OI

Variable	Total (n = 194)	PreCovid (02/2019—01/2020) (n = 108)	IntraCovid (02/2020—01/2021) (n = 86)	p—Value
Leukocytes/WBC ($\times 10^9$/l)	14.08 (±4.6)	12.51 (±4.0)	15.41 (±4.7)	**< 0.001**
CRP (mg/l)	75.49 (±63.2)	59.83 (±52.0)	88.84 (±69.0)	**0.005**
Leukocytes > 15.000 × 10^9/l	73 (37.6)	19 (17.6)	54 (62.8)	**< 0.001**
CRP > 30 (mg/l)	112 (57.7)	45 (41.7)	67 (77.9)	**< 0.001**
Weekday	133 (68.6)	74 (68.5)	59 (68.6)	0.990
Weekend	61 (31.4)	34 (31.5)	27 (31.4)	0.990
Morning	62 (32.0)	32 (29.6)	30 (34.9)	0.436
Evening	101 (52.1)	56 (51.9)	45 (52.3)	0.948
Night	31 (16.0)	20 (18.5)	11 (12.8)	0.279
Outpatient Treatment	60 (30.9)	42 (38.9)	18 (20.9)	**0.007**
Inpatient Treatment	134 (69.1)	66 (61.1)	68 (79.1)	**0.007**
ICU	18 (9.3)	2 (1.9)	16 (18.6)	**< 0.001**
Incision + Drainage intraoral	81 (41.8)	60 (55.5)	21 (24.4)	**0.015**
Incision + Drainage extraoral	113 (58.2)	48 (44.4)	65 (75.6)	**0.018**
Tracheostomy	10 (5.2)	2 (1.9)	8 (9.3)	**0.020**
Tooth extraction simultan	25 (12.9)	22 (20.4)	3 (3.5)	**< 0.001**
Tooth extraction in follow up	85 (43.8)	32 (29.6)	53 (61.6)	**< 0.001**
No tooth extraction / conservative treatment	81 (41.8)	51 (47.2)	30 (34.9)	0.083
Month				0.116
January	17 (8.8)	12 (11.1)	5 (5.8)	
February	25 (12.9)	14 (13.0)	11 (12.8)	
March	15 (7.7)	10 (9.3)	5 (5.8)	
April	18 (9.3)	12 (11.1)	6 (7.0)	
May	16 (8.2)	6 (5.6)	10 (11.6)	
June	15 (7.7)	8 (7.4)	7 (8.1)	
July	16 (8.2)	6 (5.6)	10 (11.6)	
August	19 (9.8)	14 (13.0)	5 (5.8)	
September	13 (6.7)	9 (8.3)	4 (4.7)	
October	11 (5.7)	6 (5.6)	5 (5.8)	
November	16 (8.2)	8 (7.4)	8 (9.3)	
December	13 (6.7)	3 (2.8)	10 (11.6)	

Data presented as mean (SD) and/or absolute values (percentage)

OI Odontogenic Infections, *WBC* White blood cells, *CRP* C-reactive protein, *ICU* Intensive Care Unit

Morning = 8 a.m. – 4 p.m.; Evening = 4 p.m. – 12 p.m., Night = 12 a.m. – 8 a.m

Table 5 Length of stay and timing

Variable	Total (n = 194)	PreCovid (02/2019—01/2020) (n = 108)	IntraCovid (02/2020—01/2021) (n = 86)	p—Value
Time (Symptoms—Emergency Presentation)	5.76 (±2.8)	3.72 (±1.2)	8.29 (±1.9)	**< 0.001**
Time (Symptoms—Operation)	5.81 (±2.7)	3.81 (±1.2)	8.33 (±2.0)	**< 0.001**
Length of stay	5.36 (±5.0)	3.24 (±3.6)	8.01 (±5.3)	**< 0.001**

Data presented as mean (SD) values

cohort (55.25 years) aligns with existing literature, which often notes a higher prevalence of OIs in older adults, particularly those with comorbidities like diabetes and cardiovascular diseases [23, 24]. The increased incidence of submandibular and floor of the mouth abscesses during the IC period may reflect altered patient behaviors and healthcare access issues, consistent with findings from studies indicating that delays in seeking care have led to more severe presentations of infections during the pandemic [25–27].

This is consecutively associated with a longer period of illness and symptoms. During the pandemic, access to various medical specialties (i.e. maxillofacial surgery) was made more difficult due to resource scarcity and lockdowns, especially for socially disadvantaged people [16, 17]. As a result, diseases outside of maxillofacial surgery were also found to be at a more advanced stage than before the pandemic [17, 26, 27]. The same observation can also be made in the present study. It can be assumed that the life-threatening lodge abscesses of the head and neck region (i.e. submandibular and floor of the mouth abscess) increase in size over time if they are not treated promptly. However, it is not only the size of the swelling of the abscesses/OI that increases over time, but also the accompanying symptoms including fever and dyspnea due to airway obstructions especially in mandibular OI [5, 28].

Consequently, the present study also showed a significant increase in the number of patients reporting fever and dyspnea on arrival in the emergency department during the IC period. Furthermore, significantly more patients in the IC period had pre-existing conditions and diabetes mellitus, which must be regarded as a general risk factor for OI and also for a prolonged and severer course [11, 12]. The present study also showed that patients during the IC period had significantly longer periods from the onset of OI symptoms to emergency presentation and time until surgery. Here, also, the effects of lockdowns and poorer access to the healthcare system appear to have had a clear impact on OI [17–22].

In line with the prolonged periods of OI, the significantly extended length of stay in hospital is also only a logical consequence in order to adequately treat the significantly more advanced stages of OI.

The notable increase in hospital length of stay and delays in emergency presentation and surgical intervention aligns with findings from other studies, which report that the pandemic has led to increased hospitalizations and longer treatment durations due to delayed presentations and more complicated cases [29, 30]. The data indicating prolonged times from symptom onset to treatment emphasize the critical need for improved public awareness and access to healthcare during health crises such as the Covid-19 pandemic. Furthermore, the present study also showed a significant increase in inpatient treatment due to advanced OI. The significant reduction in outpatient treatments and the increase in ICU admissions highlight a shift in patient management strategies. These findings are supported by literature showing that many patients avoided outpatient care due to fears of COVID-19 exposure, leading to more severe cases requiring hospitalization [31, 32]. The increase in extraoral incision and drainage procedures and tracheostomies also suggests that the nature of treatment for OIs has shifted towards more aggressive interventions, likely due to the more severe presentations noted during the IC period.

This is also linked to the significant increase in temporary ICU stays and the increase in tracheostomies during the IC period due to the advanced stages of OI. Also, the significant rise in multi-space infections during the IC period and the reduction in simultaneous extraction of the causative tooth due to the severe restriction of mouth opening with trismus and swelling may be due to the advanced stages of OI and are further aggravated by the increase in risk factors of patients during the IC period (i.e. diabetes mellitus type II) [11, 12]. Furthermore, the significant rise in multi-space infections during the IC period is particularly concerning and has been noted in other studies as well, suggesting a trend toward more complex presentations of infections when health systems are strained [33].

A further indication of the significantly more advanced stages of OI can be seen in the higher levels of leukocytes and CRP in the IC period. Studies have already shown that these inflammatory parameters correlate with both a more advanced stage of the infection and a longer length of stay [34]. The results of the present study are limited to the fact that the study is retrospective in nature and was conducted as a single-center study. Nevertheless, the size of the study population is comparable to other studies investigating OI in maxillofacial surgery settings [8, 35].

One limitation of this study is the potential bias introduced by missing data and unmeasured confounders. As a retrospective study, the data relied on clinical records, which may not have consistently captured all relevant variables. Although efforts were made to include only patients with complete records for the primary outcomes, missing information on secondary variables, such as detailed patient demographics or socioeconomic status, could have influenced the findings. This limitation may affect the accuracy and generalizability of the results. Furthermore, unmeasured confounders, including variations in healthcare access, comorbidities, or socioeconomic disparities during the study periods, could have impacted the patterns and severity of infections observed. For example, during the COVID-19 pandemic, changes in healthcare-seeking behavior or resource allocation might have disproportionately affected certain patient groups, potentially skewing the results. Addressing these limitations in future research will be essential. Prospective or multicenter studies with comprehensive data collection on patient demographics, comorbidities, and access to care will help reduce biases and provide a more nuanced understanding of the factors influencing infection patterns and outcomes. Despite these limitations, this study provides valuable insights into the impact of delayed care and infection management during a global health crisis.

The findings of the present study are also consistent with current literature, which documents the impact of the COVID-19 pandemic on patient management and health outcomes across various conditions. The shifts in presentation, treatment approaches, and delays in care highlight significant challenges that healthcare providers must address to improve outcomes for patients with orofacial infections and similar conditions in future public health emergencies.

The pandemic-induced delays in treatment likely stemmed from a combination of patient reluctance to seek care due to fear of infection, restricted healthcare services, and altered triage priorities. While these barriers were contextually specific to the pandemic, they provide valuable insights into how healthcare systems can be better prepared for similar crises in the future. To mitigate the impact of delayed treatment, several strategies may be consideredfor future pandemics:

1. Enhanced Telemedicine Capabilities: Implementing telemedicine platforms to enable early assessment, triage, and guidance for patients with maxillofacial infections can help bridge gaps in care during emergencies.
2. Triage and Access Pathways: Establishing clear pathways for urgent dental and maxillofacial care, even under restricted healthcare settings, is essential to prevent disease progression.
3. Public and Provider Education: Raising awareness among patients about the risks of delaying care for infections and training healthcare providers to recognize the importance of early referral can reduce delays.
4. Resilient Healthcare Systems: Building adaptive healthcare systems that maintain essential services during public health emergencies is critical for addressing the needs of patients with potentially life-threatening conditions.

By reflecting on the patterns observed during the pandemic, we can draw valuable lessons to improve healthcare delivery and preparedness for future crises. Ensuring timely access to care, even under challenging circumstances, will be pivotal in reducing the morbidity and complications associated with maxillofacial infections.

This study highlights the significant impact of the COVID-19 pandemic on the presentation and management of maxillofacial infections. A reduction in outpatient care and an increase in severe cases requiring ICU admissions were observed, emphasizing the consequences of delayed treatment during a public health crisis. These findings underline the critical importance of maintaining access to essential healthcare services and early intervention pathways, even during emergencies, to prevent severe complications. For practitioners, the study provides valuable insights into the need for heightened vigilance in identifying and managing severe odontogenic infections. Ensuring timely access to care and implementing adaptive triage protocols can mitigate the risk of delayed presentations and improve patient outcomes. Future multi-center research could address the limitations of this single-center study by incorporating larger, more diverse populations and collecting data on socioeconomic and systemic factors that influence healthcare access and outcomes. Additionally, prospective investigations should explore the long-term implications of pandemic-related delays in care and evaluate innovative approaches, such as telemedicine and public health campaigns, to improve resilience in healthcare systems during future crises.

Authors' contributions
OS, MG and FD treated the patients and revised the article. FD and SD researched the scientific literature, provided statistical findings/analysis. FD wrote the article. All Authors gave final approval for publication.

Funding
The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical approval was waived by the clinical Ethics Committee (IRB). All the procedures/diagnostics being performed were part of the routine care. Informed consent was waived by the clinical ethical board due to the retrospective nature of the study.

Consent for publication
The authors affirm that human research participants provided informed consent for publication of the images/figures.

Competing interests
The authors declare no competing interests.

Received: 20 October 2024 Accepted: 11 February 2025
Published online: 25 February 2025

References

1. Bertossi D, Barone A, Iurlaro A, Marconcini S, De Santis D, Finotti M, Procacci P. Odontogenic Orofacial Infections. J Craniofac Surg. 2017;28(1):197–202. https://doi.org/10.1097/SCS.0000000000003250. (PMID: 27930461).
2. Igoumenakis D, Gkinis G, Kostakis G, Mezitis M, Rallis G. Severe odontogenic infections: causes of spread and their management. Surg Infect (Larchmt). 2014;15(1):64–8. https://doi.org/10.1089/sur.2012.178. (Epub 2013 Oct 11 PMID: 24116736).
3. Moghimi M, Baart JA, Karagozoglu KH, Forouzanfar T. Spread of odontogenic infections: a retrospective analysis and review of the literature. Quintessence Int. 2013;44(4):351–61. https://doi.org/10.3290/j.qi.a29150. (PMID: 23479578).
4. Sato FR, Hajala FA, Freire Filho FW, Moreira RW, de Moraes M. Eight-year retrospective study of odontogenic origin infections in a postgraduation program on oral and maxillofacial surgery. J Oral Maxillofac Surg. 2009;67(5):1092–7. https://doi.org/10.1016/j.joms.2008.09.008. (PMID: 19375023).
5. Neal TW, Schlieve T. Complications of Severe Odontogenic Infections: A Review. Biology (Basel). 2022;11(12):1784. https://doi.org/10.3390/biology11121784.PMID:36552293;PMCID:PMC9775288.
6. Jevon P, Abdelrahman A, Pigadas N. Management of odontogenic infections and sepsis: an update. Br Dent J. 2020;229(6):363–370. https://doi.org/10.1038/s41415-020-2114-5. Epub 2020 Sep 25. PMID: 32978579; PMCID: PMC7517749.
7. Holmes CJ, Pellecchia R. Antimicrobial Therapy in Management of Odontogenic Infections in General Dentistry. Dent Clin North Am. 2016;60(2):497–507. https://doi.org/10.1016/j.cden.2015.11.013. (PMID: 27040298).
8. Ogle OE. Odontogenic Infections. Dent Clin North Am. 2017Apr;61(2):235–52. https://doi.org/10.1016/j.cden.2016.11.004. (PMID: 28317564).
9. Bali RK, Sharma P, Gaba S, Kaur A, Ghanghas P. A review of complications of odontogenic infections. Natl J Maxillofac Surg. 2015 Jul-Dec;6(2):136–43. https://doi.org/10.4103/0975-5950.183867. PMID: 27390486; PMCID: PMC4922222.
10. Sakkas A, Weiß C, Zink W, Rodriguez CA, Scheurer M, Pietzka S, Wilde F, Thiele OC, Mischkowski RA, Ebeling M. Airway Management of Orofacial Infections Originating in the Mandible. J Pers Med. 2023;13(6):950. https://doi.org/10.3390/jpm13060950.PMID:37373939;PMCID:PMC10304000.
11. Peters ES, Fong B, Wormuth DW, Sonis ST. Risk factors affecting hospital length of stay in patients with odontogenic maxillofacial infections. J Oral Maxillofac Surg. 1996;54(12):1386–91; discussion 1391–2. https://doi.org/10.1016/s0278-2391(96)90249-9. PMID: 8957116.
12. Joachim MV, Abdo M, Alkeesh K, Oettinger-Barak O, Abozaid S, El-Naaj IA. Factors associated with prolonged hospitalizations from odontogenic infections in children. J Clin Pediatr Dent. 2022;46(6):40–4. https://doi.org/10.22514/jocpd.2022.024. (Epub 2022 Nov 1 PMID: 36624903).
13. French G, Hulse M, Nguyen D, Sobotka K, Webster K, Corman J, Aboagye-Nyame B, Dion M, Johnson M, Zalinger B, Ewing M. Impact of Hospital Strain on Excess Deaths During the COVID-19 Pandemic - United States, July 2020-July 2021. MMWR Morb Mortal Wkly Rep. 2021;70(46):1613–6. https://doi.org/10.15585/mmwr.mm7046a5.PMID:34793414;PMCID:PMC8601411.
14. Byrnes ME, Brown CS, De Roo AC, Corriere MA, Romano MA, Fukuhara S, Kim KM, Osborne NH. Elective Surgical Delays Due to COVID-19: The Patient Lived Experience. Med Care. 2021;59(4):288–94. https://doi.org/10.1097/MLR.0000000000001503.Erratum.In:MedCare.2021Aug1;59(8):757.doi:10.1097/MLR.0000000000001615.PMID:33605673;PMCID:PMC8132560.
15. Uimonen M, Kuitunen I, Paloneva J, Launonen AP, Ponkilainen V, Mattila VM. The impact of the COVID-19 pandemic on waiting times for elective surgery patients: A multicenter study. PLoS One. 2021;16(7): e0253875. https://doi.org/10.1371/journal.pone.0253875.PMID:34228727;PMCID:PMC8259989.
16. Andraska EA, Alabi O, Dorsey C, Erben Y, Velazquez G, Franco-Mesa C, Sachdev U. Health care disparities during the COVID-19 pandemic. Semin Vasc Surg. 2021;34(3):82–88. https://doi.org/10.1053/j.semvascsurg.2021.08.002. Epub 2021 Aug 9. PMID: 34642040; PMCID: PMC8349792.
17. Ala A, Wilder J, Jonassaint NL, Coffin CS, Brady C, Reynolds A, Schilsky ML. COVID-19 and the Uncovering of Health Care Disparities in the United States, United Kingdom and Canada: Call to Action. Hepatol Commun. 2021 ;5(10):1791–1800. https://doi.org/10.1002/hep4.1790. Epub 2021 Aug 24. PMID: 34558861; PMCID: PMC8426700.
18. Mack DP, Spencer H, Wang K, Lewis GD. The Effects of the COVID-19 Pandemic on Cancer Staging in Patients Diagnosed With Head and Neck Cancer. Cureus. 2023;15(1): e34190. https://doi.org/10.7759/cureus.34190.PMID:36843727;PMCID:PMC9951633.
19. Henke O. Cancer care in East Africa amidst the Covid-19 pandemic. Int J Cancer. 2021 Sep 15;149(6):1399–1400. https://doi.org/10.1002/ijc.33611. Epub 2021 Apr 28. PMID: 33913167; PMCID: PMC8239553.
20. Dudde F, Schunk J, Telschow T, Barbarewicz F, Schuck O, Giese M, Bergmann W. Patterns of ZMC and Le Fort Fractures under the Impact of the COVID-19 Pandemic-"A Changing Face?". J Clin Med. 2024;13(16):4662. https://doi.org/10.3390/jcm13164662.PMID:39200801;PMCID:PMC11355621.
21. Dudde F, Bergmann W, Telschow T, Schunk J, Schuck O. Changing of nasal fracture patterns in maxillofacial trauma consultation-impact of the covid-19 pandemic. Oral Maxillofac Surg. 2024. https://doi.org/10.1007/s10006-024-01286-3. Epub ahead of print. PMID: 39080147.
22. Dudde F, Schuck O, Schunk J, Filip B. Influence of COVID-19 pandemic on mandible fracture patterns in a German cranio-maxillofacial trauma center: PreCOVID (2019) versus IntraCOVID (2020). Dent Traumatol. 2024;40(4):425–34. https://doi.org/10.1111/edt.12949. (Epub 2024 Apr 4 PMID: 38572818).
23. Ko HH, Chien WC, Lin YH, Chung CH, Cheng SJ. Examining the correlation between diabetes and odontogenic infection: A nationwide, retrospective, matched-cohort study in Taiwan. PLoS One. 2017;12(6): e0178941. https://doi.org/10.1371/journal.pone.0178941.PMID:28594848;PMCID:PMC5464582.
24. Mattila KJ, Asikainen S, Wolf J, Jousimies-Somer H, Valtonen V, Nieminen M. Age, dental infections, and coronary heart disease. J Dent Res. 2000;79(2):756–60. https://doi.org/10.1177/00220345000790020901. (PMID: 10728977).
25. de Wilton A, Kilich E, Chaudhry Z, Bell LC, Gahir J, Cadman J, Lever RA, Logan SA; UCLH COVID-19 Response Team. Delayed healthcare seeking and prolonged illness in healthcare workers during the COVID-19 pandemic: a single-centre observational study. BMJ Open. 2020;10(11):e040216. https://doi.org/10.1136/bmjopen-2020-040216. PMID: 33243801; PMCID: PMC7692003.
26. Alshahrani MS, Alfaraj D, AlHumaid J, Alshahrani K, Alsubaie A, Almulhim N, Althawadi D, Alam S, Alzahrani M, Alwosibai H, Alshahrani A, Makhdom R, Alkhadra F, Al-Faraj S, Al-Qahtani S, AlSulaibikh A, Jumaan MA, Asonto LP, Alahmadi S, Alghamdi M, Al-Mulhim M. Prevalence, Causes, and Adverse Clinical Impact of Delayed Presentation of Non-COVID-19-Related Emergencies during the COVID-19 Pandemic: Findings from a Multicenter Observational Study. Int J Environ Res Public Health. 2022;19(16):9818. https://doi.org/10.3390/ijerph19169818.PMID:36011457;PMCID:PMC9408350.
27. Louizakis A, Tatsis D, Paraskevopoulos K, Antoniou A, Kyrgidis A, Vahtsevanos K. The Effect of the COVID-19 Pandemic on Odontogenic Cervicofacial Infections in a Single Center in Greece. Cureus. 2024;16(5): e61333. https://doi.org/10.7759/cureus.61333.PMID:38947612;PMCID:PMC11213832.
28. Fu B, McGowan K, Sun JH, Batstone M. Increasing frequency and severity of odontogenic infection requiring hospital admission and surgical management. Br J Oral Maxillofac Surg. 2020;58(4):409–15. https://doi.org/10.1016/j.bjoms.2020.01.011. (Epub 2020 Jan 25 PMID: 31987682).
29. Akbulut S, Tuncer A, Ogut Z, Sahin TT, Koc C, Guldogan E, Karabulut E, Tanriverdi ES, Ozer A. Effect of the COVID-19 pandemic on patients with presumed diagnosis of acute appendicitis. World J Clin Cases. 2022;10(29):10487–500. https://doi.org/10.12998/wjcc.v10.i29.10487.PMID:36312473;PMCID:PMC9602222.
30. Burgard M, Cherbanyk F, Nassiopoulos K, Malekzadeh S, Pugin F, Egger B. An effect of the COVID-19 pandemic: Significantly more complicated appendicitis due to delayed presentation of patients! PLoS One.

2021;16(5):e0249171. https://doi.org/10.1371/journal.pone.0249171. PMID: 34032800; PMCID: PMC8148360.
31. Birkmeyer JD, Barnato A, Birkmeyer N, Bessler R, Skinner J. The Impact Of The COVID-19 Pandemic On Hospital Admissions In The United States. Health Aff (Millwood). 2020;39(11):2010–2017. https://doi.org/10.1377/hlthaff.2020.00980. Epub 2020 Sep 24. PMID: 32970495; PMCID: PMC7769002.
32. Hsieh YP, Yen CF, Wu CF, Wang PW. Nonattendance at Scheduled Appointments in Outpatient Clinics Due to COVID-19 and Related Factors in Taiwan: A Health Belief Model Approach. Int J Environ Res Public Health. 2021;18(9):4445. https://doi.org/10.3390/ijerph18094445.PMID:33922171; PMCID:PMC8122706.
33. Filip R, Gheorghita Puscaselu R, Anchidin-Norocel L, Dimian M, Savage WK. Global Challenges to Public Health Care Systems during the COVID-19 Pandemic: A Review of Pandemic Measures and Problems. J Pers Med. 2022;12(8):1295. https://doi.org/10.3390/jpm12081295.PMID:36013244; PMCID:PMC9409667.
34. Muna AM, ALhameed RA. The Role of C-Reactive Protein and White Blood Cell Count as Diagnostic, Prognostic, and Monitoring Markers in Bacterial Orofacial Infections. J Oral Maxillofac Surg. 2022;80(3):530–536. https://doi.org/10.1016/j.joms.2021.08.158. Epub 2021 Aug 27. PMID: 34571045.
35. Opitz D, Camerer C, Camerer DM, Raguse JD, Menneking H, Hoffmeister B, Adolphs N. Incidence and management of severe odontogenic infections-a retrospective analysis from 2004 to 2011. J Craniomaxillofac Surg. 2015;43(2):285–9. https://doi.org/10.1016/j.jcms.2014.12.002. (Epub 2014 Dec 6 PMID: 25555896).

Publisher's Note