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Case Series

Mapping the spread: insights into odontogenic maxillofacial space infections for better surgical planning: a case series analysis at a tertiary care hospital

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ABSTRACT

This retrospective study examines the clinical characteristics, spread patterns, management strategies, and outcomes of odontogenic maxillofacial space infections (MSI) treated at a tertiary care center between January 2021 and December 2023. A total of 20 patient records were analyzed, with a male predominance 75% and females comprising 25%. All patients were managed with incision and drainage along with intravenous antibiotics. The primary sources of infection were mandibular third molars, accounting for 40% on the right side and 35% on the left, with occasional involvement of the upper and lower, first and second molars. The submandibular space was the most frequently affected anatomical region, and multiple space involvement was common. The study highlights the mapping of the spread of infection, challenges in managing MSI, particularly in patients with systemic comorbidities such as diabetes, which contributed to increased severity and complexity. Also gives insights for managing the complications that were present in the patients. Although white blood cell (WBC) count was not a strong predictor of infection severity, its trend proved useful in monitoring treatment response. Early surgical intervention, aggressive antibiotic therapy, and vigilant clinical monitoring were associated with favorable outcomes. The findings align with existing literature regarding the predominance of male patients and the frequent implication of mandibular third molars. The study emphasizes the need for future research involving advanced diagnostic tools, evaluation of alternative antibiotic regimens, and assessment of the impact of self-medication on the microbiological profile of infections. Long-term follow-up and the integration of advanced imaging techniques could further enhance treatment strategies and contribute to improved patient outcomes.

Keyword: Odontogenic space infection, Odontogenic maxillofacial space infection, Incision and drainage, Necrotizing fasciitis

INTRODUCTION

Anatomical and microbiological variables, along with compromised resistance of the host and delays in receiving timely treatment, can lead to the development of a maxillofacial space infection (MSI) from a localized odontogenic infection. Because of the intricate anatomy involved and the possibility of severe medical problems even with skilled therapy, severe space infections present a considerable challenge to maxillofacial surgeons. Maxillofacial space infection may lead to potentially fatal disease such as necrotizing fasciitis, mediastinitis, cavernous sinus thrombosis, septicemia, and airway obstruction.[1] The progression of odontogenic infections is frequently uncertain. Delayed or inappropriate treatment may result in progression to life-threatening complications, such as mediastinitis, suppurative thrombophlebitis of the internal jugular vein, necrotizing cervical fasciitis, intracranial/lung abscesses, and aspiration pneumonia.[2] Reviewing the clinical features, treatment, and results of odontogenic MSI cases treated at a tertiary care facility and determining the risk factors for patients to experience potentially fatal complications were the goals of this study.[1]

Among the various etiological factors for odontogenic space infections, the most common are non-vital teeth due to decay or trauma, post-operative infections, pericoronitis, and periodontal disease. If untreated, these infections have the potential to migrate into adjacent fascial areas and have potentially fatal outcomes. This demands early detection and appropriate care through decompression of the involved space along with appropriate antibiotic therapy.

The majority of patients experience complete recovery following accurate surgical management, elimination of the odontogenic source, and the use of appropriate supportive antibiotic therapy.[3] Odontogeneic infections hardly ever penetrate the deep regions of the face and neck past the boundaries of the jaw bones. But once they occur, they are often difficult to assess accurately by clinical and conventional radiologic techniques, and the outcome may be serious and potentially life threatening. Because of its ability to locate diseases in clinically inaccessible portions of the body, computed tomography (CT) has been used to evaluate deep facial and neck infections.[4]

The development of maxillofacial space infection is influenced by microbial virulence, delayed care, weakened host immunity, and possible anatomical communications. Diagnosis of odontogenic maxillofacial space infections relies on a combination of clinical evaluation, imaging studies, and microbiological assessment. Management requires a comprehensive approach involving antimicrobial therapy, dental intervention, and supportive care.

CASE SERIES

This article presents an analysis of 20 patients diagnosed with space infections, categorized into distinct clinical clusters based on patterns of infection spread and key clinical parameters. These parameters include age, gender, diabetes status, white blood cell (WBC) count, number and type of anatomical spaces involved, organisms isolated, antibiotics administered, complications, and ICU requirements. The objective of this clustering was to identify meaningful clinical patterns through evaluation of demographics, comorbidities, laboratory markers, and treatment details, thereby enabling a structured understanding of disease severity, guiding management strategies, and aiding in risk stratification.

Clustering was conducted manually by senior author using clinical reasoning, informed by descriptive and comparative statistics derived from the dataset. Patients were grouped according to several criteria, including age, gender, diabetes status, white blood cell (WBC) count, number and type of anatomical spaces involved, organisms isolated on culture, antibiotics given, as well as any problems or the requirement for critical care.

Cluster 1: Mild, localized infection (n=4)

Patients in this cluster presented with infections confined to a single anatomical space. One of these individuals had diabetes, and all had WBC counts below 15,000. There were no complications, and none of the patients required ICU care. Treatment involved standard antibiotic therapy with Augmentin and Metronidazole and incision and drainage of the space infection. Hospital stays were generally short, lasting less than six days in most cases. Notably, no organisms were isolated in culture. This group represents low-risk, uncomplicated odontogenic infections that responded well to first-line treatment and routine drainage, with minimal intervention required. The patient with diabetes presented with swelling in the parotid space.

Cluster 2: Moderate, multi-space infection (n=10)

This cluster consisted of patients with infections involving multiple anatomical spaces, most commonly the submandibular, buccal, and masseteric regions. While diabetes was absent, a few patients showed borderline features. WBC counts were variable but predominantly remained below 15,000. Antibiotic regimens included combinations beyond the standard first-line treatment, occasionally incorporating second-line agents such as Linezolid or Gentamycin. Despite the broader extent of infection, there were, minimal complications with no ICU admissions, and hospital stays typically lasted less than a week. Bilateral involvement of the submental, sublingual and submandibular areas was observed in two patients. Management was done by starting the empirical antibiotics augmentin and metronidazole followed by incision and drainage from midline submental region and bilateral submandibular region. These patients represent an intermediate-risk group where the spread of infection prompted more comprehensive empirical therapy, although systemic deterioration was not observed.

Cluster 3: Severe or complicated infection (n=6)

The third cluster's patients had the most severe illness characteristics. Most had underlying diabetes, and WBC counts were consistently elevated above 15,000. Infections involved multiple deep or critical anatomical spaces, such as the superficial and deep temporal, parotid and lateral pharyngeal regions. Several patients experienced complications, including abscess extension and airway compromise, with some requiring ICU-level care. In one case, Burkholderia cepacia was isolated on culture, the same patient had a complication of necrotizing fasciitis which was manage by debridement under general anaesthesia, followed by regular irrigation and drainage.

Soft tissue management was done with placentrax gel and paraffin dressing. Treatment required the use of advanced, broad-spectrum antibiotics such as Piperacillin-Tazobactam (Pipzo), Meropenem, and Zostum. Hospital stays exceeded six days for all patients. This cluster represents high-risk individuals who required intensive and often multidisciplinary management, with diabetes and elevated WBC counts serving as strong predictors of disease severity and complications. Other case presented with swelling over neck and clavicular region. She had previously received treatment at a private hospital for bilateral submandibular and submental space infection, which included dental extractions of teeth 37 and 38 and placement of rubber drains in the respective regions.

Table 1: Data describing the analysis of the study.

Variable	Category	N	%
Gender	Male	15	75
	Female	5	25
Diabetes	Present	5	25
	Absent	15	75
Fever	Present	12	60
	Absent	8	40
WBC count	>15000	9	45
	<15000	11	55
Complication	Present	4	20
	Absent	16	80
No. of spaces involved	Single	4	20
	Multiple	16	80
Teeth involved	1 tooth	11	55
	2 teeth	9	45
Organisms isolated	Burkholderia cepacia	1	5
	Not Applicable (NA)	19	95
Antibiotic combination used	Augmentin+Metronidazole	12	60
	Other combinations	8	40
Hospital stay duration (days)	<6	10	50
	>6	10	50
ICU/special care required	Yes	2	10
	No	18	90

The patient reported new-onset swelling in the left cervical and clavicular regions, raising concerns about possible progression or recurrence of infection. A Contrast-Enhanced CT (CECT) of the neck and thoracic inlet was performed, revealing multiple abscess collections suggestive of an ongoing infective etiology. The patient was taken up for incision and drainage under sterile conditions. From the left lower cervical and sub clavicular areas, around 100 millilitres of purulent discharge were extracted. Rubber drains were installed so that drainage could continue. Post-operatively, the patient was started on intravenous Linezolid and Metronidazole (Metrogyl) to target both aerobic and anaerobic organisms.

The patient was monitored for systemic signs of infection, and regular wound irrigation and drain care were performed. Continued improvement was observed over the following days with a reduction in swelling and local inflammation.

DISCUSSION

In our study, we have tracked the treatment of the odontogenic maxillofacial space infection with antibiotics, incision and drainage and definitive dental extraction. Multiple factors were analyzed including age, gender, number and position of damaged teeth, spaces involved, and related systemic disease, symptoms, blood investigations, and complications. Out of total 20 subjects, 15 were males and 5 were females. This study's male majority was consistent with previous research in the field. As a result, 25% of the patients in our research were women and 75% were men. With an average age of 40.4 years, the patients' ages ranged from 23 to 65. This result was in correspondence with the retrospective analysis done by George C. Mathew in 2011 in Punjab.[1] The middle-aged patients were infected probably as they were more invested in social and financial responsibilities so they were ignorant for the treatment and when presented at the tertiary care they were already infected with primary and/or secondary spaces infection.

According to retrospective analysis conducted by Weise et al he analysed 483 patients all underwent at least one surgical procedure that involved an extraoral incision and drainage as well as high volume irrigation intraoperatively. The author concluded that odontogenic infections with fulminant progression should be treated according to clinical and imaging data with immediate surgical incision, intensification of intra and postoperative irrigation, and drainage to eliminate odontogenic foci. If needed, repeat imaging followed by further incisions should be performed. Immediate anti biotic treatment adapted to the antibiogram is of utmost importance.[5] In order to surgically decompress the swelling, an incision and drainage must be conducted as quickly as possible. It is necessary to remove the odontogenic focus, debride the necrotic tissue, and remove any dead space that may have formed during the cellulitic phase. Until the results of the culture and antibiotic sensitivity tests are obtained, empirical antibiotic therapy is started. If necessary, antibiotic substitution is then implemented.[3] Even in the age of antimicrobial pharmaceuticals, managing odontogenic maxillofacial infections is an uphill battle for the surgeon.

Patients who have not had treatment frequently arrive at the dentist's office with many secondary spaces involved, which can be fatal because of airway blockage.[6] Reducing mortality as well as morbidity in surgical practice can be achieved through timely and pertinent interventions in an infectious process. A complicated series of metabolic and systemic reactions brought on by infections or other damage sources may constitute the initial phase of the response. Signs and symptoms alone may not always be enough to determine the severity of a medical condition and its clinical impact in patients. To monitor patients with infections, inflammatory markers and clinical data are used together. Because fascial spaces are so close to crucial tissues, it's critical to pay special attention to the clinical status of individuals with OSI.

Spread of odontogenic head and neck infections occurs via hematogenous dissemination, lymphogenous dissemination, and/or direct extension into fascial spaces.[2] Accumulated pus perforates bone at the weakest and thinnest part of the bone. In the mandible, this is in the lingual aspect of the molar region. An odontogenic infection will move into the sublingual or submandibular region if it penetrates this area of bone. As these spaces are partially separated by a sheet of mylohyoid muscle, infection in either space easily spreads into the other. Consistent with this, we observed simultaneous involvement of these spaces in our study. Three of the patients included in cluster 1 showed this type of pattern of spread.[4] It is yet unclear how the disease spreads to the submandibular area. Infections originating in the mandible often spread to the submandibular space and several possible pathways have been suggested such as: spreading directly beyond the mylohyoid ridge of the mandible: spreading posteriorly from the adjacent sublingual space: spreading from the inflammatory periostitis of the mandible: spreading downward from the masticatory space.[7]

The superficial fascia extends from the head and neck to the thorax, shoulders, and maxilla. Deep to the superficial fascia lies the deep cervical fascia made of three layers: Superficial, middle, and deep layer. The submandibular and sublingual spaces communicate around posterior border of mylohyoid Edema and swelling of this space will cause superior and posterior displacement of the floor of the mouth and tongue causing airway compromise. The parapharyngeal space has the shape of a cone with its base facing the skull and communication with the brain can result in a cerebral abscess. Communication occurs via various foramina such as foramen ovale, foramen lacerum, and jugular foramen. The pretracheal space lies anterior to the trachea, and it descends into the anterior mediastinum. Spread of infection along this route is not common, accounting for only 7% of cases of descending necrotizing mediastinitis. The retropharyngeal space abscess can reach the mediastinum causing mediastinitis and more rarely, pericarditis. About 70% of cervical infections extend into the mediastinum via retropharyngeal space. Anterior to the vertebral bodies, the prevertebral fascia divides into the alar fascia (anterior) and the true prevertebral fascia (posterior). Between these fascial layers is a potential space called the “danger space”.[8]

Infection spreads into the masticator space likely through direct extension from the jaw bone where the infection originates, particularly around the roots of posterior teeth. The masticator space anatomically encompasses the posterior mandibular body, ramus, and parts of the maxilla, which predisposes it to involvement from infections in these areas. One patient in cluster 1 presented with parotid space infection. The parotid space abuts the posterior masticator space and is enveloped by a layer of the deep cervical fascia. Infections in the parotid space have been thought to result mainly from parotitis. The spaces adjacent to the masticator space are the parotid space posteriorly, the parapharyngeal space medially, and the submandibular and sublingual spaces inferiorly. The teeth involved were first and second molar of right mandibular arch. But the current investigation shown that odontogenic infections can sometimes spread into the parotid space, most likely through the masticator region.[4]

Cluster 2 included ten patients with moderate, multi-space infection. It is possible to communicate freely from the sublingual or submandibular area because of the midline.6 However, we encountered two patients who had bilateral involvement of the sublingual, submandibular space originating from mandibular molar infection. No complication was presented as both the patient was surgically drained at appropriate time under antibiotic coverage. Necrotizing fasciitis (NF) is an acute, rapidly progressive infection of the fascia and subcutaneous tissues that is well-recognized in various parts of the body, but is less common in the head and neck region. Necrotizing Fasciitis of the head and neck is most commonly referred to as cervicofacial necrotizing fasciitis (CNF), and can be subdivided into craniofacial Necrotizing Fasciitis, occurring above the lower border of the mandible, and cervical necrotizing fasciitis occurring below. The most common cause of CNF is odontogenic infection, particularly in those patients with chronic disease or those who are immune suppressed. Other causes include oropharyngeal infection such as tonsillitis and peritonsillar abscess, insect bites, trauma and postoperative infection.[9]

According to theory, temporalis muscle involvement was more frequently linked to maxillary infections than mandibular infections. Furthermore, in no case was maxillary infection associated with involvement of the sublingual or submandibular space. In cluster 3 a patient presented with the right buccal, right submandibular, and bilateral submental and submandibular, right temporal, and right para-pharyngeal spaces. Grossly carious tooth involved in space infection were right maxillary lateral, second molar, third molar and right mandibular second and third molar tooth. Cervicofacial space infections, particularly those arising from odontogenic sources, can progress rapidly if not diagnosed early. The patient developed necrosis of skin in the midline neck region. The unusual isolation of Burkholderia cepacia, an opportunistic pathogen more commonly seen in immunocompromised individuals, presents an added therapeutic challenge due to its resistance profile. In this case, prompt surgical intervention, identification of the causative organism, and antibiotic adjustment were key to successful management. Necrotizing fasciitis of the neck, while rare, requires high suspicion, especially in rapidly deteriorating patients. Literature supports early and aggressive surgical debridement as a cornerstone of treatment, in addition to broad-spectrum and culture-directed antibiotics.

Deep space head and neck infections today are still among the most frequent clinical pictures within the maxillofacial area and mostly require an immediate and accurate treatment.[10] There are two main factors that promote spreading of Deep Neck Infections towards the mediastinum: the cervical anatomy with an almost enclosed space along the fascial planes of the neck and chest, and the effects of gravity and the recurrent changes in the negative intrathoracic pressures that occur with respiration.[11] The case of left subclavicular space infection from cluster 3 emphasizes the potential for odontogenic infections to spread to deep cervical and subclavicular spaces, particularly when the infection tracks along fascial planes. Although bilateral submandibular and submental drainage was initially performed, residual infection or missed pockets can serve as foci for further spread. This highlights the importance of comprehensive imaging, particularly CECT, in evaluating cervicofacial infections that do not respond to initial treatment. While deep neck infections are well documented, involvement of the subclavicular region is less common and demands high clinical suspicion. Early surgical intervention remains critical, and antibiotic selection should be guided by the suspected polymicrobial flora of odontogenic origin.

Diabetes is a progressive metabolic disease that manifests as chronic hyperglycemia in type 1 and type 2 diabetes, respectively, due to defects in beta cell insulin output and/or peripheral tissue insulin resistance. Patients with diabetes not only have a higher chance of contracting infectious diseases, but they also react poorly to infections once they do arise, especially when their glucose control is unsatisfactory. The immune system, including complement, immunity within cells, and neutrophil function, is disrupted by systemic hyperglycemia.[6] The penicillin's today is still widely used and are often the antibiotics of first choice. But concern exists about the potential risk of an increase of bacterial resistance even against modern synthetic antibiotics.[10]

Combinations of antibiotics were used among which most common was amoxicillin plus clavulinic acid and metrogyl. Compared to amoxicillin alone, amoxicillin/clavulanic acid had greater effectiveness against both the aerobic pathogens (100%) and the anaerobic pathogens (90.76%). By providing beta lactamase resistance, the addition of clavulanic acid broadens the spectrum to include staphylococcus and other anaerobes. Other antibiotics used were clindamycin, linezolid, gentamycin, pipzo, meropenem and cefoperazone plus sulbactam.

In 95% of the cultured samples in our investigation, no growth of bacteria was detected, and anaerobes were isolated in only a couple of cases. Similar results have been seen in other places. Patients in India frequently prescribe themselves and use medicines available without a prescription. In addition to seeing several dental professionals, patients with oral infections seek out symptomatic alleviation without receiving full treatment. The majority of patients who arrive at a tertiary facility with a serious infection have already taken several courses of antibiotics. The results of the microbiological tests may have been impacted by the administration of antibiotics before admission, large dosages of intravenous antibiotics before surgical drainage, inappropriate specimen collection, the lack of routine anaerobic cultures, and the challenge of culturing anaerobes.[1]

All patients responded satisfactorily to empirical antibiotic therapy, despite the fact that 95% of the cases did not result in any growth. Because high-dose antibiotics are begun according to protocol right away and therapy is not altered based on culture and sensitivity results until the patient does not appear to be responding clinically, the clinical use of regular testing has been questioned. Furthermore, despite being slightly different from that of an acute dental infection, the bacteriology of severe odontogenic infections is still a complicated mixture of facultative and stringent anaerobes, the culture of which might be difficult for a non-specialist microbiology.

Unless a failure in clinical response indicates otherwise, culture and sensitivity testing of pus might be postponed in contexts where routine testing is challenging due to a lack of facilities and the high expense to the patient.[1] 60% of patients were discharged within 6 days of admission with adequate mouth opening and absence of any symptoms. Forty percent of patients spent more than six days in hospital. On consecutive follow- ups patients had no fresh complaints or recurrence. A 5-year retrospective study conducted by George Mathew and his colleagues showed that 71% of the patients were discharged within 6 days of their admission.

CONCLUSION

The retrospective study highlights the complexities in managing odontogenic maxillofacial infections, particularly in patients with systemic conditions like diabetes. The study underscores the importance of early surgical intervention, aggressive antibiotic therapy, and vigilant monitoring of inflammatory markers to ensure positive clinical outcomes. Male preponderance and mandibular third molars as the main infectious source were consistent with previous literature. The majority of patients presented with multiple space infections, with the submandibular region being the most often involved. Three distinct clinical profiles emerged from this cluster analysis of patients with space infections. Cluster 1 included those with mild, localized infections managed effectively with first-line treatment and short hospital stays. Cluster 2 represented moderate cases with multi-space involvement requiring broader antibiotics, though without systemic complications. Cluster 3 consisted of severe cases characterized by comorbid diabetes, high WBC counts, deep-space infections, complications, and the need for intensive care. Key indicators of disease severity included WBC count, diabetes status, and the extent of anatomical involvement. Recognizing these clusters can support early risk stratification, optimize empirical antibiotic selection, and enhance resource planning, particularly with respect to ICU utilization. Future studies should incorporate advanced diagnostic tools, evaluate alternative antibiotic regimens, and assess the impact of self-medication on the microbiological profile of odontogenic infections. Additionally, long-term follow-ups and the use of advanced imaging techniques could enhance treatment strategies and improve patient outcomes.

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