



ODONTOGENIC INFECTIONS: UPDATED RECOMMENDATIONS AND BEST PRACTICES

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ABSTRACT

Odontogenic infections stemming from the teeth or surrounding tissues are a prevalent source of discomfort and illness in oral health. It is imperative to treat these infections effectively because, if left untreated, they may have serious consequences. With the latest discoveries in pathogenic processes, antibiotic treatments, and integrated patient care techniques, this publication offers revised recommendations and best practices for managing odontogenic infections. Tooth caries, periodontal disease, tooth trauma, and invasive dental procedures are the main causes of odontogenic infections because they allow bacteria to invade and multiply. A comprehensive medical exam, complete records of affected patient, and proper imaging strategies are necessary for analysis. Prompt antibiotic usage is encouraged in updated guidelines, with first-line antibiotics like amoxicillin being chosen, unless contraindicated, to prevent resistance and limit side effects. In addition, particular dental processes like endodontic therapy, abscess drainage, and tooth extraction are used as part of the treatment program to remove the source of infection. Treatment for sepsis, osteomyelitis, Ludwig's angina, and cellulitis should be initiated quickly. Maintaining good oral hygiene, managing systemic illnesses appropriately, using antibiotics properly, and controlling infections in dental practices are all important aspects of prevention. This article includes case research highlighting the management of severe odontogenic infections, together with surgical interventions and antibiotic treatments. Moreover, it underscores the importance of early prognosis, targeted treatment, and preventive measures to control odontogenic infections correctly, improving patient outcomes and reducing the incidence of severe complications.

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KEYWORDS: *Odontogenic infection, antibiotic therapy, periodontal disease, microbial diagnosis, sepsis, Ludwig's angina, abscess drainage*

INTRODUCTION

Odontogenic infections are infections that start in the gums, alveolar bone, periodontal ligaments, or teeth themselves (1). They can range from localized abscesses to more serious systemic diseases, and they are among the most frequent causes of pain and illness in oral health (2). Odontogenic infections need to be managed carefully since they can spread to other anatomical tissues and, if left untreated, can result in serious side effects such as mediastinitis, deep neck infections, or even potentially fatal sepsis (3).

The pathophysiology of odontogenic infections has been brought to light by recent advances in our understanding of these disorders, which have specifically focused on the involvement of polymicrobial communities and the interactions between aerobic and anaerobic bacteria (4). Traditional therapeutic approaches have also been called into question due to the advent of antibiotic-resistant bacteria, with a focus on the importance of accurate microbiological diagnosis and focused antimicrobial therapy (5). As a result of advancements in our knowledge of the pathogenic mechanisms underlying odontogenic infections, the development of novel antibiotic therapies, and the adoption of a more comprehensive patient care approach involving not only otolaryngologists and infectious disease specialists but also dentists, guidelines for the management of these infections have changed in recent years (6). In addition, the use of computer-aided surgery and 3D imaging has improved the diagnosis and surgical treatment of many infections by enabling less intrusive and more accurate procedures (7).

DISCUSSION

Causes and pathogenesis of odontogenic infections

Infections that start in the teeth or the supporting dental structures are referred to as odontogenic infections. Anaerobic bacteria like *Streptococcus*, *Peptostreptococcus*, and *Bacteroides* species are the most frequent causes of these illnesses, which are essentially bacterial in origin. Dental caries, or tooth decay, are frequently the first cause because they open a crack in the enamel that allows germs to enter the dental pulp. Bacteria can be introduced into dental tissues or their surrounding areas via invasive dental procedures, trauma, and periodontal disease, among other contributing factors. Bacteria can multiply and spread to the surrounding bone and soft tissues once they get to the pulp of the tooth (8). This bacterial invasion causes the host tissue to become inflamed, which may lead to the development of osteomyelitis, cellulitis, or abscesses. Odontogenic infections are caused by bacteria that produce toxins, break down natural tissue barriers, and activate the host's immune system. Serious pain, swelling, and even systemic problems may result from these infections if they are not treated right away (9). Antibiotic medication to suppress the infection and dental treatments such as extractions, root canal therapy, or drainage to address the underlying cause are usually necessary for effective management.

Cavities, also referred to as dental caries, are a major source of odontogenic infections. The acidic byproducts of bacterial metabolism demineralize the enamel at the start of the process. Bacteria can easily enter deeper tissues through the carious lesion's direct progression into the dentin and eventual arrival at the tooth pulp. When an infection extends past the tip of the root into the surrounding bone, it can lead to the formation of a periapical abscess (10).

The gums, periodontal ligament, and alveolar bone are among the tissues that support the teeth that are chronically inflamed and infected by periodontal disease. Because of bone loss and gum recession, periodontal pockets emerge, which foster the growth of harmful germs. The breakdown of the alveolar bone and periodontal ligament as periodontal disease progresses can make it easier for bacteria to go from the gums to the surrounding tissues and circulation.

Tooth trauma, such as fractures or severe cracks, can cut off blood flow to the pulp, which can result in pulp necrosis and open the door for bacterial growth. Due to their increased susceptibility to trauma, anterior teeth injuries are especially common. Bacteria can enter and grow in necrotic pulp, which increases the risk of an abscess or the infection spreading to other tissues (11).

Implant installation, endodontic treatments, and extractions are dental operations that, if not carried out under appropriate sterile conditions, might introduce bacteria into sterile areas. Also, by allowing germs to colonize surgical areas, poor oral hygiene and insufficient post-operative care might raise the risk of infection even further (12).

Due to the accumulation of plaque and tartar on teeth, poor oral hygiene practices play a major role in the development of odontogenic diseases in humans. Increased risk of bacterial invasion into deeper dental and periodontal tissues results from this build-up, which can cause both gum disease and tooth damage (13).

Pathogenesis of Odontogenic Infections

The host's immune system and pathogenic microbes interact intricately throughout the pathogenesis of odontogenic infections. The principal bacteria implicated include facultative and anaerobic species, such as *Fusobacterium nucleatum*, *Porphyromonas gingivalis*, *Prevotella spp.* and *Streptococcus mutans*.

Numerous pathways, including carious lesions, periodontal pockets, and traumatic trauma, allow bacteria to enter oral tissues. After they break through the barriers of soft tissue or enamel, bacteria avoid the body's defenses and start an infection (14).

Bacteria spread quickly throughout the infected tissues, triggering an immediate inflammatory reaction. The hallmark of this reaction is the inflow of neutrophils, which try to stop the infection but frequently cause tissue damage that leads to pus and the formation of abscesses. In the event that the infection is not adequately managed, it may progress via the head and neck's fascial planes and cause systemic side effects such as sepsis, cellulitis, or osteomyelitis. When virulent bacterial strains or an overtaxed local immune response are present, the likelihood of systemic involvement increases dramatically (15).

Diagnosis and Initial Evaluation

Compiling a full clinical examination, employing the right diagnostic instruments, and getting a detailed patient history are all necessary for a complete and accurate diagnosis of odontogenic infections (16).

When pain, swelling, fever, and pus leakage are present, clinicians should obtain a thorough history of the patient's symptoms. Any recent dental work, injuries, or adjustments to oral hygiene practices that may increase the risk of infection should also be noted (17).

Observing the oral cavity visually, palpating any uncomfortable or swollen areas, testing the movement of the teeth, and looking for purulent drainage or fistulas are all important components of the clinical examination. Determining the degree of periodontal disease, carious lesions, and periapical infections requires the use of radiographic imaging, such as panoramic and intraoral (periapical and bitewing) X-rays. Computed tomography (CT) scans can give precise information regarding the location and severity of an illness in more complicated cases (18).

Antibiotic Therapy

Antibiotics must be used carefully while treating odontogenic infections to reduce the chance of bacterial resistance and any negative side effects.

When there are indications of generalized cellulitis, fever, lymphadenopathy, or when local drainage is not possible, an antibiotic prescription should be made. Antibiotics might not be required for confined infections that can be successfully drained (19).

Because of their effectiveness against common oral bacteria, amoxicillin and amoxicillin with clavulanic acid are often prescribed as first-line antibiotics. Clindamycin or metronidazole are suitable substitutes for penicillin allergy sufferers. Depending on the severity and persistence of the infection, the course of antibiotic therapy typically lasts between five and seven days. If the infection worsens or does not go away, further treatments can be required (20).

Dental Interventions

In addition to medication, targeted dental procedures are necessary to address the infection's source.

The recommended treatment for infections of the tooth pulp is root canal therapy, including cases of acute pulpitis and periapical abscesses. Along with cleansing and closing the root canals to stop reinfection, this operation includes removing the affected pulp tissue. Surgical drainage becomes necessary to release pressure and remove pus in circumstances when an abscess has formed. Incision and drainage or root canal therapy can accomplish this. Extraction may be necessary to remove the source of infection from a tooth that is significantly damaged or irreparable. To remove any necrotic tissue and prevent additional infection, post-extraction care involves complete debridement of the site (21).

For infections originating from periodontal disease, deep cleaning procedures, such as scaling and root planing, are effective in removing plaque and tartar below the gum line, thereby reducing bacterial load and inflammation (22).

Management of complications

In dentistry and medicine, the care of odontogenic infection-related problems is essential since these infections can result in both local and systemic issues that call for quick and forceful intervention. These consequences can include potentially fatal illnesses, such as sepsis, as well as the spread of infection into soft tissues and bone structures (23).

1. Ludwig's Angina and Cellulitis

Serious side effects linked to odontogenic infections include cellulitis and Ludwig's angina, which are characterized by the infection spreading through the soft tissues of the face and neck. There is a strong chance of airway blockage and considerable swelling from this (24). The patient is managed with prompt intravenous antibiotic therapy, surgical drainage to remove pus and lower tissue pressure, and, in more serious situations, airway management procedures including tracheotomy or intubation to guarantee proper breathing (25).

2. Osteomyelitis

Dental infections that extend to the underlying bone can result in osteomyelitis, an infection of the jawbone. Prolonged intravenous antibiotic therapy is necessary for this situation in order to guarantee appropriate medication concentration at the infection site (26). Surgical intervention for debridement or removal of non-viable bone portions may be required if the infection results in bone tissue necrosis. To completely remove the infection and stop more problems, a combination of antibiotic medication and surgery is required (27).

3. Odontogenic Sinusitis

Odontogenic sinusitis, which is characterized by facial pain, nasal congestion, and perhaps purulent discharge, can result from infections affecting the upper teeth spreading to the maxillary sinuses (28). Decongestants are used to lessen sinus swelling and inflammation and antibiotics are used to treat the infection in the early stages of treatment. To restore proper sinus function, surgical drainage may be required if there is a sizable accumulation of pus or fluid in the sinuses (29).

4. Sepsis

Sepsis is a serious and sometimes fatal illness involving the systemic inflammatory response to infection which can occasionally result from odontogenic infections. Severe sepsis patients need to be admitted to an intensive care unit (ICU) immediately, where they should receive intravenous (IV) broad-spectrum antibiotics to fight the underlying infection (30,31). In order to sustain blood pressure and guarantee sufficient blood flow to essential organs, hemodynamic support could also be required (32,33). A multidisciplinary strategy is important to manage sepsis, and involves experts in infectious disease, critical care specialists, and, if required, maxillofacial surgeons to address the primary source of infection (34,35).

In conclusion, a variety of consequences can result from odontogenic infections, and each one calls for a unique and frequently intricate course of therapy. Effective patient recovery and the avoidance of unfavorable consequences depend heavily on prompt diagnosis and vigorous intervention (36,37).

Prevention and Best Practices

Maintaining a healthy mouth and general wellbeing prevents odontogenic infections. Practicing good oral hygiene is one of the best methods to lower the risk of this illness. This entails educating patients on the value of consistent brushing and flossing in addition to arranging for regular dental examinations (38,39). These habits aid in the prevention of odontogenic infections, which are frequently brought on by gum disease and tooth decay (40,41). Long-term oral health can be promoted, and the risk of infections can be greatly reduced by teaching patients these basic principles of dental care (42,43).

Keeping systemic health issues under control is just as vital as practicing basic oral hygiene (44,45). An individual may be more vulnerable to infections, particularly oral infections, if they have certain medical conditions such as diabetes (46,47). Patients with health conditions need to be closely monitored and managed in collaboration with their medical professionals to lower their risk of infection (48,49). When dental and medical providers coordinate care, patients are given all-encompassing care that considers all facets of their health, which reduces the risk of infection-related issues (50,51).

Another important element in preventing odontogenic infections is the appropriate use of antibiotics (52,53). Antibiotic resistance and other negative effects can result from the overuse or misuse of antibiotics, making it more difficult to treat diseases successfully (54,55). As a result, it's critical to adhere to tight standards for the use of antibiotics, making sure that they are only provided when necessary and at the appropriate dosage and duration (56,57). Dental practitioners can safeguard patient health and stop the growth of resistant germs by following these recommendations (58,59).

Maintaining current knowledge on infection prevention, diagnosis, and treatment is another essential aspect of continuing education for dental practitioners (60,61). Ensuring that the highest standards of care are upheld can be achieved by keeping up with the latest techniques (62,63). Furthermore, the incidence and severity of odontogenic infections can be decreased by teaching patients about infection prevention techniques, identifying warning symptoms, and realizing the significance of receiving healthcare promptly (64-66).

And lastly, two crucial strategies for infection control in dental clinics include keeping all dental treatments sterile and utilizing appropriately hygienized instruments (67,68). All patients will have a safer and healthier experience if dental practitioners adhere to these thorough precautions, which can effectively avoid odontogenic infections, reduce problems, and enhance patient outcomes (69,70).

CASE 1

A 70-year-old Caucasian male with a complex medical history including obesity, hypertension, type II diabetes, ischemic heart disease, chronic obstructive pulmonary disease, and a previous transient ischemic attack presented to the Bari Polyclinic in Italy with dyspnea, spontaneous pain, and swelling in the right mandible. The patient had been previously treated at another hospital with antibiotics for the mandibular edema but was later transferred to the ICU at Bari due to severe mediastinal involvement from a purulent phlegmon. A rectal swab revealed an infection with *Klebsiella Pneumoniae Carbapenemase* (KPC).

Initial blood tests showed no leukocytosis, but C-reactive protein was elevated. A non-contrast CT scan of the neck and chest revealed inhomogeneous tissue with air bubbles in the right sub-mandibular area, suggesting an abscess affecting the surrounding muscles, including the sternocleidomastoid muscle, the right thyroid lobe, and the right submandibular gland. The mediastinum and lung parenchyma also showed signs of infection and inflammation.

The patient underwent a complex surgical procedure, including intubation, tracheostomy, sialoadenectomy, and abscess drainage. The surgery involved extensive dissection to drain abscesses and protect vital structures. Post-operatively, the patient was treated with a combination of broad-spectrum antibiotics. Follow-up CT scans showed a reduction in the mediastinal and prevertebral abscesses, although the right submandibular area remained swollen.

The patient's condition was complicated by the presence of *Klebsiella Pneumoniae* and *Staphylococcus hemolyticus*, confirmed by cultures from swabs and aspirates. Dental surgery was later performed to extract an infected tooth, which was identified as the source of the infection (Fig.1-4) (Fig.5-8).



Fig. 1, 2, 3, 4. Intraoral photo and a detail of the dental element 4.3 before the extraction; extracted 4.3 and intraoral photo after the extraction in which hemostasis with Tabotamp was performed.

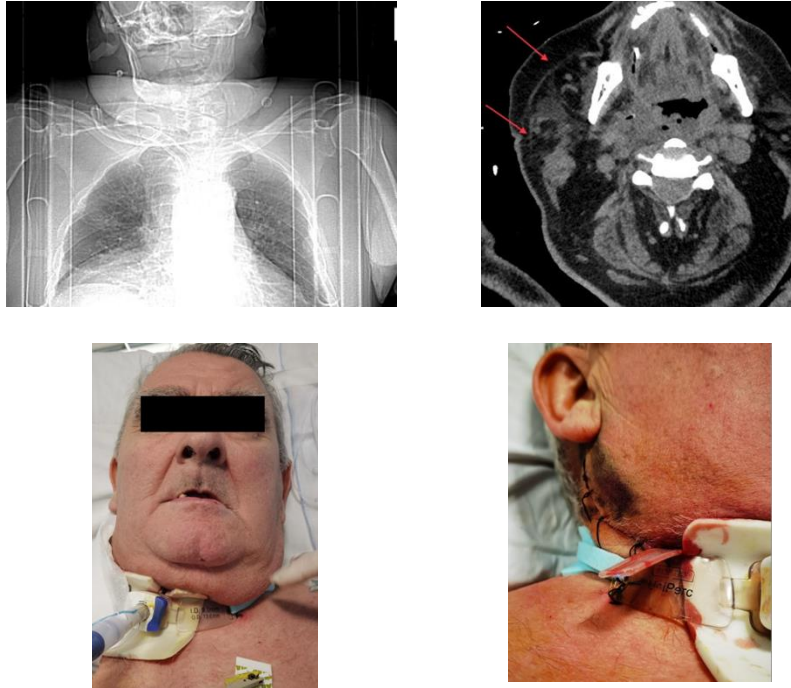


Fig. 5, 6, 7, 8. Patient photos after the emergency surgery: front and right side. Evidence of the tracheotomy and of placement of cannula type Porte n. 9.

This case highlights the serious risks associated with untreated odontogenic infections, which can spread to the neck and mediastinum, leading to life-threatening conditions such as deep neck abscesses, cellulitis, and necrotizing fasciitis. Early diagnosis and prompt surgical intervention are crucial to prevent fatal outcomes. Imaging techniques like CT scans play a vital role in assessing the extent of infection and guiding treatment. Despite the availability of antibiotics and advanced surgical techniques, deep-neck infections remain a significant clinical challenge due to their potential for rapid progression and severe complications.

CASE 2

This case report details the medical journey of a 59-year-old retired woman with decompensated type 2 diabetes mellitus and hypercholesterolemia. She was admitted during the COVID-19 pandemic with swelling in the right mandibular region, which worsened over seven days, leading to dysphonia and difficulty swallowing (Fig.9-11). Initial physical examination revealed a large abscess on the right side of her face, trismus (jaw muscle spasm), and edema in the tongue and mouth floor. Diagnostic tests, including a negative COVID-19 swab, blood tests, and imaging studies (X-ray, CT scans), were conducted. The scans revealed gas bubbles in the cavernous sinuses and a significant phlegmon (a type of inflammation) extending through the neck and face (Fig.12).



Fig. 9, 10, 11. Evident swelling of the medial and inferior third of the right side of the face.



Fig. 12. Neck-Chest CT that highlights presence of bilaterally gas bubbles in correspondence of the cavernous sinuses. At the level of the neck, a large phlegmonous collection with a considerable contextual air share located mainly in the right half face, the platysma and the ipsilateral parotid gland capsule. Medially it extends to the buccal floor to the left submandibular lodge and the sternocleidomastoid fascia.

Given the severity of the infection, emergency surgery was performed to drain the abscess and remove the right submandibular gland. A tracheostomy was also conducted to secure the patient's airway. Post-surgery, the patient was prescribed a combination of antibiotics (Teicoplanin, Levofloxacin, Ceftriaxone) and was closely monitored.

Despite the surgery, the patient developed septic shock by the third day of hospitalization, necessitating admission to ICU and the administration of vasopressors to maintain blood pressure. Further imaging studies showed an increase in the phlegmonous collection, especially on the left side, and the continued presence of gas bubbles in the cavernous sinuses. However, no venous thrombosis was detected.

Subsequent surgeries included the extraction of teeth associated with the infection and additional drainage procedures. The patient remained under controlled mechanical ventilation and gradually improved, with the Sequential Organ Failure Assessment (SOFA) score dropping, indicating stabilization. Over the next few days, her condition continued to improve, leading to successful weaning from the ventilator on the ninth day.

After further consultations, a new CT scan revealed stable conditions with no need for additional surgery. The patient remained stable for ten days post-surgery, showing good neurological orientation and gas exchange. She was discharged approximately one month later.

A follow-up three months after discharge showed no visible external swelling and good intraoral tissue healing. Control imaging revealed significant improvement, with almost complete reabsorption of the gas bubbles in the cavernous sinuses and a reduced phlegmon in the neck, with no further complications.

CASE 3

A 42-year-old male patient with a history of good oral health had recently developed a dental infection in tooth 3.7. The patient had always paid attention to his oral hygiene, but despite this, he began to experience acute pain and increasing sensitivity in the affected tooth. Initially, he attributed the pain to a simple trauma or cavity, but when the pain became unbearable, he decided to consult his trusted dentist (Fig.13-15).



Fig. 13, 14, 15. Evident swelling of the medial and inferior third of the left side of the face. Photograph showing a close view of the phlegmon on the internal side of the left cheek.

During the visit, the dentist conducted a thorough examination and detected the presence of a periapical abscess which was confirmed by a dental X-ray. The abscess was the result of a bacterial infection that had developed around the tip of the tooth's root. Immediate treatment was essential to prevent the spread of the infection and to alleviate the patient's pain.

The treatment involved opening the tooth to drain the abscess, followed by cleaning and disinfection of the root canal. The dentist used endodontic techniques and external drainage to remove the infected tissue and to ensure that the root canal was thoroughly sterilized. After the cleaning, the canal was sealed to prevent further infection.

In addition to this treatment, the patient was prescribed a course of antibiotics to fight the infection. The patient was instructed on how to monitor the treatment site and what to look for in terms of signs of residual infection or post-operative complications.

After the treatment, the patient reported significant relief from the pain and expressed his gratitude for the timely and professional intervention by the dentist. The patient is now following a rigorous oral hygiene routine, which includes the use of dental floss and rinsing with an antibacterial mouthwash, to prevent future infections and maintain the health of his teeth and gums.

The case illustrates the importance of quick and effective intervention to avoid the serious risks associated with untreated odontogenic infections and shows that early diagnosis and intervention are crucial to prevent serious complications.

CONCLUSIONS

Odontogenic disorders pose a serious threat to both oral and general health and require a comprehensive approach to treatment. A combination of early diagnosis, targeted dental care, appropriate antibiotic medication, and other therapies should be employed in addition to effective preventive measures. By following the most recent recommendations and best practices, healthcare practitioners can significantly reduce the incidence of these illnesses and the associated damage. Such proactive measures not only improve clinical outcomes and patients' quality of life, but also ensure that they receive the best care possible. The wide-ranging impacts of odontogenic infections must be managed and prevented with an integrated approach.

Author Contributions

Conceptualization, A.D.I., F.I., A.M.I., G.I. and A.S.; methodology, A.D.I., D.C., P.M., G.D., G.I. and A.L. software, F.I., G.D., A.D.I., D.C. and A.S.; validation, F.I., A.M.I., G.D., A.L. and P.M. formal analysis, A.D.I., A.M.I., A.L., D.C. and G.S.; investigation, G.D., P.M., G.I., F.I. and A.S.; resources, A.M.I., A.S., A.D.I., F.I. and G.D.; data curation, G.D., D.C., P.M., A.S. and F.I.; writing original draft preparation, A.D.I., P.M., D.C. and G.I.; writing review and editing, F.I., A.L., D.C., A.M.I. and G.I.; visualization, D.C., A.S., A.D.I., A.L. and A.M.I.; supervision, G.D, F.I., A.D.I., A.M.I. and G.I.; project administration, P.M., D.C., F.I., A.M.I. and G.D.. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

Data is contained within the article.

Conflict of interest

The authors declare that they have no conflict of interest.

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