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Review Article

Odontogenic Infection: A Review

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Abstract

Odontogenic infections are frequently seen in the dental practice, being dental caries its main etiology; therefore, dentists should be familiarized with its presentation and management as it can spread rapidly and have serious consequences. The purpose of this article is to provide essential knowledge on the pathogenesis, diagnosis, possible complications and treatment of odontogenic infections.

Keywords: Odontogenic infection, Dental infection, Infection, Complications, Management.

Introduction

Odontogenic infections (OI) are infections that start in the pulp or gums, affect the alveolar bone, and can spread through the bone marrow, cortical bone, and periosteum to parts of the body far from the mouth.

OI is one of the most common diseases. In fact, it is the reason that 60 percent of people go to the dentist [1,2]. The main cause is dental caries, but it can also come from pericoronitis, periodontal pockets, or exodontia [3]. The severity of the infection depends on many things, like how dangerous the bacteria are, how the patient's body is doing, and what parts of the body are infected.

Sometimes, symptoms and clinical signs can get so bad that they need to be treated in the hospital. Spreading OI can make it hard to breathe, which puts lives at risk [4].

Since Hippocrates' time, it has been known that the only way to get rid of an OI is to get rid of the infectious agent and drain the wound. It also needs to be paired with antibiotic treatment [6].

The goal of this article is to give you important information about what causes

odontogenic infections, how to diagnose them, and how to treat them, allowing a treatment to be set up that keeps the infection localized and stops it from spreading to deep anatomical spaces. This keeps the patient safe.

Pathogenesis

How the host reacts to an infection

The immune system is a group of specialized cells that work as a protective barrier. The immune system is made up of two parts: the innate system and the acquired system [7].

The innate system is a type of defense that works when an antigen comes in contact with it. On the other hand, the acquired system is a type of defense that is specific to an antigen and can recognize the antigen it is up against. So, making memory cells that can quickly find an antigen and act against it if it comes back [7]. The immune system is made up of leukocytes like T, B, and killer lymphocytes, granulocytes like neutrophils, basophils, eosinophils, and mast cells, and antigen-presenting cells like macrophages, Langerhans cells, and dendritic cells [8].

When bacteria get into the body, a series of immune responses happen to fight the infection. The macrophage is the body's first line of defense. It does two things: it releases chemotactic factors that bring neutrophils to the site of the injury, and it acts as an antigen-presenting cell for the neutrophils, which eat bacteria. Chemicals like histamines, bradykinins, cytokines, and prostaglandins are released, which causes the blood vessels to widen and the spaces between endothelial cells to open. This lets plasma flow into the spaces between the cells, where it builds up and then turns into fibrin. During an infectious process, people can see the classic signs of inflammation, like swelling, redness, pain, edema, and loss of function [9]. To sum up this process, we can say: 1) Increased blood flow from dilated blood vessels; 2) Extravasation of plasma and white blood cells; 3) Increased permeability and neutrophil diapedesis; 4) Formation of fibrin walls; 5) Ingestion of bacteria by macrophages; and 6) Deposition of dead tissue by macrophages [2].

Patients with low immunity

There are many things that can weaken the immune system, such as using corticosteroids for a long time, getting a transplant, having HIV, being an alcoholic, having liver disease, or having diabetes [10].

OI is a lot more likely to happen when a person has a health problem. Even more than the location of an infection, systemic diseases have been shown to make a person stay in the hospital longer and take longer to get better [11].

The most common systemic condition is diabetes, which, when not under control, makes infections worse and lengthens hospital stays because the immune system doesn't work as well [12].

Hyperglycemia happens when diabetes isn't under control. This affects the body's defense cells and makes it easier for an infection to stay around [7,13,14]:

1. Lessening of leukocytes' ability to move, stick together, move, and eat. They are less able to fight off bacteria and keep the inflammatory state going for longer.

2. Fewer fibroblasts, endothelial cells, and collagen are being made. stops tissue from healing.

3. Macrophages and monocytes avoid apoptosis, which makes them make more cytokines and keeps the inflammatory process going for longer. Insulin resistance gets worse when there is chronic inflammation.

4. Microangiopathy slows blood flow, which means fewer oxygen and nutrients get to cells that protect and heal. Also, it makes it harder for antibiotics to get to the place where the infection is.

5. Keratinocytes can't make as many copies

as they used to, so wounds take longer to heal.

Microbiology

Normal oral flora is made up of a mix of bacteria that can live with or without oxygen [15]. Aerobic bacteria can live and grow in places where there is oxygen. They set up the environment so that anaerobic bacteria, which live and grow without oxygen, can spread and take over. Due to their high virulence, strict anaerobic bacteria are more likely to get into tissues and damage them [4].

OI is caused by many different kinds of bacteria. There are more gram-positive cocci and gram-negative rods than gram-negative rods, with streptococci being the most common Table 1 [16,17]. The number of anaerobic bacteria to aerobic bacteria is 3 to 1. 75 percent have anaerobic bacteria, and 25 percent have aerobic bacteria [2]. Even though the virulence of the bacteria is one thing that can affect how bad an infection is, the number of bacteria is often more important in getting past the host's defenses [4]. The increment in bacterial load increases the diversity of microorganisms. When they work together, there is a synergy that makes them more dangerous [18].

Table 1: Common bacteria in OI. Adapted from Brook I, et al. [17].

Gram stain	**Type of bacteria**	**Aerobes or facultative anaerobes**	**Strict anaerobios**
Gram-positive	Cocci	Streptococcus spp Staphylococcus spp	Peptococcus spp Peptostreptoccus spp
	Rods	Lactobacillus spp	Eubacterium Actinomyces
Gram-negative	Cocci		Veilonella
	Rods	Capnocytophaga spp Actinobacilo spp Eikenella spp	Porphyromonas spp Bacteroides spp Prevotella spp Fusobacterium spp Selenomonas sputigena

Table 2: Anatomic spaces of the oral and maxillofacial region. Adapted from Hupp JR, et al. [20].

	Localization	**Spaces**
Primary	Maxillary	Buccal, palatal, vestibular
	Mandibule	Vestibular
Secondary	Maxillary	Canine/infraorbital, orbital
	Mandibule	Sublingual, submandibular, parotid, pterigomandibular, superficial temporal, submental, deep temporal, peritonsillar masseteric
Advanced	Deep neck	Lateral pharyngeal, retro pharyngeal, carotid, pretracheal, visceral, mediastinum

Table 3: Severity scale of the compromised anatomic spaces. Adapted from Flynn T, et al. [21].

Severity Scale	**Anatomic space**
1 : Mild risk	Canine, vestibular maxillary and mandibular, palatal
2: Moderate risk	Submandibular, sublingual, submental, pterigomandibular,

	submasseteric, temporal,
3: Severe risk	Retropharyngeal, pterigopalatal, pretracheal, pterigopharyngeal
4: Extreme risk	Mediastinum, intracranial, prevertebral

Dissemination of odontogenic infection (OI):

OI start in dental and/or periodontal tissues and spread to deeper parts of the body [19]. When bacteria get to the dental pulp, they cause necrosis and cause an abscess to form. Once the infection is in the periapical tissue, it goes through the cortical bone periosteum and follows the path of least resistance.

1. Muscle attachments that show which way the infection is going and where it is.

2. The location of the tooth's tip.

3. How thick the bone around the tooth is.

There are three ways that OI gets around:

1) By continuity through anatomical spaces that, because they are virtual and don't have real physical ļimits, make it easy for the infection to spread from one to the other. 2) Getting into the circulatory system through the hematological route. 3) By lymphatic route: If it gets into the lymphatic system of the head and neck, it can spread through the lymph from the primary nodule close to the infectious focus to a secondary nodule in a different place [4].

Flynn et al. classify the severity of an infection based on which parts of the body are affected [21]. Figure 3. It has been said that the vestibular space (50%) is the aponeurotic space that is most often affected. However, other studies have found that it is the buccal space (60%) and the submandibular space (35%). Beyond these differences, it was decided that 43–60% of deep neck space infections are caused by infections that start in the mouth [23,24].

Diagnosis

The clinical picture

The patient's medical history and symptoms are used to figure out if he or she has an OI. When you know when the symptoms started and how fast the infection spread, you can figure out how bad it is [20].

During diagnosis, it is very important to look at the patient's body. In the later stages of OI, vital signs change and there are fewer white blood cells. This is called Systemic Inflammatory Response Syndrome. Temperature is between 36° and 38°, heart rate is over 90/min, breathing rate is over 20/min, and neutrophils are over 12,000 mm3 [25].

During the examination, the affected area is seen to be swollen and red. The patient's dental, periodontal, and perioral health should be looked at [9]. During the exam of a person with OI, there are three stages that can be found: Cellulitis, immunization, or abscess [20].

Pain, redness, heat, swelling, and loss of function are all signs and symptoms of inflammation. Depending on how bad the infection is, there may be a rise in body temperature, diaphoresis, general malaise, odynophagia, dyspnea, dysphagia, and trismus. Some of these signs and symptoms point to an infection that needs to be treated by a specialist in the hospital [3,9,20].

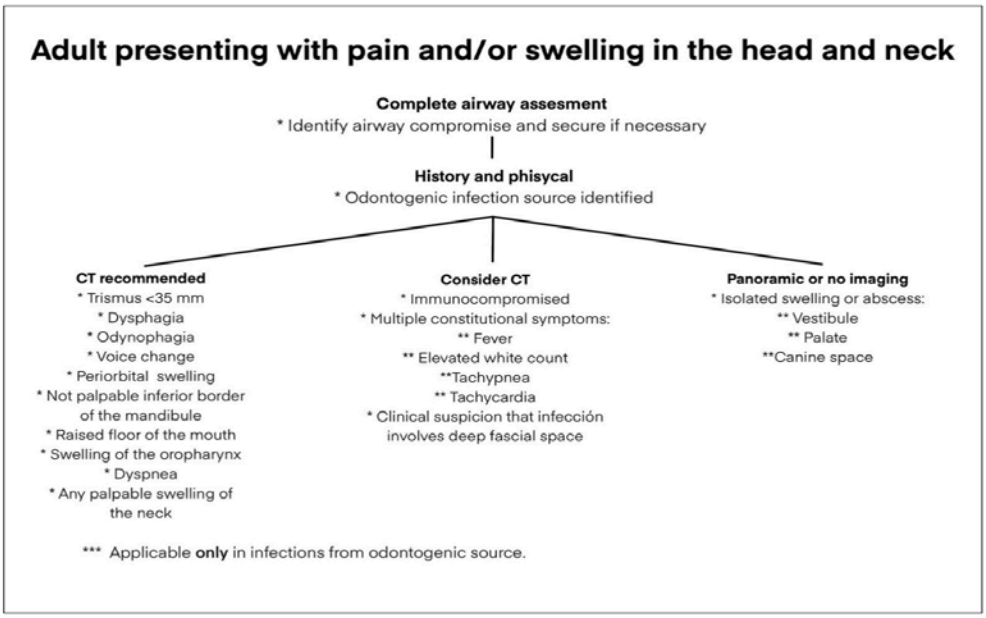
Imaging

There are many options, such as panoramic radiography, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound [16,26].

In the protocol for treating OI, panoramic radiography is the first choice for imaging because it shows signs of bone and tooth damage that help the doctor find the source of the infection [27].

Table 4: Stages of infection. Adapted from Hupp JR, et al. [20].

Stages of infection			
	Edema	**Cellulitis**	**Abscess**
Definition	Interstitial fluid from neighboring inflammation or infection	Spread of bacteria into space along with interstitial accumulation	Breakdown of liquefactive necrosis to form purulence within the soft tissue
Duration	0-3 days	3-7 days	> 5 days
Pain	Mild-moderate	Severe	Severe
Location	Diffuse	Diffuse	Well-circumscribed
Palpation	Soft	Tender	Fluctuant
Skin	Normal to firm	Firm	Firm to hard
Loss of function	None to minimal	Moderate to severe	Moderate to severe
Tissue fluid	Edema	Serosanguineous or purulence	Collection of purulence
Severity	Mild	Moderate to severe	Severe
Bacteria profile	Aerobic	Mixed	Anaerobic



It has been talked about more than once that CT is used too often to diagnose OI. Weyh, et al. published a guideline for CT requests that looks at signs and symptoms as "red flags" that indicate a higher risk of spreading the infection to deep anatomic spaces, which increases the risk of complications [28]. Image 1. Some of them are trismus, trouble breathing, trouble swallowing, not being able to feel the edge of the lower jaw, and tachycardia [28,29].

Even though MRI is better than other methods for diagnosing changes in bone and soft tissue, it has many drawbacks. For example, it takes a lot of time and money to do. On the other hand, if a CT scanner is not available, an ultrasound can be a great tool for evaluating and telling the difference between areas with pus and areas with

blood vessels [16].

Lab studies

Most of the time, lab tests are not asked for when treating an odontogenic infection. But they can be helpful when the infection is in a deep place that makes a physical exam hard. A complete blood count is the test to ask for. In this test, the white blood cells are looked at, but the differential count is given more attention. During the bacterial infection, neutrophils rise above 12,000 mm3, which shows that the immune system is fighting the infection. After treatment, neutrophils return to normal levels, which shows that the infection is gone [19].

Culture

Most of the time, getting rid of the source of the infection, cutting and draining the area, and treating it with drugs are enough to get rid of the infection. Most are localized and can be treated without hospitalization, so culture is not a good reason [28,30].

Culture and bacterial sensitivity testing is done when infections spread quickly to places with a moderate or high risk, when infections come back, when a person doesn't have a strong immune system, or when infections don't get better after 48 hours of antibiotic treatment [20,30].

It is very important to know how to take samples for culture and antibiogram. Bacteria that are part of the normal flora of the skin or mouth should never get into the sample, so the area should be sterilized beforehand [4].

Aspirating at least 2 ml of purulent material is the best way to get a sample. But if incision and drainage are needed, "culturettes" tubes should be made. These are sterile tubes that carry both aerobic and anaerobic bacteria [20].

Complications

In normal systemic situations, the immune system keeps the infection from spreading, so the vast majority of OI are localized. Patients with systemic diseases that weaken their immune systems are more likely to have complications. These complications can be local, affecting nearby tissues in the face and neck, or systemic, spreading to the bloodstream and causing septicemia or an infection far from the source [22]. Due to the closeness of structures like the airway, brain, and heart, early diagnosis and treatment are important to keep the patient's life from being in danger. The OI has a death rate of between 10 and 40% [25].

As a result of an odontogenic infection, many problems have been reported, such as necrotizing mediastinitis [31], Ludwig's angina [32], infratemporal and temporoparietal fossa abscesses [33], deep neck infections [23,24], meningitis [34], osteomyelitis [35], intracranial abscesses [36,37], cavernous sinus thrombosis [38], necrotizing fasci

Ludwig angina

It is the most common thing that can go wrong with OI [2]. It means that there is cellulitis in the submental, submandibular, and sublingual areas on both sides. Is seen as an emergency because it happened so quickly [6]. Ludwig's angina from a dental source usually starts in the second or third lower molar because the dental tips are close to the submandibular and sublingual spaces, which are connected to the submental space and can spread to the pharyngeal spaces until they reach the mediastinum [40].

Some of the most common signs of Ludwig's angina are lingual proptosis and an elevated floor of the mouth, which block the airway and cause shortness of breath, trouble swallowing, slurred speech, and blue skin [4].

The main goal of treatment is to secure the airway, either with an endotracheal tube or a tracheostomy [6]. Eliminating the source of the infection, cutting and draining all infected areas, and giving antibiotics [41].

Osteomyelitis

Osteomyelitis is a rare infection and inflammation of the medullary zone of the bone. It is caused by a bacterial invasion of the medullary zone of the bone, which can be caused by mandibular trauma, infections that start in the mouth or elsewhere in the body, or infections that spread through the blood. Since there is usually a lot of bone damage, there is a chance that the bone could break [35]. Since the blood vessels of the periosteum don't go through the cortical bone, it happens more often in the mandible [20].

Osteomyelitis is characterized by pain, tenderness, winding paths, pus, and bones that stick together. During the first weeks, there are no signs of infection that can be seen on an x-ray. In the long-term stages, bone sequestrum shows up as a radiolucent image that shows bone destruction and necrosis. An involucrum, which is a halo of more dense bone around the sequestrum, suggests that bone regeneration is a response to inflammation [25]. Broad-spectrum antibiotic therapy and a lot of surgical curettage are recommended, as well as bone resection for large bone destruction [2].

Thrombosis of the cavernous sinuses

Is an infection of the sinuses in the head. Because veins don't have valves, blood flows in from many directions. The cavernous sinus is connected to the face by the angular vein, which connects to the superior ophthalmic vein. The inferior ophthalmic vein connects the pterygoid plexus to the palate. No matter how the infection gets to the cavernous sinus, thrombosis happens [9]. But infections coming from the canine area through the angular vein are more common [38].

The nerves III, IV, VI, V1, and V2 are all in the cavernous sinus. You can see ophthalmoplegia, loss of infraorbital and supraorbital sensitivity, mydriasis, ptosis of the eyelids, and amaurosis [38].

Surgery and broad-spectrum antibiotics given through an IV are needed. Most people die if they don't start treatment within the first 4 to 7 days [25,38]. The death rate has gone down to less than 30 percent over time [38].

Abscesses in the eyes

Orbital abscesses are either pre-septal or post-septal, depending on where they are. Because they are so close to the brain, post-septal abscesses can turn into very serious problems [41]. Its symptoms are periorbital swelling, chemosis, proptosis, ophthalmoplegia, and loss of vision [42].

Deep neck infections deep in the neck

Happens when the infection spreads to the back of the neck through anatomical planes, such as the lateral pharyngeal and retropharyngeal spaces [23].

Deep neck infections caused by teeth are the cause of 43% of cases [23], and between 10% and 40% of these cases are fatal [43]. When the airway is blocked, people have trouble breathing, swallowing, and speaking [23]. Because signs may not show up until late in the process, a CT scan is recommended to see how far the infection has spread and where it is [44]. Drainage surgery and antibiotics given through a vein are needed [23].

Necrotizing fasciitis.

Is an infection of the skin and the tissue under the skin that spreads quickly and widely and has a 20–40% mortality rate. Must have aggressive and thorough surgical debridement, fasciotomy, and support for breathing and blood flow [25].

Actinomycosis of the face and neck

An infection that affects the soft tissues of the maxillofacial area, but it can also affect bone tissue [20]. It is caused by an anaerobic gram-positive rod called Actinomyces israelii. It can take days, weeks, months, or even years to get worse [45].

Clinically seen as a reddish-brown discoloration of the mandibular skin and sometimes as suppurative, irregular masses

on the skin [45]. Unlike other infections, it doesn't spread along anatomical planes. Instead, it breaks through soft tissues and forms a winding path that drains into the skin [20].

Culture results are the only way to make a diagnosis. As an anaerobic bacteria, it is important to be very careful when taking a sample, which should preferably be done by aspiration [45].

For the infection to go away, the source of the infection must be removed, the fistulous tract must be cut out, and a drain must be put in place [20]. Antibiotics like penicillin G, penicillin V, erythromycin, cephalosporins, or clindamycin should be taken with it [45].

Blockage of the airway

When the airway is blocked, extra muscles like the platysma and intercostal will be used to breathe [46], stridor and sibilance will be heard, and the patient's head will be tilted forward or to the side opposite the infection to line up the upper airway with the trachea and help them breathe better. Oxygen levels of less than 94% and clinical signs of airway obstruction are signs that a safe airway should be made by endotracheal intubation, tracheostomy, or cricothyroidotomy [10]. When there is trismus, a fiberscope must be used to intubate the person while they are awake [47–50].

Treatment

Depending on how far along the disease is, OI is treated with a combination of local care, antibiotic therapy, and surgery [19].

Local control

The first treatment should include analgesics to control pain, glycemic balance in diabetic patients, and control of temperature and electrolyte balance, since 250 ml of fluid are lost through sweat for every degree of fever [10,19]. Some authors recommend giving a single dose of 2-3 mg/kg of methylprednisolone or 4-8 mg of dexamethasone over 24 hours to reduce swelling, pain, and trismus [6,16]. In the authors' experience, putting warm physical means on an infected area speeds up the formation of an abscess, so it can be cut open and drained faster.

The use of antibiotics

To choose the right antibiotic, you should look at the stage of the infection, the microorganisms that caused it, how it will be given, the patient's immune system, and the drug's spectrum and effects [2].

Antibiotics should be given in a way that matches the stage of the infection. This is to avoid killing off too many normal microorganisms, which makes it easier for resistant bacteria to take over. During inoculation, only gram-positive aerobic flora is present, so antibiotics with a narrower range, like penicillin V, can be given. In the stage of cellulitis, the flora is mixed, but in the stage of an abscess, the flora is strictly anaerobic, and gram-negative bacilli are more common. Antibiotics with a wide range of effects must be given, like amoxicillin/clavulanic acid, ampicillin/sulbactam, cephalosporins, azithromycin, clindamycin, moxifloxacin, and metronidazole [2,19]. The length of treatment depends on the doctor and how the infection is doing, but it is usually between 2 and 7 days [46].

It is very important to choose between antibiotics that kill bacteria and antibiotics that stop bacteria from growing. Bacteriostatics like macrolides and tetracycline stop bacteria from growing and multiplying. This lets immune system cells get to the infection site and do phagocytosis. Bactericidal antibiotics like penicillin and clindamycin kill bacteria without using the immune system. Because of this, they are the best choice for people whose immune systems aren't working well [2,20].

If the infection gets worse quickly, the first drug doesn't work, or more coverage and killing of bacteria is needed, a double antibiotic regimen should be used. Also,

antibiotics should be given intravenously when the infection starts to spread from primary areas [2].

Surgery treatment

Surgical treatment for OI is based on two main ideas: getting rid of the source of the infection and making a cut and draining it [20].

Endodontic treatment or tooth extraction can be used to get rid of the source of the infection. In cases of trismus or acute suppurative pericoronitis, however, it is best to wait a few days for the antibiotic to work, because touching the tissues in this state could spread the infection [10].

The goal of ID is to remove dead or dying tissue and get rid of bacteria in the tissues underneath. When an abscess is drained, the area's hydrostatic pressure drops, which improves blood flow and brings more white blood cells and antibiotics to the infected area [20].

The best time to get an ID is a point of debate. Some doctors say it should be done during the cellulitis stage because it changes the environment of the infection and makes it less likely that it will spread and cause tissue death. In deep neck infections, it is almost impossible to tell from a physical exam or an x-ray if an abscess is forming, so waiting is not a good idea [46]. On the other hand, those who say to wait until an abscess forms do so because antibiotics and getting rid of the source of the infection can cure cellulitis without having to do anything invasive [16].

The cut is made according to certain rules, like staying away from nerve and blood vessel structures, making it as low as possible in the tension zone, following the facial relaxation lines, and being supported by healthy skin and subcutaneous tissue [46]. Inside the mouth, cuts are made where the swelling is the worst or through the gingival sulcus [9]. It may be necessary to use a surgical drain, which lets fluids leave the wound and makes it easier to clean the area [46].

Follow-up

Mild OI should be checked on after 48 hours to see if the infection is getting worse or getting better [10]. When ID and a drain are used to treat severe OI, the wound needs to be cleaned every day and the drain needs to be changed every 72 hours. Between 48 and 72 hours after surgery, trismus, pain, swelling, and the number of neutrophils should go down [46].

If the patient isn't getting better in the first 48 hours after surgery, lab tests, imaging studies, and antibiotic therapy should be changed until the patient is getting better. Once the patient is no longer contagious, he or she can be sent home. [46].

Conclusion

Odontogenic infections are caused by many different kinds of bacteria, but the most common ones are gram-negative rods and gram-positive cocci. Complications from odontogenic infections can be fatal if they aren't treated properly, and the most important thing to do to get rid of an infection is to get rid of its source and treat it with antibiotics. Is a common pathology, so the doctor should know the basics of how to treat it to stop it from getting worse and putting the patient's life at risk. This work gives guidelines for diagnosing and treating odontogenic infections and gives information about how they show up and what problems they might cause.

Abbreviations

OI: Odontogenic Infection; ID: Incision and Drainage; CT: Computed Tomography; MRI: Magnetic Resonance Imaging

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