



Brief Review

Odontogenic Infection; a Brief Review to Newly Qualified Dentists

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Introduction

Odontogenic infection (OI) is one of the most frequently presenting cases for the maxillofacial on-call team. OI counts for 50-89% of all maxillofacial space infections in records from different parts of the world. [1] It is an infection of the alveolar bone or the face that arises from teeth or supporting tissues. The most common reasons are dental caries, deep restorations, failed endodontic treatments, or pericoronitis. [2] These infections usually vary from straightforward cases that do not require hospital admission, to severe and complicated cases that need intensive care. There are specific conditions that contribute to the severity of the infection such as the virulence of bacteria, the patient immune system, anatomical factors plus the delay in receiving suitable treatment, which all result in uncertainty for junior trainees as to whether to admit patients to the hospital or discharge them. Therefore, trainees must liaise with their senior colleagues to ensure suitable management.[1,3,4,5] OI becomes severe when the infection spreads along the fascial spaces of the head and neck, potentially causing life-threatening deep space infections with a risk of major complications such as upper airway obstruction, thoracic empyema, mediastinitis, pericarditis or septic shock. [6] Although the incidence of these infections has been decreased through the use of new antibiotics and the increased awareness of oral hygiene, they still occur and are considered to be a source of morbidity and high mortality. [6] The diagnosis will be made according to the dental history, clinical examination, and relevant investigations. The management of OI is based on the medical history of the patient and the assessment of the infection severity. Management may include extraction of the causative tooth, incision and drainage, and antibiotics, as well as considering any airway obstruction caused by swelling due to the spread of

infection or any other systemic manifestation. [5] Examples of OI cases spread to fascial spaces can be seen in Figure 1.



Figure 1: Clinical photographs illustrating (OI) – (Left) “(A) Buccal and submandibular abscess – significant RHS extra-oral swelling extending below the mandible. (B) Limited jaw opening secondary to dental infection and involvement of fascial spaces. “ Ludwig angina: bilateral submandibular swelling, mental space swelling, and bilateral sublingual spaces.” – (Right). Sourced.²

Assessment

Emergency assessment

Odontogenic space infections may develop serious life-threatening complications such as respiratory obstruction, sepsis, and endocarditis.⁷ Therefore, patients with a spreading OI require urgent assessment.

Airway

The patient attended A&E with submandibular swelling which may lead to multiple space infections, including the submandibular triangle of the neck around the angle of the mandible. As the source of infection is a lower tooth, the patient is at risk of airway compromise, leading to respiratory obstruction, due to possible swelling of the floor of the mouth, trismus, edema, and abscess formation. [7] Ludwig’s angina poses a serious risk of airway obstruction, caused by OI, especially from a lower tooth. It is a serious life-threatening infection, presenting as a rapid brawny board-like swelling spreading to the submental, sublingual, and submandibular spaces. Patients will often display fever, protrusion of the tongue, drooling, and difficulty swallowing. [2] To assess a patient’s airway, mouth opening should be measured as the vertical distance between the upper and lower incisors. A mouth opening of lower than 20-30mm indicates difficulty in intubating the patient and alternative management is required. The distorted airway anatomy, tissue firmness, and limited access to the mouth caused by the swelling make orotracheal intubation or tracheal intubation

challenging. Therefore, tracheostomy under local anaesthetic is the gold standard of airway management in patients with deep neck space infection. [7,8,9] Studies have shown that patients with severe deep OI who had tracheostomy spent less time in the intensive care unit with fewer complications compared to those who had endotracheal intubation. [10] However, others reported that patients who had tracheostomies had an uneventful recovery.¹ Hospital admission is required depending on airway compromise, and signs of possible systemic infection, and the patient should be under the care of an oral and maxillofacial surgeon. [2,9,11]

Sepsis

The patient with OI is at risk of developing sepsis which is the systemic response to infection. It is a common cause of morbidity and mortality. [12] Patients are at risk of sepsis if they present with two or more of the systemic inflammatory response syndrome (SIRS) criteria: 1) Temperature below 36°C or above 38 °C, 2) Heart rate above 90beats/min, 3) Respiratory rate above 20 breaths/min, 4) White Blood Cells (WBC) above 12000/cumm or below 4000/cumm. It is of utmost importance to treat sepsis as early as possible with directed antimicrobial therapy to have favorable outcomes. [13] Blood cultures are essential before starting antimicrobial therapy to avoid the growth of blood-borne bacteria. [14] Based on SIRS results, the diagnosis of sepsis and management will be according to the risk stratification tool for adults of NICE guidelines as follows. Table 1.

High-risk criteria	Management
<ul style="list-style-type: none"> • Behaviour - evidence of altered mental state. • Heart rate - above 130 beats/min. • Respiratory rate - above 25 breaths/min, - need 40% Oxygen or above to maintain 92% saturation (88% in case of Chronic Obstructive Pulmonary Disease). • Systolic blood pressure (SBP) - below 90mmHg or 40mmHg below normal. • The patient didn’t urinate in the previous 18 hours. • Ashen appearance. • Cyanosis of skin, lips, or tongue • A non-balancing rash of the skin 	<ul style="list-style-type: none"> • 1 or more high-risk criteria met An immediate review by senior clinical staff <ul style="list-style-type: none"> • Venous blood tests - blood gas for Glucose and lactate - blood culture - Full blood count - C-reactive Protein - Urea and Electrolyte - Creatinine - clotting screen • IV antibiotics without any delay (within a maximum of 1 hour) <ul style="list-style-type: none"> • Options to be considered - according to lactate (above 4mmol/L & SBP below 90 or 2-4mmol/L or above 2mmol/L), intravenous fluids (bolus injection) should be administered without delay within an hour - observation and monitoring every 30 min.
Moderate risk criteria	Management

<ul style="list-style-type: none"> • Behaviour - history of new onset of altered mental state - history of acute deterioration of the functional ability • Impaired immune system (illness or drugs) • Invasive procedure in the last 6 weeks • Respiratory rate 21-24 breaths/min • Heart rate 91-130 beats/min • New-onset arrhythmia • SBP 91-100mmHg • Not urinating in previous 12 – 18 hours • Tympanic temperature below 36°C • Signs of potential infection <ul style="list-style-type: none"> - redness - swelling or discharge of the surgical site - breakdown of the wound 	<p>2 or more moderate criteria met or SBP 91-100mmHg</p> <ul style="list-style-type: none"> • Venous blood tests as mentioned above • Clinician review and results review in 1 hour • Options to be considered <p>- lactate > 2mmol/L or assessed as having acute kidney injury, escalate to high risk</p> <p>- lactate 2mmol/L or less & no acute kidney injury, a definitive diagnosis should be taken. If not, repeat the assessment hourly.</p> <p>Only 1 moderate criterion met</p> <ul style="list-style-type: none"> • Clinician review and consider blood tests in an hour. a definitive diagnosis should be taken. If not, repeat the assessment hourly.
Low-risk criteria	Management
<ul style="list-style-type: none"> • Normal behaviour • No high-risk or moderate criteria met • No non-blanching rash 	<ul style="list-style-type: none"> • Suspected sepsis no risks criteria met - clinical management according to clinical judgement

Table 1: Illustrates the SEPSIS risk tool for patient who are above 18 and at the hospital. It presents both signs and symptoms, and management [15].

Assessment of medical history and dental complain

Following emergency management, a thorough infection history should be taken including the nature of the pain, when did it start, and any treatment received so far. [16] Extra-oral and intra-oral examinations should assess the extent and location of the swelling and whether the swelling is fluctuant or cellulitic. [11,17] A thorough medical history, including any allergic reactions, should be obtained to rule out any predisposing factors for infection, or conditions that may complicate management, such as poorly controlled diabetes mellitus, alcoholism, steroid therapy, previous endocarditis or immunosuppressant medication; as these conditions may lead to longer hospital stays [7,16,18].

Assessment of Aetiology

Studies have found that the most common disease to cause severe OI was caries (65%) followed by pericoronitis (22%) and periodontal diseases (22%); while third molars were the most common cause of both single-space and multi-space infections that required hospital admission. [19,20] Other studies stated that OI is a polymicrobial infection and found that gram-positive cocci (*Streptococcus viridians*) were the predominant bacteria, followed by gram-negative rods. Additionally, both stated that the submandibular space was the most commonly infected. [1,21] The infection spreads to the maxillofacial spaces through the infected tooth roots. Once root canals are colonized by anaerobic bacteria, an abscess will be formed by bacteria and their toxic products after accessing the periapical tissue through the apical foramen.

OI spreads from the dentoalveolar structure along the path of the least resistant potential fascial spaces of the head and neck. [1,22] Figure 2.

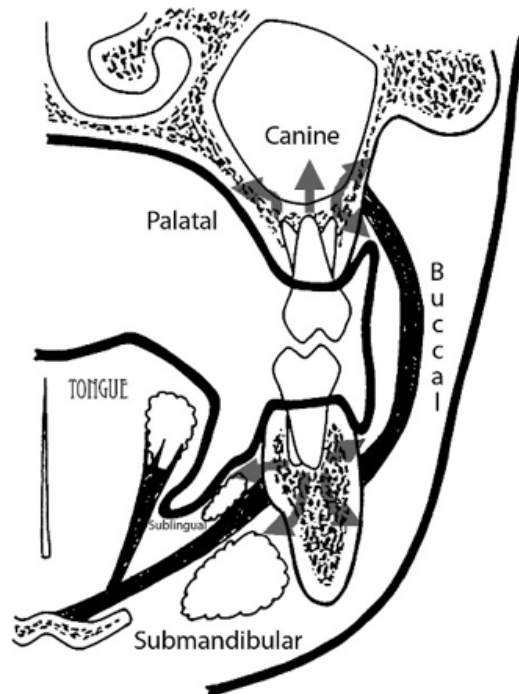


Figure 2: Various pathways of odontogenic infection spread to potential anatomical spaces in the head and neck [23].

Investigations

Imaging

Radiographs are required to confirm the diagnosis and spread of infection. Despite orthopantomograms are often available in hospitals and being helpful to give a full view of the dentition and jaws, they do not show early changes and details of the periapical bone. CT scans and MRIs are used to show the routes of the spread of severe OI. [24] Additionally, both scans are useful for operation planning and assessing drain placement or residual areas of fluid or pus collection. [17] Preoperative CT scans are useful in determining airway displacement or effacement before airway management, while postoperative CT helps in identifying correct drain placement and tracking the anatomic pathways of the OI spread [2,25,26].

Blood Tests

A C-Reactive Protein (CRP) test is required which is used in the diagnosis and monitoring of many infections such as pneumonia, septic arthritis, and acute meningitis. It helps indicate the severity of OI as high levels of CRP are associated with a more severe course of infection. [22] Studies have shown that CRP is beneficial for patient assessment. The mean CRP level was elevated at 140mg/L in patients who required critical care, while it was 76.6mg/L in those not requiring critical care. [27] Furthermore, CRP appears to be more sensitive than WBC in determining the control of fascial space infections of odontogenic origin. [28] On the other hand, the Erythrocyte Sedimentation Rate (ESR) is a representative marker of acute phase reaction. It is affected by increasing concentration of fibrinogen, the main clotting protein, and alpha globulin. However, CRP is a more critical and certain marker of acute phase reaction and is responsive to changes in a patient's condition. [29]

Management

Management of localised acute dental infection can be done by extraction of the infected tooth and incision and drainage of pus or root canal treatment. [30] However, there are no adequate randomised controlled trials to evaluate the protocols of management of severe spreading OI. Therefore, OI management is according to expert clinicians, case series, and guidelines of the medical society. [24]

Incision and Drainage

Extraction of the causative tooth and drainage of swelling under local or general anaesthetic is the most important step in OI treatment. [31] There is one quote that has successfully stood the test of time which is, "never let the sun go down on undrained pus". [32] Despite that early incision and drainage cannot be obtained before sorting other comorbidities, an early incision, and drainage results in a significantly shorter time of hospitalisation. [33] The

incision and drainage procedure should break up all loculi within the abscess cavity and evacuate the accumulated pus, following purulence evacuation and diluting the bacterial population by copious irrigation. [2] The incision can be done intra-orally or extra-orally according to the infection location and the principles of establishing a drainage path. The incision should be made without damaging any vital structures and any areas of skin or mucosal breakdown. [34] Blunt dissection is used to explore the involved space, and then a drain is placed until drainage is ceased. Drains include a Penrose (non-irrigating drainage) or Jackson-Pratt drain (irrigated drainage).[17] Figure 3a,b. The use of a drain allows the continuous drainage of pus in postoperative settings; there are two approaches to drainage, the first based on daily irrigation of the drainage, while the other based on gravity only. However, both approaches are equally effective in the management of OI. [35]



Figure 3a: Extraoral drainage of submandibular abscess and placement of a Penrose drain. Sourced (Torriani., 2013).



Figure 3b: Jackson-Pratt drain. Sourced (Web).

Antibiotic Therapy

OI treatment often requires antibiotic prescription besides the removal of the source of infection, which is still considered a challenge for clinicians as to which antibiotic to use. Studies have

shown that all antibiotics used in situations of regional or systemic body manifestations were effective. [31] However, the choice of antibiotic was not as essential as the surgical intervention; that was confirmed by a randomised control trial which compared a group taking penicillin for OI with a group receiving no antibiotic; it was found that antibiotics did not make any difference for localised OI while it was recommended for OI with systemic manifestations. [36,37] The antibiotic regimen should be based on pharmaceutical principles which include the safety and efficacy of the drug. To have an effective therapy, a culture of abscess contents should be performed. [17] A combination of Penicillin G with Metronidazole has shown to be effective in the treatment of OI, due to penicillin's ability against Gram-positive organisms, gram-negative cocci, and non-beta lactamase-producing anaerobes; on the other hand, metronidazole has antibacterial activity against anaerobes, Bacteroides and Clostridium species. [38] While, Clindamycin as a single drug which was assessed also in that study, has shown a lower failure rate than Penicillin G with Metronidazole, despite that Clindamycin has a narrower antimicrobial spectrum. It has been concluded that the failure rate of Clindamycin and Penicillin with Metronidazole was 3.5% and 4.7% respectively, which are both below the critical value of 5%. [38]

Although penicillin is still the gold standard in OI treatment, [16] others found that penicillin failed to treat some cases due to Penicillin resistance, and Clindamycin was a satisfactory alternative. [20,39] Furthermore, certain factors can contribute to a more aggressive course of OI, as some anaerobic bacterial metabolites could aid in the virulence of aerobic bacteria, which would create a favourable medium for the anaerobic bacteria. [40] Therefore, preoperative antibiotics would concentrate on these bacteria to prevent the spreading of inflammation with serious complications. [34,41].

Antibiotic	IV dose	Oral dose
Penicillin G	0.6-2.7 g every 4-6 hours	500 mg three times daily
Metronidazole (allergic to penicillin)	500 mg every 6-8 hours	500 mg three times daily
Clindamycin (allergic to penicillin)	300-900 mg every 6-8 hours	300 mg four times daily

Antibiotic administration starts intravenously until signs of improvement then switch to oral therapy according to the following Table 2.

Table 2: illustrates the different treatment modalities if patients are allergic and not allergic to penicillin.[17]

Monitoring and postoperative setting

The patient should be monitored for signs of improvement. CRP and WBC should be ordered to ensure the decreasing level of both tests. Furthermore, monitoring vital signs and checking electrolyte levels is advisable. In case of no improvement, a CT scan would be useful to assess whether the drainage was adequate or needed further treatment.[17]

Conclusion

If OIs are treated at an early stage, they can often be managed as an outpatient. However, in more severe cases, early intervention is key to preventing the spread of infection, leading to life-threatening airway compromise and possible sepsis. Surgical management and suitable intravenous antibiotics are still the mainstay treatment option for those cases requiring hospital admission. Dentists should be aware of the possible serious complications associated with OI and these infections should never be underestimated.

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