

Life-Threatening Complications of Odontogenic Infection (Literature Review)

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Abstract: *Odontogenic infection is one of common diseases that is easily encountered, especially in developing countries where people doesn't have adequate oral hygiene awareness. Even multiple prevention programs and early treatment has been performed in primary health center, the society oftenly avoid any dental treatment because of various social and economic reasons. Odontogenic infection treatment is commonly uncomplicated, but in some circumstances it may develop to life-threatening complications and giving mortality rate at about 10-40%. Life-threatening odontogenic infection due to spread of the infection further from common facial spaces may affect other vital structures. For instances, airway obstruction, thoracic complications, Descending Necrotizing Mediastinitis (DNM), Adult Respiratory Distress Syndrome (ARDS), Sepsis, Lemierre's syndrome, Sinus Cavernous Thrombosis, Disseminated Intravascular Coagulation (DIC), and Brain Abscess. Odontogenic infection may cause life-threatening complications if not treated precisely and as soon as possible. It is contributed with other systemic risks factors that may worsen patient's condition. In summary, odontogenic infection may cause life-threatening condition because of impairment in ABCD (Airway, Breathing, Circulation, and Disability), which are airway obstruction, breathing problems (thoracic complications, DNM, ARDS), hemodynamic problems (septic shock, thrombosis, DNM, DIC), and increasing of intracranial pressure (brain abscess). It can be concluded that odontogenic infection cannot be underestimated, delayed treatment may cause life-threatening complications. This will make the treatment more complicated as well as increasing the morbidity and mortality rate of the patient.*

Keywords: Odontogenic Infection, Complications, Life-Threatening

1. Introduction

Odontogenic Infections have been one of the most common diseases in the oral and maxillofacial region.¹ The incidence and severity of odontogenic infections have diminished since the advent of antibiotic therapy.^{1,2} However, morbidity and mortality of these infections significantly continues,² with mortality rate of 10-40%.¹ This rate is contributed by multiple severe complications of odontogenic infections that may result in life threatening conditions e.g airway obstruction, descending necrotizing mediastinitis, cavernous sinus thrombosis, sepsis, thoracic complications, cerebral abscess, etc.¹

The complications of odontogenic infection mainly because of the rapid progress into several organs and structures away from the source of infection. This is because odontogenic infection is still considered a simple disease and easy to treat. Many clinician may underestimating the consequences of delaying any aggressive treatment therapy. Neglected odontogenic infection may be stable and have no complications at all, it may progress into local granuloma or local periapical abscess with no other complications. But in some cases when the patient risk factors contribute in weakening of the host or highly virulent and multi-drug resistant pathogen invade, some will progress into other complications that may be life-threatening. When this occurs, it will increase the patient morbidity and mortality, harder to treat and worsen the prognosis.

This study will overview some complications of odontogenic infection which has progressed away from its origin. It is important for clinician to understand how simple odontogenic infection can be fatal and hard to treat. This

paper will also explain the spreading process of the infection, the risk factors, and also how it compromises vital organs and structures which causing life-threatening condition.

2. Spread of Odontogenic Infection

It all started with odontogenic infection as port d'entry of the bacterial infection, which is mainly categorized as pulpal (tooth caries and infected throughout the pulp of the tooth into apices), marginal (an infection of periodontal origin due to periodontitis), pericoronal (infection of pericoronal tissues that emerges usually in the eruption of lower third molar), needle tract (an infection that occurs due to complication in anesthetic injection), and extraction site (an infection in the tooth socket after tooth extraction).³ According to Mathew et al, the most common origin of odontogenic infection is pulpal (about 71%) followed by periodontal (about 17%).³ Most common tooth that may progress into maxillofacial space infection is mainly due to lower third molar (36%) and other lower posterior teeth (41%).³ Upper teeth are less causative with upper third molar (7%) and other upper posterior teeth (6%).³

Lower posterior molars roots lie below the mylohyoid muscle providing the infection with a possibility of an immediate access to the submandibular space.^{4,5} This may consider prophylactic third molar removal remains a key focus of interest in healthcare with both medical and economic dimensions. It is generally accepted that substantial risks may arise both from third molar removal, as well as from a "wait and see" policy.^{1,4}

The infection spread occurs when accumulated pus perforates bone at the weakest and thinnest part. In the mandible, the lingual aspect of the molar region represents the easiest way. If odontogenic infection perforates this portion of bone, it will spread into the sublingual or submandibular space. As these spaces are partially separated by a thin sheet of mylohyoid muscle, infection in either space easily spreads into the other.⁶

The sequence of odontogenic infection spread that most commonly occurs is:⁶

- a) The masticatory space is the primary site of spread from mandibular infection.
- b) The parotid and pharyngeal spaces are the secondary sites of spread from the masticatory space.
- c) Mandibular infection spreads directly to the sublingual and submandibular spaces
- d) Maxillary infection spreads to the deep facial and neck spaces in a different way from that of mandibular infection

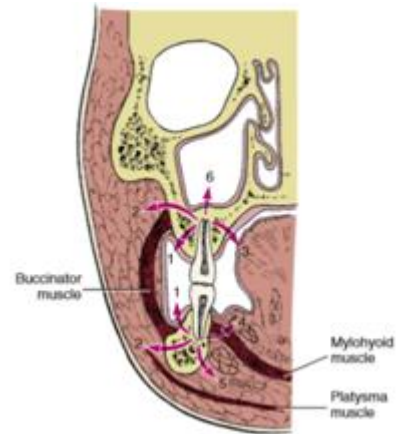


Figure 2: Red arrows indicating the contiguous anatomic structures that can be affected by an odontogenic periapical infection.² 1. Vestibule; 2. Buccal space; 3. Palate; 4. Floor of mouth/sublingual; 5. Submandibular; 6. Maxillary sinus

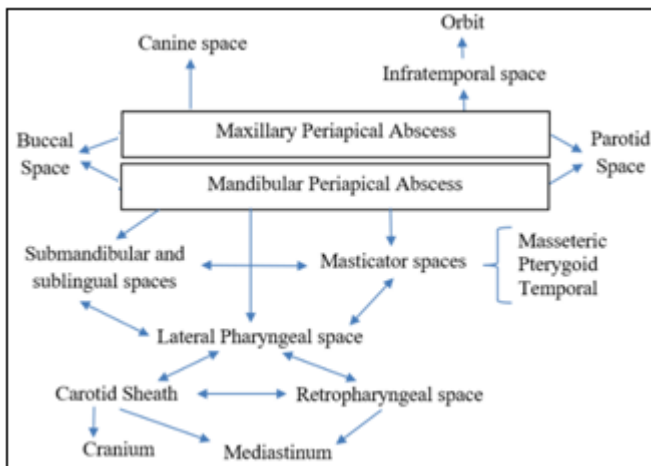


Figure 1: Schematic review of odontogenic infection spread.¹

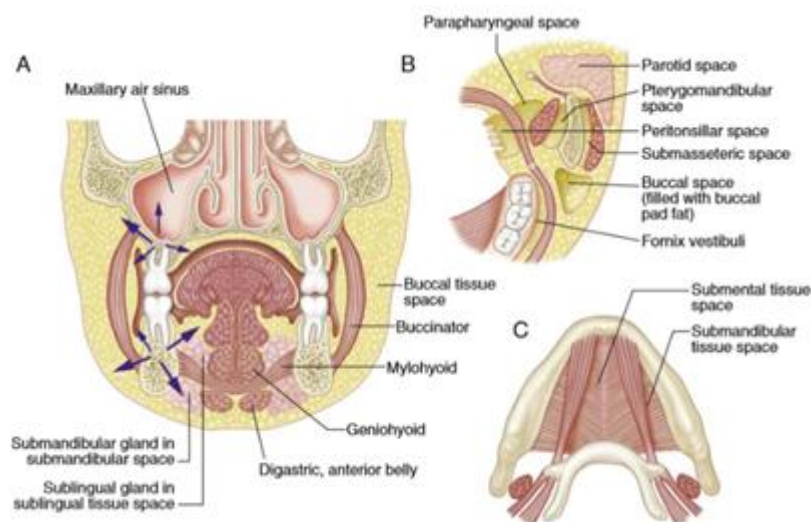


Figure 3: Depiction of primary odontogenic periapical infection routes and adjacent anatomic spaces.²

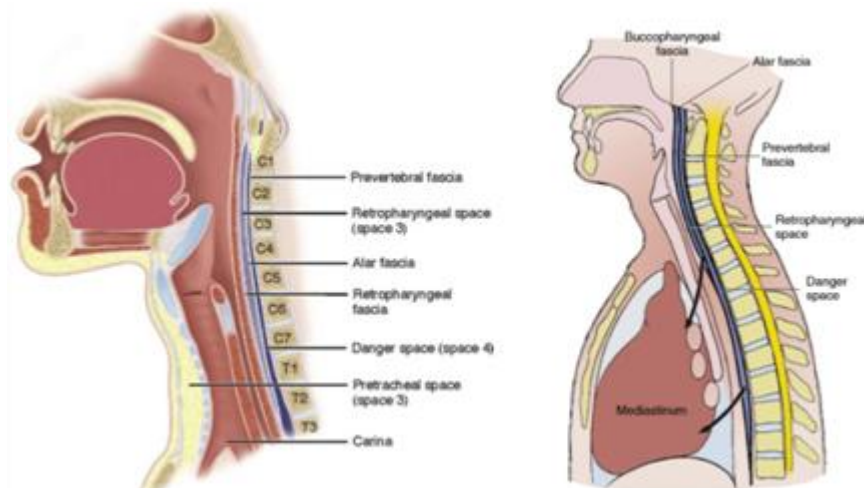


Figure 4: Sagittal section through the head and neck, the relationships of the pretracheal and retropharyngeal spaces and the danger space (left).² Sagittal plane depiction of fascial spaces communication with the mediastinum (right)²

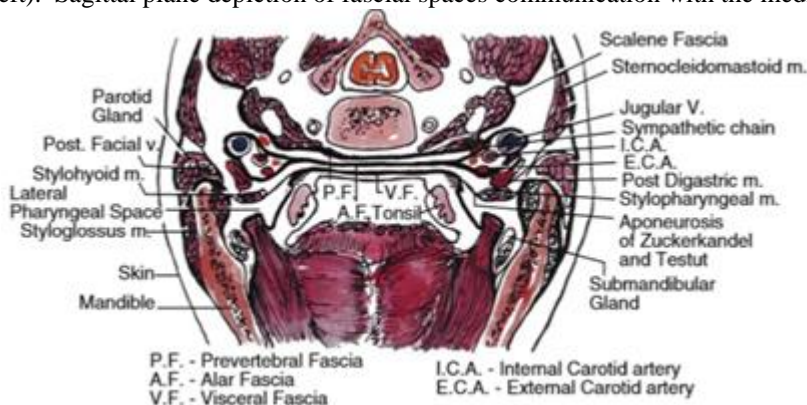


Figure 5: Diagrammatic oblique section through the ascending ramus and condylar neck of the mandible, illustrating the contents and relations of the lateral pharyngeal space and carotid sheath.²

3. Risk Factors of Complications in Odontogenic Infections

Infections will not occur when there is a balance condition among host, agent, and environment. A port d'entry is causing unbalance of environment, giving pathway for pathogen bacteria to invade inside the host and causing tissues damage. Oral bacteria is largely numerous, odontogenic infections is a polymicrobial infections,² which started from aerobic bacteria infections and develops inside the body into anaerobic bacteria infections.² Our body as a host has the part of defending and localizing the infection from progressing. But in some cases, hosts with systemic diseases have impairment in resistance of the progression of odontogenic infections.² Some of these known risk factors are:^{1,6}

- Diabetes Mellitus
- Alcoholism
- HIV, measles, chronic malaria, tuberculosis
- Hyper and hypothyroidism
- Liver disease, renal failure, heart failure
- Blood dyscrasias, anemia, sickle cell disease
- Irradiation
- Steroid therapy
- Cytotoxic drugs
- Excessive antibiotics
- Malnutrition
- Allergic reactions

- Anatomical abnormalities

Life-Threatening Complications of Odontogenic Infections

Underestimating odontogenic infection may prove costly and fatal. Unawareness of some clinician in the danger of the developing odontogenic infections into complications may lead to delay in diagnosis and late or wrong therapeutic approach.⁶ This is the root problem that provide high morbidity and mortality rate in complications of odontogenic infection. Some complications may not be life-threatening, but require costly treatment and high morbidity of the patient. Some other may be life-threatening and need emergency management, these complications are: Airway obstruction, thoracic complications, Descending Necrotizing Mediastinitis (DNM), Adult Respiratory Distress Syndrome (ARDS), Sepsis, Lemierre's syndrome, Cavernous Sinus Thrombosis, Disseminated Intravascular Coagulation (DIC), and Brain Abscess.¹

Airway Obstructions

Airway obstructions is one of the fastest leading death complications. Airway obstructions may be due to swelling of floor of mouth, trismus, edema, and abscess formation leading to narrowing and eventually to the loss of airway.⁶ Some complications that leads to airway obstructions are: Epiglottitis, peritonsillar abscess, parapharyngeal abscess and retropharyngeal abscess (deep neck space infections).^{2,4,6} Tracheal intubation in patients with deep neck

infections is challenging because of distorted airway anatomy, tissue immobility, and limited access to the mouth. Rupture of an abscess and aspiration of pus have been reported during an attempted orotracheal intubation and blind nasal intubation. Blind nasotracheal intubation should be avoided.^{2,4,6}



Figure 6: Retropharyngeal space abscess after extraction of a mandibular third molar. Note the massive soft tissue swelling with tracheal displacement²

Descending Necrotizing Mediastinitis

Acute mediastinitis is a severe, life-threatening infection of the mediastinal connective tissues, interpleural spaces and

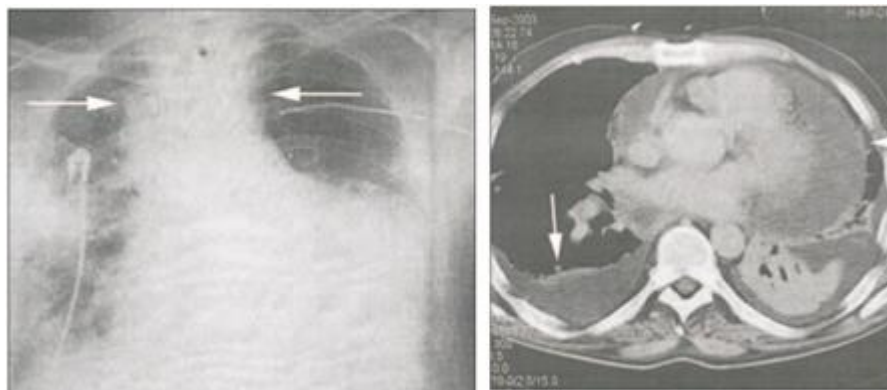


Figure 7: Chest radiograph showing a widened mediastinal configuration (left).⁹ CT scan thorax shows bilateral pleural effusions and large pericardial effusion (right)⁹

Adult Respiratory Distress Syndrome

Adult Respiratory Distress Syndrome (ARDS) is an impaired gaseous exchange and may eventually leads to respiratory failure.¹⁰ ARDS is commonly secondary to sepsis, which leads to damage in pulmonary vascular due to toxins causing the release of proinflammatory cytokines from macrophages and amplification of the complement-mediated response of the leukocytes, which release toxic oxygen radicals, proteases, and prostaglandins.¹⁰ However, ARDS may also complications related with thoracic complications, caused by diffuse pulmonary infection or increasing permeability and intra-alveolar interstitial edema.¹⁰ The treatment of ARDS requires early diagnosis and the use of mechanical ventilation, to prevent further damage which leads to respiratory failure.¹⁰

surrounding thoracic organs.^{5,7} In various reported cases of DNM, 60-70% originate from odontogenic infections.⁶ There are 3 primary routes of spread of odontogenic infections into the neck and thoracic region: the pretracheal space into the anterior mediastinum, viscerovascular space, and the retropharyngeal space into posterior mediastinum.^{8,9} Review of the literature shows that although DNM is quite rare, this variety of mediastinitis is a highly lethal disease with a mortality rate of 37–60% and is frequently associated with pleural and pericardial effusion, compression of the local blood vessels, persistent sepsis, and multiorgan failure.⁶

Thoracic Complications

Intrathoracic complications commonly follow descending neck infection, and the outcome of such infections depends on early diagnosis and aggressive treatment.⁸ These severe complications are lethal, causing damage to thoracic organs, and breathing impairment. Empyema, Pyothorax, aortopulmonary fistula, the erosion of the carotid artery or aorta, purulent pericarditis, multiple damages to the organs are some life-threatening complications and require aggressive therapy.⁵ This complications mainly because of late diagnosis of the spreading odontogenic infections.^{5,8}

Sepsis

The sepsis syndrome is defined as SIRS with an identifiable source of infection, and is caused by the interplay of microorganism virulence factors with the host inflammatory response.^{2,11} It is a clinical state where the host systemic response remains compensated in the face of infective insult.^{2,11} This clinical phase precedes sepsis-induced organ dysfunction and thus merits careful but aggressive resuscitative management.^{2,11} Delay in identification of sepsis may be fatal, sepsis may leads to multiple organ dysfunction due to septic shock, and death is not an uncommon end result if not treated properly as soon as possible.^{2,11} Early Goal Directed Therapy (EGDT) has been established as a standar resuscitative management for sepsis, and it may still developing from time to time to achieve better management in sepsis.^{2,12}

Lemierre's Syndrome

In 1936, Andre Lemierre, a French physician and microbiologist, described a series of patients who presented with infections of the head and neck regions complicated by anaerobic septicaemia, distant septic emboli and internal jugular vein (IJV) thrombosis. This constellation of signs came to be known as Lemierre's syndrome.¹³ Lemierre's syndrome has been reported in the context of odontogenic infection and as a postoperative complication of lower third molar surgery, and other teeth.^{2,13} Thrombosis of the IJV is generally thought to occur by direct spread of infection from the lateral pharyngeal or parapharyngeal space through the carotid sheath, or extension of an existing thrombophlebitis from the peritonsillar veins into the IJV.^{2,13} The mortality of Lemierre's syndrome has previously been reported as ranging from 5% to 9%.¹³ The principles of management are the same for all surgical infections, the role of anticoagulant therapy in Lemierre's syndrome is not supported by evidence and is somewhat controversial.¹³ Anticoagulation has been suggested when septic emboli persist despite antibiotic therapy. Surgical ligation of the IJV also remains an option but should only be reserved for cases of persistent septic emboli in the context of maximal medical therapy.¹³

Cavernous Sinus Thrombosis

Cavernous sinus Thrombosis (CST) is a serious encephalic complication of cranial, cervical or facial infections that can progress to death if not treated in time.^{14,15} Dissemination of a dental infection via the blood vessels occurs when the pathogenic microorganisms circulate through the veins that drain the infected oral cavity for tissues from other regions, like the cavernous sinus.^{2,14,15} This occurs by virtue of the absence of valves in the veins in that region, allowing the blood to circulate both outside and inside the cranial cavity.^{2,15} In septic CST, the infection can spread to the extra and subdural spaces, to the leptomeninges and adjacent brain, and to other venous sinuses, lesions such as mycotic aneurysms can occur in the intracavernous portion of the internal carotid artery.¹⁵ CST can be fatal when a thrombus forms in the cavernous sinus, and also may develop into meningitis.^{2,14} Mortality rate of CST is still relatively high at 14-30%.¹⁴ In successful treatment of CST may also result in morbidity sequelae, mainly residual lesions of the oculomotor and abducens nerve.¹⁵

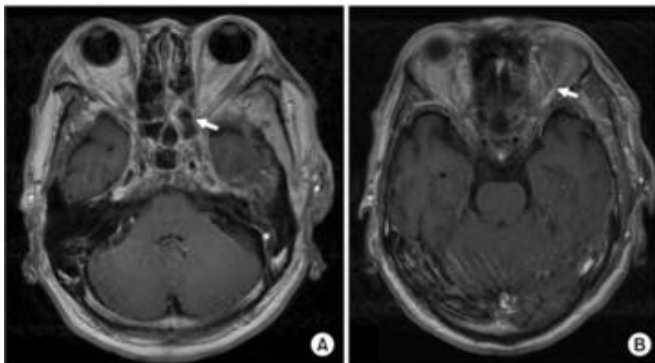


Figure 8: T1-weighted magnetic resonance image with gadolinium. **A.** Filling defect and bulging contour of the left cavernous sinus (arrow). **B.** Venous dilation of the left superior ophthalmic vein (arrow)

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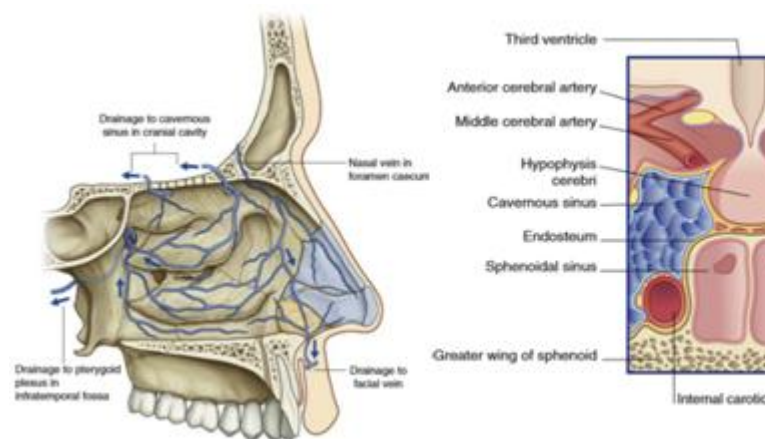


Figure 9: Venous drainage of the nasal cavity (left).² Coronal depiction of the cavernous sinus anatomy and contents (right).²

Disseminated Intravascular Coagulation

Coagulation abnormalities, ranging from thrombocytopenia to a fulminant state of disseminated intravascular coagulation (DIC), are well recognized in ICU patients with septicemia.² It has been suggested that thrombocytopenia reflects the severity and progression of the underlying infection, and may serve as an indicator of acute infection.¹⁶ A close relationship between sepsis and thrombocytopenia has been suggested.^{2,16} Sepsis was found to be one of the predominant risk factors for the development of thrombocytopenia which may lead to DIC.^{2,16} Occurrence of thrombocytopenia in sepsis has been thought to be due to increased platelet destruction, impairment of platelet production, or adherence of platelets to damaged endothelium.¹⁶ Sepsis and DIC will collaborate in causing septic shock condition due to uncompensated leakage of vascular permeability.¹⁶ DIC may also leads to mild, moderate, or severe hemorrhagic disorder which prevents surgical procedure cannot be performed, and increasing the risk of morbidity and mortality.¹⁶

Brain Abscess

Brain abscess may be very rare complications of odontogenic infections, but there were several case reported.¹⁷ The incidence is 3-10% originated from odontogenic infections.¹⁷ The diagnosis may be confirmed from microbial pus culture of the brain abscess, it is usually linked to dental infections which is gram-positive anaerobic streptococcal species, but other cases may not be identified until autopsy.¹⁷ The pathway of odontogenic infections into brain abscess may be progressed from hematogenous spread or pericranial from orbital abscess or CST into meningitis.^{2,17} Brain abscess may lead to death or permanent handicap, the abscess inside the brain can cause damage and increasing the intracranial pressure.¹⁷ This condition is life-threatening and may require emergency surgical treatment of craniotomy evacuation of the abscess.^{2,17}

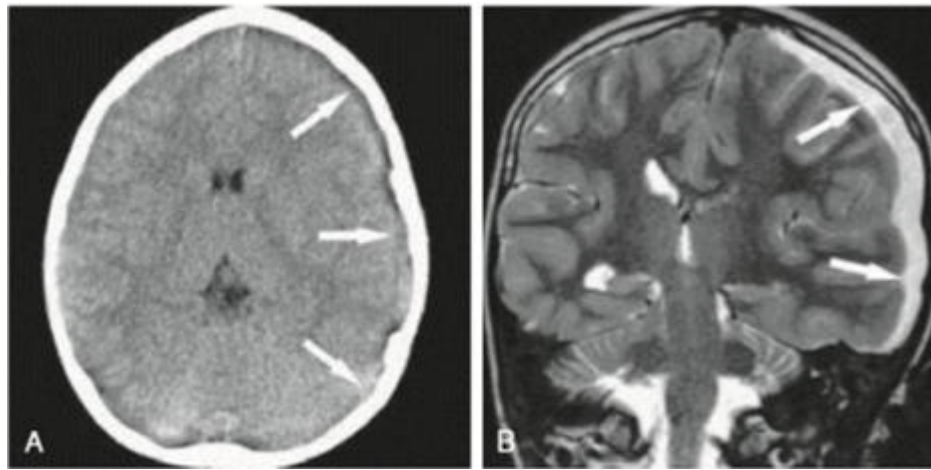


Figure 10: Subdural empyema in a 5-year-old boy with periorbital swelling and seizure.²

A. Non contrast axial CT image showing diffuse cerebral swelling and slight left to right midline shift. A subtle, thin intermediate-to-low density collection is identified on the left (arrows). **B.** T2-weighted coronal image of the brain showing a left subdural convex fluid intensity collection (arrows)

4. Discussion

There are several ways of odontogenic infection progress into complications that life-threatening, it may not be easy to learn all of the types of complications that may happen. In summary, life threatening condition is an impairment ABCD (Airway, Breathing, Circulation, Disability) which is very commonly used in trauma patients assessment. This assessment may be helpful for clinician as a guide to identify life-threatening odontogenic infections condition, leading to prompt and proper treatment of the infection.

Airway obstructions is the most lethal and may cause sudden death without any deteriorating condition of the patients. Clinician should aware of the swelling that occurs in maxillofacial and neck region which may causing obstruction of the respiratory airway.^{1,2,4} Another possibility of airway obstruction is aspiration of pus due to rupture of deep neck spaces infection and directly drainage into the trachea.⁴ This eventually leads to sudden apnea and death is prompt, even intubation on this situation wouldn't be able to save the patient. Clinician should consider various treatment to secure airway patency. Surgical tracheostomy is widely used to secure the airway, and may be performed as a preventive action before things gone uncontrolled.^{2,4} Some other may also use a corticosteroid therapy to reduce the inflammation, reducing the swelling around the airway.¹⁸ The use of corticosteroid is controversial because of its side effect of reactive hyperglycemia and immunosuppressive,¹⁸ but it is a considerable option if surgical tracheostomy is not possible or having a higher risk of developing into other complications.

Breathing impairment is mostly related with thoracic region complications. It may happen when the infection is spreading directly into thoracic region, or a secondary complication of sepsis (e.g ARDS). Direct spread into thoracic region has worse prognosis,⁴ because the source of infection is harder to treat, damage of the vital organ and structures are more extensive.^{8,9} This may progress into respiratory failure, causing death in several hours.⁸ Clinician should aware any clinical signs of breathing impairment: high respiratory rate, abnormalities in lung inspections,

agitated mental status, restless, body position preferences, etc. Diagnostic may be confirmed with chest x-ray, any sign of empyema or pyothorax (existence of pus/fluid and air) indicates thoracic complications.^{5,8,9} This complication may also accompanied with descending necrotizing mediastinitis as a pathway into pleural cavity.⁸ Even prognosis is poor, prompt and proper treatment may lead to successful treatment. Drainage of the empyema could be treated with insertion of chest tube thoracostomy,⁸ and further necrotomy debridement thoracostomy may be essential for source control of the necrotizing mediastinitis, which if not treated leading to worsening of sepsis condition.^{5,9}

Hemodynamic problems in odontogenic infections mostly caused by sepsis. Sepsis remain the main problem of all types of infections which may lead to death. It is important for clinician to identify the sign of sepsis, severe sepsis, septic shock, multiple organ dysfunction & failure. Sepsis remain the highest cause of death, because sepsis may cause not only hemodynamic problems, but also other complications like ARDS which lead to respiratory failure.^{2,12} Other sepsis complications is thrombocytopenia and DIC, which may further deteriorate the patient condition in septic shock.^{2,16} Early assessment of sepsis is necessary, resuscitative management should be performed in 3 hours and 6 hours package according to Surviving Sepsis Campaign guide.^{2,12} EGDT should be performed to achieve targeted goal for stable hemodynamic of the patient. Multiple organ dysfunction should also be identified, and treated as soon as possible to prevent any other complications that may contribute in worsening the patient's condition.^{2,11,12} Other circulatory life threatening condition is vascular thrombosis, e.g Cavernous Sinus Thrombosis, and Lemierre's Syndrome. Even rarely happens, these thrombus in the vein may cause septic embolization and respiratory failure.^{2,13,14}

Disability problem due to infection may be rare to find, especially due to odontogenic infection. The clinical sign of this problem may be: headache, vomiting, neurological deficits, seizures, decrease of consciousness, etc. All of the sign is mainly due to increase of intracranial pressure. Brain abscess is probably the only one odontogenic infections

complication that is life-threatening because increasing the intracranial pressure.¹⁷ It may cause damage to the brain, and brain herniation which lead to sudden death because of respiratory center depression.^{2,17} Emergency surgery is needed to perform drainage inside the cranial cavity.^{2,17} Brain abscess may spread from the odontogenic infection through hematogenous or pericranial.^{2,17} Hematogenous spread may not be easy to assess, but in deep neck spaces infection, the infection may spread into vascular space, in which carotid artery is flowing blood directly into the brain.⁵ On the other hand, pericranial spread is easier to assess, the odontogenic infection start from maxillary tooth and progressing superiorly into orbital abscess or cavernous sinus thrombosis, spreading into cranial cavity and causing meningitis.² Any signs of infection in orbital region may rise suspicion of brain abscess, clinical sign should be assessed carefully.

It is important for clinician to know how a simple odontogenic infection may progress into life-threatening conditions. This complications is mainly due to unawareness, underestimating thought, delay in diagnosis, wrong or late therapeutic approach of clinicians. The principles management of odontogenic infection are:¹³(1) removal of the source of infection; (2) initiation of adequate drainage of pus/ collection; and (3) supportive therapy in the form of antibiotics and other adjuncts such as nutrition, rehydration and adequate glycaemic control. These management should be performed as soon as possible, preventing any complications that may increase the morbidity and mortality of the patient.

5. Conclusion

Odontogenic infection cannot be underestimated, delayed treatment may cause life-threatening complications. This will make the treatment more complicated as well as increasing the morbidity and mortality rate of the patient. It is important for clinician to treat odontogenic infection as soon as possible, when the infection is still localized with no other complications.

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