

# Spread of Dental Infection



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**T**he healthy body usually lives in balance with a number of resident normal flora. However, pathogens can invade and initiate an infectious process.<sup>1</sup> Dental infections involving the teeth or associated tissues are caused by oral pathogens that are predominantly anaerobic and usually of more than one species.<sup>2</sup> These infections can be of dental origin or from a nonodontogenic source. Those of dental origin usually originate from progressive dental caries or extensive periodontal disease. Pathogens can also be introduced deeper into the oral tissues by the trauma caused by dental procedures, such as the contamination of dental surgical sites (e.g., tooth extraction) and needle tracks during local anesthetic administration. Treatment consists of removal of the source of infection, systemic antibiotics, and area drainage.

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DENTAL INFECTION CAN BE A SERIOUS COMPLICATION FOR PATIENTS, ESPECIALLY THOSE WITHOUT ADEQUATE DENTAL OR MEDICAL CARE. THIS MODIFIED EXCERPT FROM *ILLUSTRATED ANATOMY OF THE HEAD AND NECK* DISCUSSES DENTAL INFECTION LESIONS. IT ALSO EXAMINES THE SPREAD OF DENTAL INFECTIONS FROM THE TEETH AND ASSOCIATED ORAL TISSUES TO VITAL TISSUES OR ORGANS, AS WELL AS PREVENTION AND MANAGEMENT OF THIS POTENTIALLY LIFE-THREATENING COMPLICATION. DISCUSSION OF MEDICALLY COMPROMISED PATIENTS IS ALSO INCLUDED.

abstract

Some dental infections are secondary infections incited by an infection in the tissues surrounding the oral cavity, such as the skin, tonsils, ears, or sinuses. These nonodontogenic sources of infections must be diagnosed and treated early. Prompt referral to the patient's physician will prevent further spread and potential complications. However, many people today do not have adequate dental or medical care.

Dental infections can result in different types of lesions, depending on the location of the infection and the type of tissue involved. An oral abscess occurs when there is localized entrapment of pathogens, with suppuration from a dental infection in a closed tissue space (Figures 1 and 2). A periapical abscess formation can occur with progressive caries, when pathogens invade the pulp and the infection spreads apically.<sup>3</sup> Pathogens can become entrapped in deep pockets with severe periodontal disease or around an erupting third molar, causing periodontal abscess or pericoronitis, respectively.<sup>4</sup> Abscess formation may not be detectable radiographically during the early stages.<sup>5</sup> In the later stages of infection, abscess formation can also lead to the formation of a passageway, or fistula, in the skin, oral mucosa, or even bone in

order to drain the infection and suppurate at the surface (Figures 1 and 2). The infectious process causes the overlying tissues to undergo necrosis, forming a canal in the tissue, with a stoma. If the dental infection is surrounded by the alveolar bone, it will break down the bone in its thinnest portion (either the facial or lingual cortical plate), following the path of least resistance.<sup>2</sup>

The soft tissue over a fistula in the alveolar bone may also have an extraoral or intraoral pustule — a small, elevated, circumscribed, suppuration-containing lesion of either the skin or oral mucosa.<sup>6</sup> The position of the pustule is largely determined by the relationship between the fistula and the overlying muscle attachments. Again, the infection will follow the path of least resistance (Table 1). The muscle attachments to the bones serve as barriers to the spread of infection, unlike the other facial soft tissues.<sup>2</sup>

Cellulitis of the face and neck can also occur with dental infections, resulting in the diffuse inflammation of soft tissue spaces.<sup>2</sup> The clinical signs and symptoms are pain, tenderness, redness, and diffuse edema of the involved soft tissue space, causing a massive and firm swelling (Table 2). There may also be dysphagia or restricted eye opening, if the cellulitis

occurs within the pharynx or orbital regions, respectively. Usually, the infection remains localized and a facial abscess can form that, if not initially treated, may discharge upon the facial surface. Without treatment, cellulitis could spread to the entire facial area, due to perforation of the surrounding bone. Cellulitis is treated by administration of antibiotics, and removal of the cause of infection.

Another type of lesion related to dental infections is osteomyelitis, an inflammation of the bone marrow.<sup>1</sup> Osteomyelitis can locally involve any bone in the body or be generalized (Figure 3). This inflammation develops from the invasion of the tissue of a long bone by pathogens usually from a skin or pharyngeal infection. For those involving the jaw bones, the pathogens are most often from a periapical abscess, from an extension of cellulitis, or from contamination of surgical sites<sup>2</sup> (Figure 3). Osteomyelitis most frequently occurs in the mandible and rarely in the maxilla, because of the mandible's thicker cortical plates and reduced vascularization.

Continuation of osteomyelitis leads to bone resorption and sequestra formation. Bone damage is easily detected by radiographic evaluation.<sup>5</sup> Paresthesia, evidenced by burning or prickling, may develop in the mandible if the infection involves the mandibular canal that carries the inferior alveolar nerve.<sup>2,6</sup> Localized paresthesia of the lower lip may occur if the infection is distal to the mental foramen where the mental nerve exits. Treatment consists of drainage, surgical removal of any sequestra, antibiotic administration, and, in some patients, the additional use of hyperbaric oxygen.

### MEDICALLY COMPROMISED PATIENTS

Normal flora usually do not create an infectious process. If, however, the body's natural defenses are compromised, then they can create opportunistic infections.<sup>7</sup> Medically compromised individuals include those with AIDS, Type I diabetes, and those undergoing radiation therapy. Some patients, due to their medical history, have a higher risk of complications from dental infections. Patients in this category include those at risk for infective endocarditis.

### SPREAD OF DENTAL INFECTIONS

Many infections that initially start in the teeth and associated oral tissues can have significant consequences if they spread to vital tissues or organs. Usually a localized abscess establishes a fistula in the skin, oral mucosa, or bone, allowing natural drainage of the infection and diminishing the risk of the infection's spread. This process can be interrupted by dental or medical treatment.



Figure 1. A periodontal abscess of the maxillary central incisor with fistula and stoma formation (probe inserted) in the maxillary vestibule.



Figure 2. Abscess formation can lead to formation of a fistula in order to drain the infection. (Photography courtesy of Dr. Michael A. Brunsvold.)



Figure 3. Osteomyelitis of the mandible, with swelling.

**Table 1** Most Common Teeth and Associated Periodontium Involved in Clinical Presentations of Abscesses and Fistulae

**Maxillary vestibule**

- Maxillary central or lateral incisor, all surfaces, and roots.
- Maxillary canine, all surfaces, and roots (short roots below levator anguli oris).
- Maxillary premolars, buccal surfaces, and roots.
- Maxillary molars, buccal surfaces, or buccal roots (short roots below buccinator).

**Penetration of nasal floor**

- Maxillary central incisor, roots.
- Maxillary canine, all surfaces, and root (long root above levator anguli oris).

**Palate**

- Maxillary lateral incisor, lingual surfaces, and roots.
- Maxillary premolars, lingual surfaces, and roots.
- Maxillary molars, lingual surfaces, or palatal roots.

**Perforation into maxillary sinus**

- Maxillary molars, buccal surfaces, and buccal roots (long roots).
- Maxillary molars, buccal surfaces, and buccal roots (long roots above buccinator).
- Mandibular first and second molars, buccal surfaces, and buccal roots (long roots below buccinator).

**Mandibular vestibule**

- Mandibular incisors, all surfaces, and roots (short roots above mentalis).
- Mandibular canine and premolars, all surfaces, and roots (all roots above depressors).
- Mandibular first and second molars, buccal surfaces, and roots (short roots above buccinator).

**Submental skin region**

- Mandibular incisors, roots (long roots below mentalis).

**Sublingual region**

- Mandibular first molar, lingual surfaces, and roots (all roots above mylohyoid).
- Mandibular second molar, lingual surfaces, and roots (short roots above mylohyoid).

**Submandibular skin region**

- Mandibular second molar, lingual surfaces, and roots (long roots below mylohyoid).
- Mandibular third molars, all surfaces, and roots (all roots below mylohyoid).

Occasionally, a dental infection will spread to the paranasal sinuses, through the blood system, or through the lymphatics.

**SPREAD TO THE PARANASAL SINUSES**

The paranasal sinuses of the skull can become infected through the direct spread of infection from the teeth and associated oral tissues, resulting in a secondary sinusitis. A perforation in the wall of the sinus can also be caused by an infection. Secondary sinusitis of dental origin occurs mainly with the maxillary sinuses, since the maxillary posterior teeth and associated tissues are in close proximity to these sinuses (Figure 4). Thus, maxillary sinusitis can occur through a spread of infection from a periapical abscess initiated by a maxillary posterior tooth that perforates the sinus floor to involve the sinus mucosa. A contaminated tooth or root fragment also can be displaced into the maxillary sinus during an extraction, stimulating infection.

Most infections of the maxillary sinuses are not of dental origin, but caused by an upper respiratory infection, when infection in the nasal region spreads to the sinuses.<sup>2</sup> An infection in one sinus can also travel through the nasal cavity to other sinuses, leading to serious complications for the patient, such as infection of the cranial cavity and brain. Thus it is important that any sinusitis be treated aggressively by the patient's physician to eliminate the initial infection.

The symptoms of sinusitis are headache, usually near the involved sinus, and foul-smelling nasal or pharyngeal discharge, possibly accompanied by fever and weakness. The skin over the involved sinus can be tender, hot, and red due to inflammation in the area. Dyspnea occurs, as well as pain, when the nasal passages and the sinus ostia become blocked by the effects of tissue inflammation. Early radiographic evidence of the sinusitis is thickening of the sinus walls. Subsequent radiographic evaluation may show increased opacity and, possibly, perforation.<sup>5</sup> Acute sinusitis usually responds to antibiotic therapy, with drainage aided through the use of decongestants. Surgery may be indicated for chronic maxillary sinusitis to enlarge the ostia in the lateral walls of the nasal cavity, so that adequate drainage can diminish the effects of the infection.<sup>2</sup>

**SPREAD BY THE BLOOD SYSTEM**

The blood system of the head and neck can allow the spread of infection from the teeth and associated oral tissues, because pathogens can travel in the veins and drain the infected oral site into other tissues or organs. The spread of dental infection by

**Table 2** Possible Space, Teeth, and Periodontium Involved With a Clinical Presentation of Cellulitis from the Spread of Dental Infection

CLINICAL PRESENTATION OF LESION	SPACE INVOLVED	MOST COMMON TEETH AND ASSOCIATED PERIODONTIUM INVOLVED IN INFECTION
Infraorbital region, zygomatic region, buccal region	Buccal space	Maxillary premolars, and maxillary and mandibular molars
Posterior border of mandible	Parotid space	Not generally of odontogenic origin
Submental region	Submental space	Mandibular anterior teeth
Unilateral submandibular region	Submandibular space	Mandibular posterior teeth
Bilateral submandibular region	Submental, sublingual, and submandibular spaces with Ludwig's angina	Spread of mandibular dental infection
Lateral cervical region	Parapharyngeal space	Spread of mandibular dental infection



way of the blood system can occur from bacteremia or an infected thrombus.<sup>2</sup> Bacteria traveling in the blood can cause transient bacteremia following dental treatment. Individuals with a high risk for infective endocarditis may have these bacteria lodge in the compromised tissues, promoting significant infection deep in the heart, that can result in massive and fatal heart damage. These patients may need antibiotic premedication to prevent bacteremia from occurring during dental treatment.<sup>7</sup>

An infected intravascular clot or thrombus can dislodge from the inner blood vessel wall and travel as an embolus. Emboli can travel in the veins, draining the oral cavity to areas such as the dural venous sinuses within the cranial cavity. These dural sinuses are channels by which blood is conveyed from the cerebral veins into the veins of the neck, particularly into the internal jugular vein. Because these veins lack valves, however, blood can flow both into and out of the cranial cavity.

The cavernous sinus is most likely to be involved in the potentially fatal spread of dental infection.<sup>2</sup> The cavernous sinus is located on the side of the body of the sphenoid bone.<sup>8</sup> Each cavernous venous sinus communicates with the one on the opposite side, and also with the pterygoid plexus and the superior ophthalmic vein, which anastomoses with the facial vein (Figure 5). These major veins drain teeth through the posterior superior and inferior alveolar veins and the lips through the superior and inferior labial veins. None of the major veins that communicate with the cavernous sinus have valves to prevent retrograde blood flow back into the cavernous sinus. Therefore, dental infections that drain into these major veins may initiate an inflammatory response, resulting in an increase in blood stasis, thrombus formation, and increasing extravascular fluid pressure. Increased pressure can reverse the direction of venous blood flow, enabling the transport of the infected thrombus into this venous sinus, and thus cause cavernous sinus thrombosis.

Needle-track contamination can also result in a spread of infection to the pterygoid plexus if a posterior superior alveolar anesthetic block is incorrectly administered.<sup>2</sup> Nonodontogenic infections originating from what physicians consider the dangerous triangle of the face — the orbital region, nasal region, and paranasal sinuses — also may result in this thrombosis.

The signs and symptoms of cavernous sinus thrombosis include fever, drowsiness, and rapid pulse. In addition, there is loss of function of the abducent nerve, since it

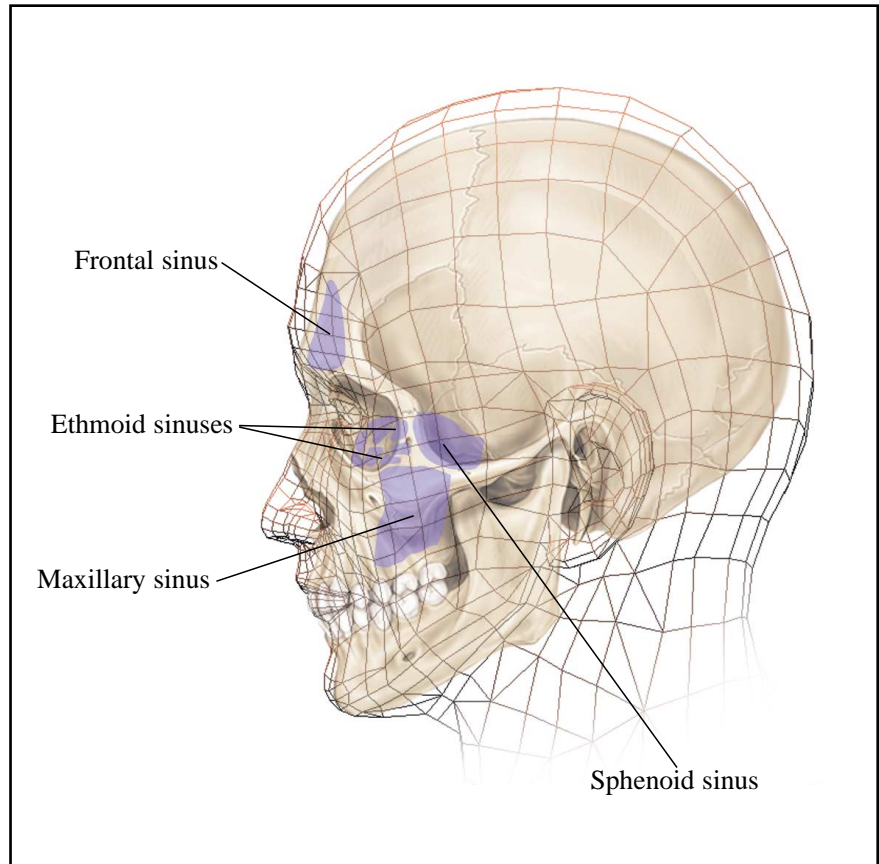


Figure 4. Lateral view of the skull and the paranasal sinuses.

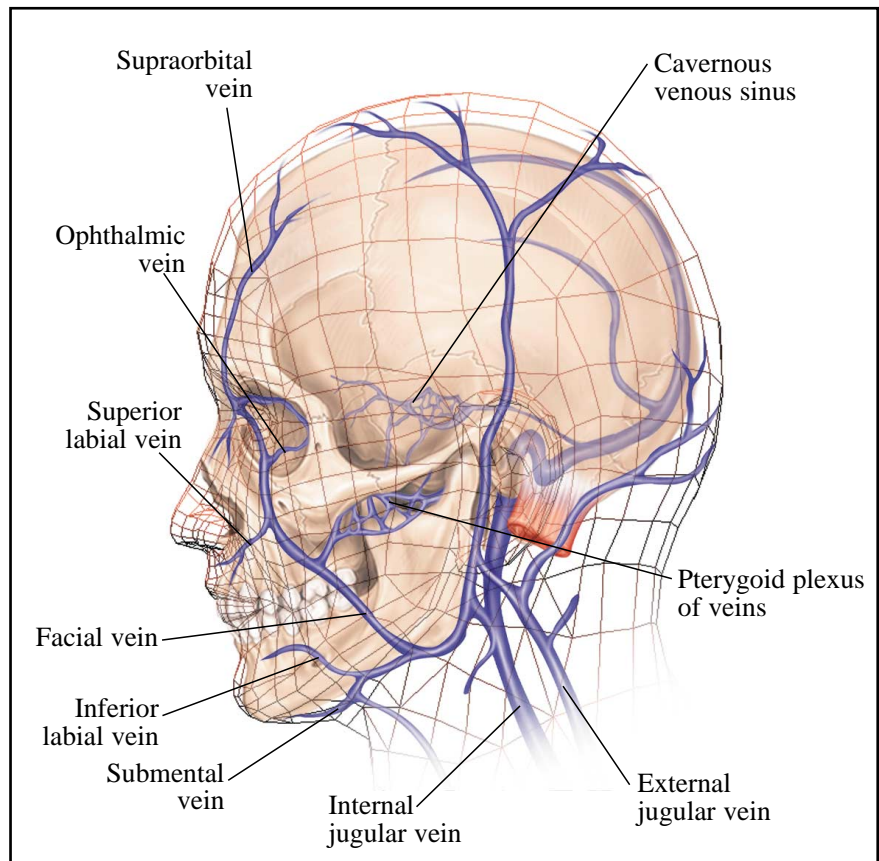


Figure 5. Pathways of the internal jugular vein and facial vein, as well as the location of the cavernous venous sinus.

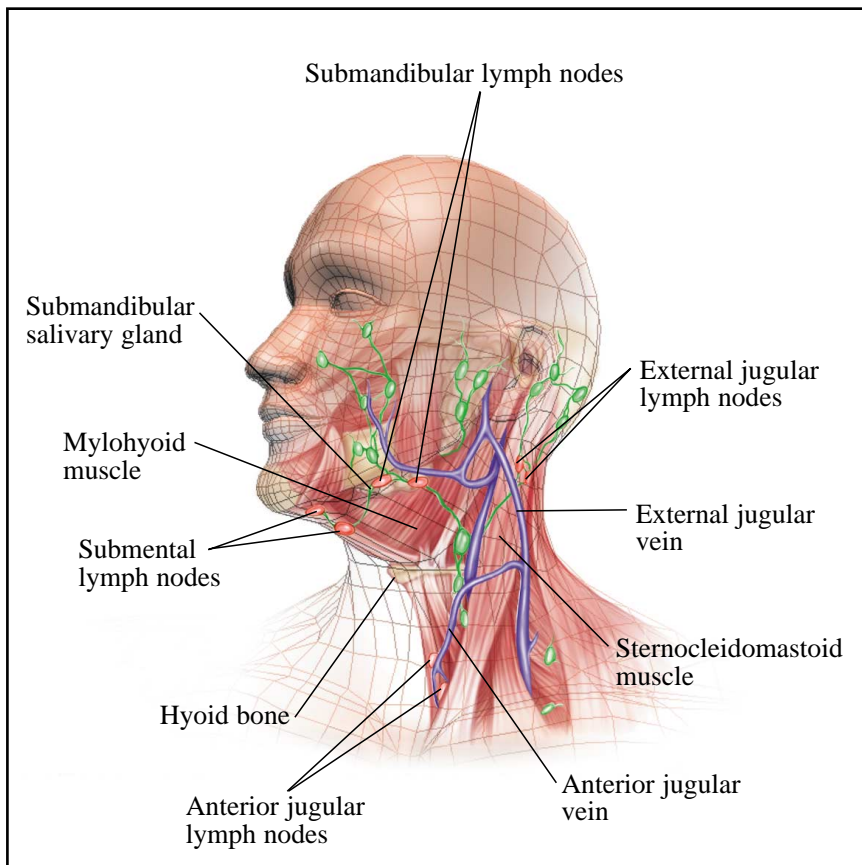


Figure 6. Superficial cervical lymph nodes and associated structures.

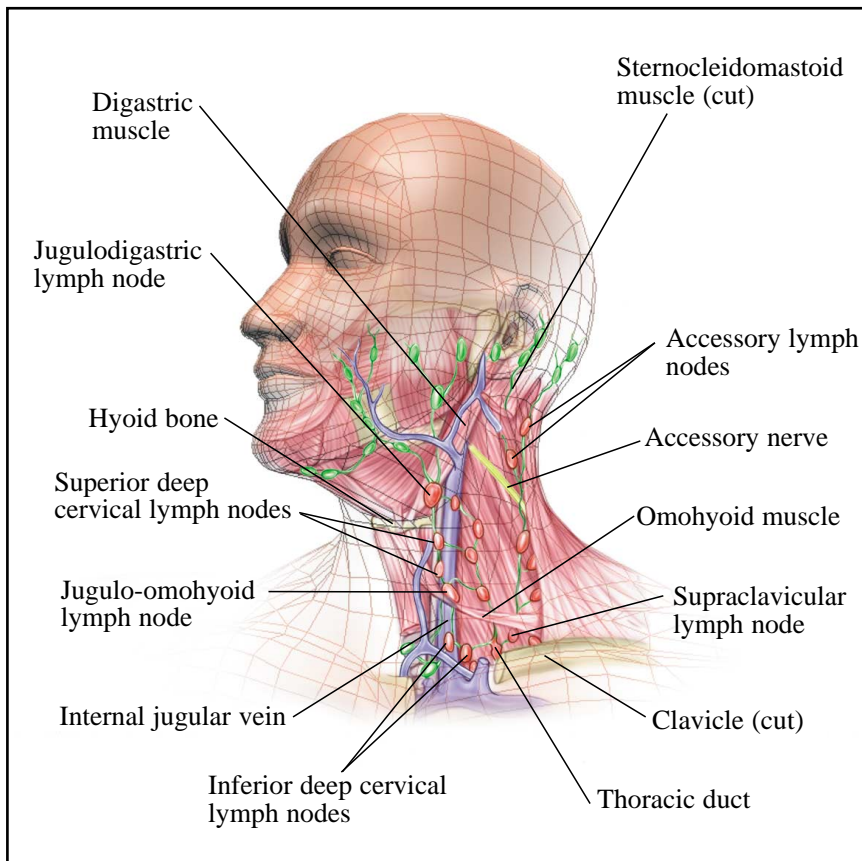


Figure 7. Deep cervical lymph nodes and associated structures.

runs through the cavernous venous sinus, resulting in nerve paralysis. Because the muscle supplied by the abducent nerve moves the eyeball laterally, the inability to perform this movement suggests nerve damage. Also, the patient will usually have double vision because of the restricted movement of the one eye. There will also be edema of the eyelids and conjunctivae, tearing, or exophthalmos, depending on the course of the infection. With cavernous sinus thrombosis there may also be damage to the other cranial nerves, such as the oculomotor and trochlear, as well as the ophthalmic and maxillary divisions of the trigeminal and changes in the tissues they innervate, since all these nerves travel in the cavernous sinus wall.<sup>8</sup> Finally, this infection can be fatal because it may lead to meningitis, which requires immediate hospitalization with intravenous antibiotics and anticoagulants.<sup>1</sup>

### SPREAD BY LYMPHATICS

The lymphatics of the head and neck can allow the spread of infection from the teeth and associated oral tissues. This occurs because the pathogens can travel in the lymph through the lymphatics that connect the series of nodes from the oral cavity to other tissues or organs. Thus, these pathogens can move from a primary node near the infected site to a secondary node at a distant site.<sup>6</sup>

The route of dental infection traveling through the nodes varies according to the teeth involved<sup>8</sup> (Figures 6 and 7). The submental nodes drain the mandibular incisors and their associated tissues. Then the submental nodes empty into the submandibular nodes, or directly into the deep cervical nodes. The submandibular nodes are the primary nodes for all the teeth and associated tissues, except the mandibular incisors and maxillary third molars. The submandibular nodes then empty into the superior deep cervical nodes, the primary nodes for the maxillary third molars and their associated tissues. The superior deep cervical nodes empty into either the inferior deep cervical nodes or directly into the jugular trunk and then into the vascular system. Once the infection is in the vascular system, it can spread to all tissues and organs as previously discussed.

A lymph node involved in infection undergoes lymphadenopathy, which results in a size increase and a change in consistency of the lymph node so it becomes palpably firm.<sup>3</sup> Evaluation of the involved nodes can determine the degree of regional involvement of the infectious process, which is instrumental in diagnosis and management of the infectious process.<sup>2</sup>



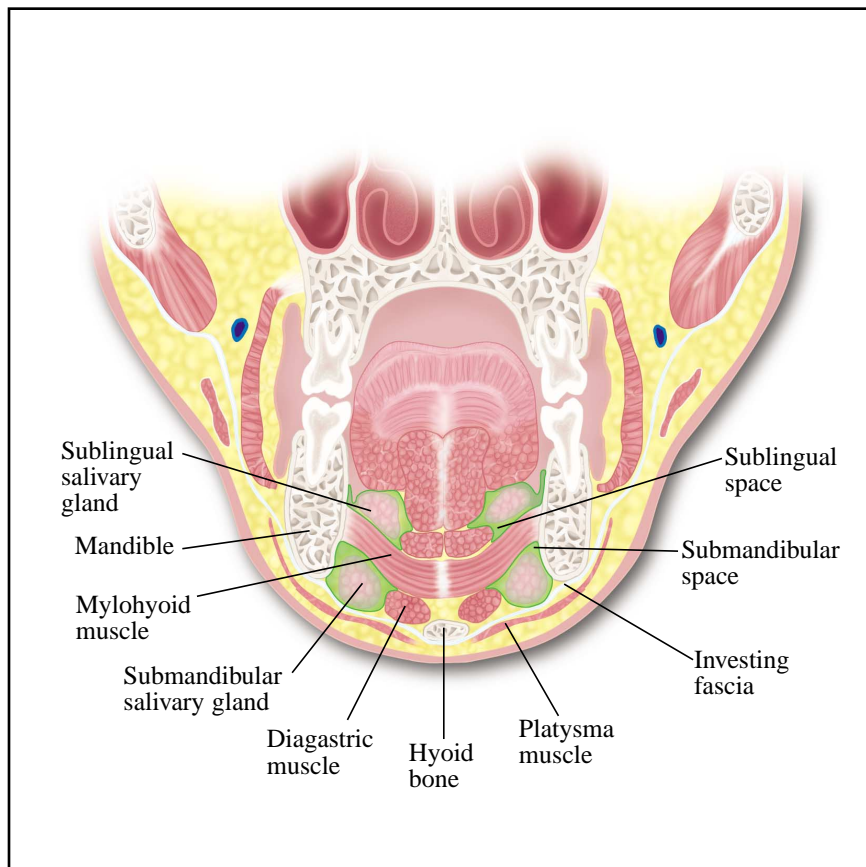


Figure 8. Frontal section of the head and neck highlighting the submandibular and sublingual spaces.

### SPREAD BY SPACES

The spaces of the head and neck can allow the spread of infection from the teeth and associated oral tissues because the pathogens can travel within the fascial planes, from one space near the infected site to another distant space, by the spread of the related inflammatory exudate.<sup>2</sup> When involved in infections, the space can undergo cellulitis, which can cause a change in the normal proportions of the face (Table 2).

If the maxillary teeth and associated tissues are infected, the infection can spread into the maxillary vestibular space, buccal space, or canine space. If the mandibular teeth and associated tissues are infected, the infection can spread into the mandibular vestibular space, buccal space, submental space, sublingual space, submandibular space, or the space of the body of the mandible. From these spaces, the infection can spread into other spaces of the jaws and neck, possibly causing serious complications, such as Ludwig's angina.<sup>2</sup>

Ludwig's angina is a cellulitis of the submandibular space (Figure 8).<sup>6</sup> This involves a spread of infection from any of the mandibular teeth or associated tissues to one space initially, either the

submental space, sublingual space, or even the submandibular space itself. Then the infection spreads to the submandibular space bilaterally, with a risk of infiltration to the parapharyngeal space of the neck. With this complication, there is massive bilateral submandibular regional swelling, which extends down the anterior cervical triangle to the clavicles. Swallowing, speaking, and breathing may be difficult; high fever and drooling are evident. Respiratory obstruction may rapidly develop because the continued swelling displaces the tongue upwards and backwards, thus blocking the pharyngeal airway. As the parapharyngeal space becomes involved, edema of the larynx may cause complete respiratory obstruction, asphyxiation, and death. Ludwig's angina is an acute medical emergency requiring immediate hospitalization and may necessitate an emergency cricothyrotomy to create a patent airway.

### PREVENTION OF THE SPREAD OF DENTAL INFECTIONS

Early diagnosis and treatment of dental infections must occur for all patients. Particular care must be taken not to contaminate surgical sites, such as those from extractions or implant placement. There must also be a strict adherence to aseptic

protocol during nonsurgical dental treatment, such as restorative and periodontal debridement therapy, to prevent the spread of infection.<sup>4</sup> This may include the removal of heavy plaque accumulations or the use of an antiseptic prerinse prior to treatment. During treatment, the use of a rubber dam or an antimicrobial-laced external water supply with ultrasonics or irrigators may be of help in preventing the spread of infection. After treatment, this might include an antiseptic postrinse at home or antibiotic coverage. Finally, it is important to not administer a local anesthetic through an area of dental infection, as this could move pathogens deeper into the tissues.

A thorough medical history with periodic updates will allow the dental professional to perform safe treatment on medically compromised patients, to avoid serious complications of their dental diseases. These patients may require antibiotic premedication before dental treatment to prevent any serious sequelae or other changes in the dental treatment plan.<sup>7</sup> A medical consultation is indicated when there is uncertainty regarding the risk of opportunistic infection for the individual patient.<sup>9,10</sup>

### CONCLUSION

Dental infections can have significant medical ramifications, including death. As the health care practitioner most familiar with patients' oral health, the dental hygienist must be knowledgeable of the appearances, causes, and symptoms of dental infection lesions.

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To submit your CE Exercise answers, please use the enclosed Answer Card found opposite page 52, and complete it as follows: 1) Complete the address; 2) Identify the Article/Exercise Number; 3) Place an x in the appropriate answer box for each question. Return the completed card to the indicated address.



The 10 multiple-choice questions for this CE exercise are based on the article "Spread of Dental Infection" by Margaret J. Fehrenbach, RDH, MS,

and Susan W. Herring, PhD. This article is on pages 13-18. Answers for this exercise will be published in the November/December 1997 issue of *The Journal of Practical Hygiene*.

**Learning Outcomes:**

- Cite the cause of dental infection.
- Cite the potential consequences of various dental lesions.
- Describe the spread of dental infection throughout the body.

- 1. What directly causes dental infection involving the teeth or associated tissues?**
  - A. A specific, aerobic oral pathogen predominant in the oral mucosa.
  - B. Cellulitis of the ethmoid sinus.
  - C. Oral pathogens that are mainly anaerobic and usually of more than one species.
  - D. Proliferating bacteria transferred via the blood system of the head and neck.
- 2. What is a potential consequence of orofacial cellulitis?**
  - A. Edema of the diaphragm.
  - B. A facial abscess that may discharge upon the surface.
  - C. The lodging of bacteria deep within the lungs.
  - D. Osteoarthritis.
- 3. Continuation of orofacial osteomyelitis can lead to:**
  - A. Abscesses of the inner ear.
  - B. Bone resorption and sequestra formation.
  - C. Paresthesia of the lower extremities.
  - D. Weakening of the central nervous system.
- 4. Most infections of the maxillary sinuses are of dental origin.**
  - A. True.
  - B. False.
- 5. What early radiographic evidence indicates sinusitis?**
  - A. A localized abscess of the sinus walls.
  - B. Decreased opacity of the sinus ostia.
  - C. Enlargement of the sinus ostia.
  - D. Thickening of the sinus walls.
- 6. What is a potential consequence of sinusitis?**
  - A. Increased opacity and perforation of the sinus walls.
  - B. Localized paresthesia of the lower lip.
  - C. Dysphagia.
  - D. Nerve damage.
- 7. How can infection from the teeth and associated oral tissues spread throughout the body?**
  - A. Always due to overall decreased immunity.
  - B. Through infectious saliva.
  - C. Through the blood system of the head and neck.
  - D. Through the transference of infectious cells.
- 8. Which of the following is most likely to be involved in the potentially fatal spread of dental infection?**
  - A. The carotid sinus.
  - B. The cavernous sinus.
  - C. The dural venous sinuses.
  - D. The lymphatic sinus.
- 9. What are the potential consequences of Ludwig's angina?**
  - A. Decreased blood flow to the brain.
  - B. Decreased metabolism.
  - C. Muscle atrophy.
  - D. Respiratory obstruction, asphyxiation, and death.
- 10. Why should a local anesthetic not be administered through an area of dental infection?**
  - A. Decreased area blood flow increases toxicity.
  - B. Needle causes a negative ionic field.
  - C. This could move pathogens deeper into the tissues.
  - D. Pathogens may enter saliva and be swallowed.