

Odontogenic infections arising in the mandible first spread upward, into the masseter and/or medial pterygoid muscles in the masticator space, and downward, into the sublingual and/or submandibular spaces, and then spread into the spaces or muscles adjacent to one or more of these locations. Infections from the masseter muscle spread into the parotid space to involve the temporalis and lateral pterygoid muscles. Infections from the medial pterygoid muscle spread into the parapharyngeal space to involve the lateral pterygoid muscle. Infections in the maxilla did not spread downward; instead, they tended to spread upward and superficially into the temporal and/or masseter spaces and deeply involve the lateral and/or medial pterygoid muscles in the medial masticator space.

CONCLUSION: CT may be useful to depict the extent of infection and to plan treatment of

Odontogenic infections rarely extend beyond the jaw bone barriers into the deep spaces of the face and neck (1). But once they occur, they are often difficult to assess accurately by clinical and conventional radiologic techniques, and the outcome may be serious and potentially life threatening (2). Because of its ability to locate diseases in clinically inaccessible portions of the body, computed tomography (CT) has been used to evaluate deep facial and neck infections (2–4). However, CT studies in large populations of patients with widespread deep infections of the neck originating from odontogenic infections have been scarce, and pathways through which the inflammatory processes extend have not been studied intensively. We assessed profiles of involvement of the deep facial and upper neck spaces by infections of odontogenic origin.

Fascial Infections Derived from Maxillary Odontogenic Origins

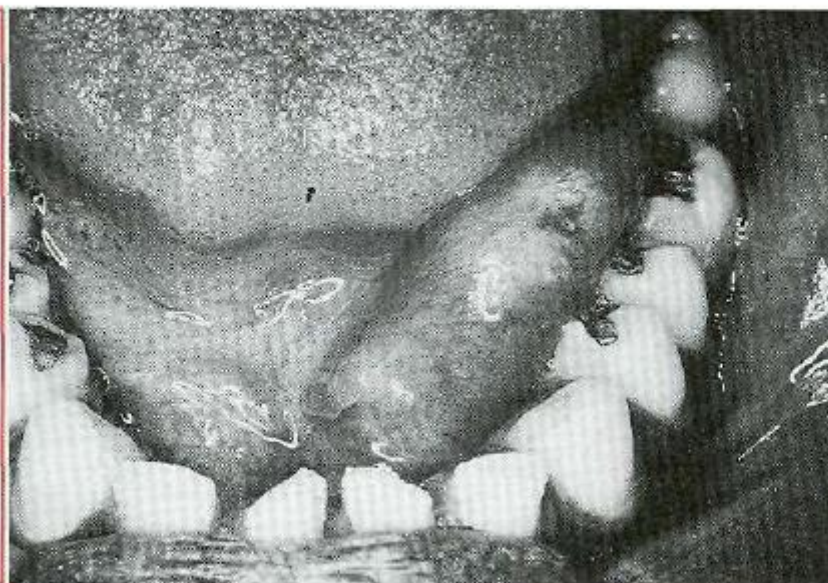
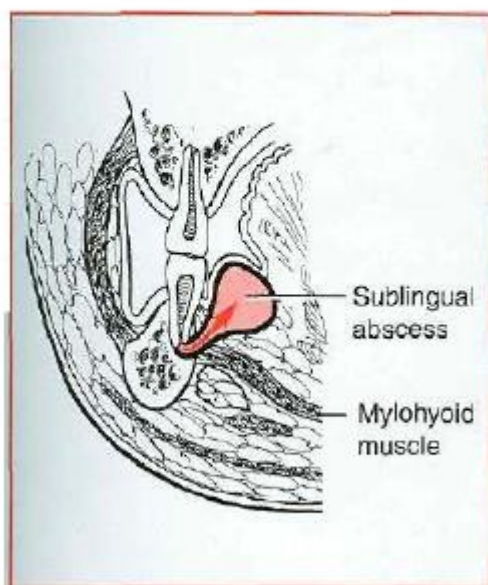
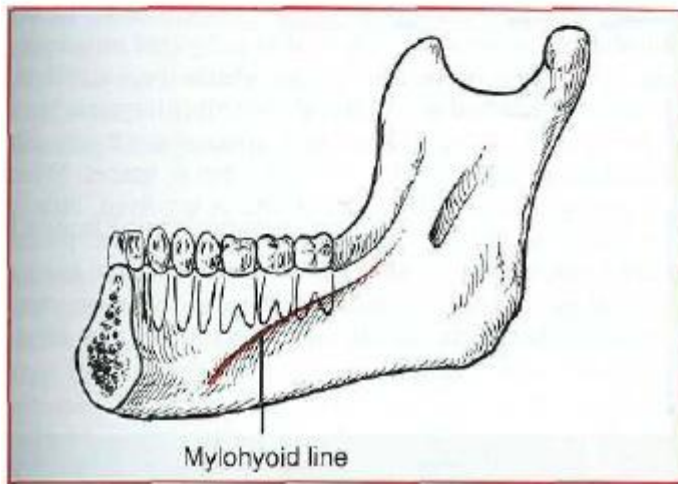
The spread pattern of maxillary infection differed from that of mandibular infection. First, involvement of the temporalis muscle occurred in seven (100%) of seven patients; involvement from mandibular infection occurred in only 10 (26%) of 38 patients (Table 2). Second, downward spread (spreading into the sublingual and submandibular spaces) never occurred in patients with maxillary infection (Table 2). The lateral pterygoid and masseter muscles were frequently involved (six [86%] of seven), as in the case of mandibular infection. The other spaces (parapharyngeal and parotid) were also involved, but much less frequently. The buccal space was involved in four (57%) of seven patients with maxillary infection.

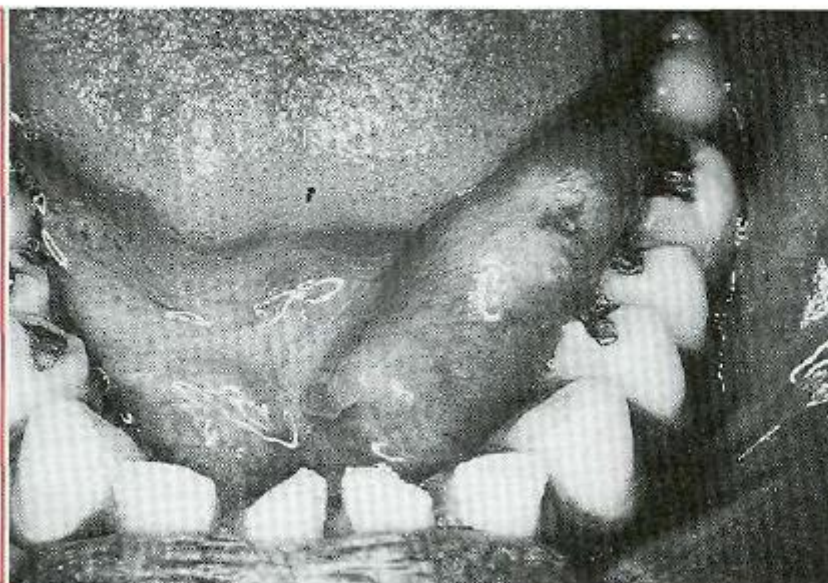
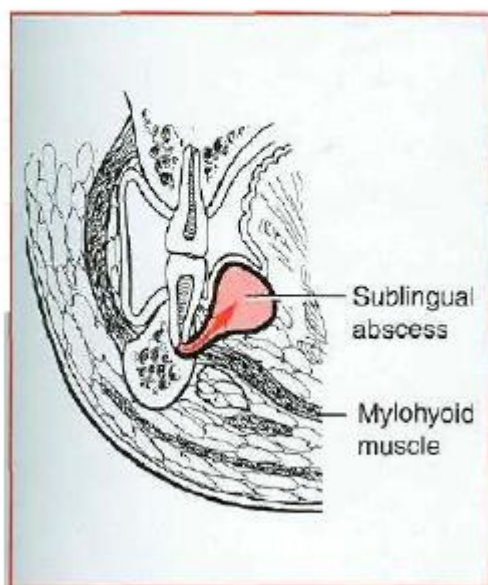
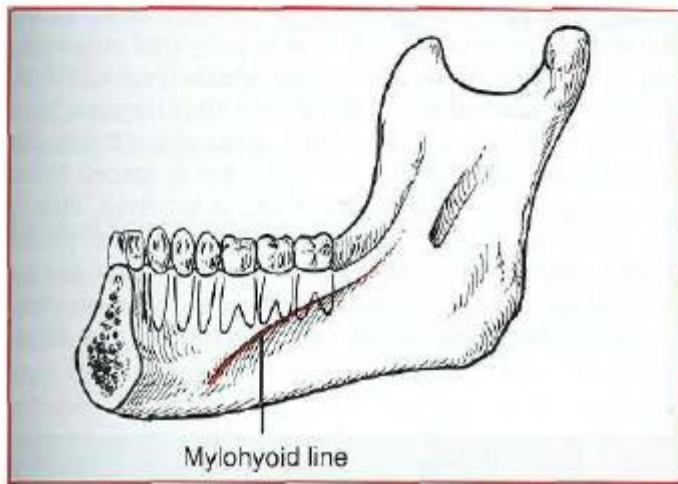
Fascial Infections Derived from Mandibular Odontogenic Origins

Tables 1 and 2 summarize the CT profiles of the spread of odontogenic infection into the facial and neck spaces. The masticator space—which encompasses the posterior body of the mandible, ramus, and condyle, and a part of the alveolar ridge of the mandible as well as associated masticatory muscles (Fig 1A and B)—was found to be most frequently involved in the spread of mandibular infection (in 33 [87%] of 38, Table 2). Of the masticator muscles involved in these patients, the masseter (29 [76%] of 38) and medial pterygoid (24 [63%] of 38) muscles were most often involved. The temporalis (10 [26%] of 38) and lateral pterygoid (8 [21%] of 38) muscles were less frequently involved (Table 2). In no case was infection of the anterior teeth found to be associated with infection of the masticator space.

Spaces other than the masticator space were involved much less frequently. The parapharyngeal space, which is adjacent medially to the medial pterygoid muscle in the masticator space (Fig 1A), was frequently involved (19 [79%] of 24) when the medial pterygoid muscle was involved, and the medial pterygoid muscle was always involved when the parapharyngeal space was involved (Table 2). The parotid space, which is adjacent posteriorly to the masticator space and is located in the vicinity of the masseter muscle (Fig 1B), was involved in 17 (59%) of the 29 patients who had masseter muscle involvement, and the masseter muscle was always involved when the parotid space was involved (Table 2). The retropharyngeal space, which is posteromedially adjacent to the parapharyngeal space, was not involved as far as we could judge on the CT scans (Table 2). These results suggest that the parapharyngeal and parotid spaces are the secondary sites of spread of infection from the masticator space.

The sublingual and submandibular spaces are located at the floor of the mouth, separated partially by the mylohyoid muscle (Fig 1A). The sublingual space borders the lower part of the mandibular body. Seventeen (45%) of the 38 patients had involvement of this space (Table 2). The submandibular space was involved in 23 (61%) of the 38 patients with odonto-





MANDIBULAR SPACES

Although most infections of the mandibular teeth erode into the buccal vestibule, they may also spread into fascial spaces. The four primary mandibular spaces are (1) the submental, (2) the buccal, (3) the sublingual, and (4) the submandibular spaces.

The submental space lies between the anterior bellies of the digastric muscle and between the mylohyoid muscle and the overlying skin (Fig. 16-6). This space is primarily infected by mandibular incisors, which are sufficiently long to allow the infection to erode through the labial bone apical to the attachment of the mentalis muscle. The infection is thus allowed to proceed under the inferior border of the mandible and involve the submental space. Isolated submental space infection is a rare occurrence.

FIG. 16-7 Mylohyoid line is area of attachment of mylohyoid muscle.

Unguocortical plate perforation by infection from premolars and first molar causes sublingual space infection, whereas infection from third molar involves submandibular space. (From

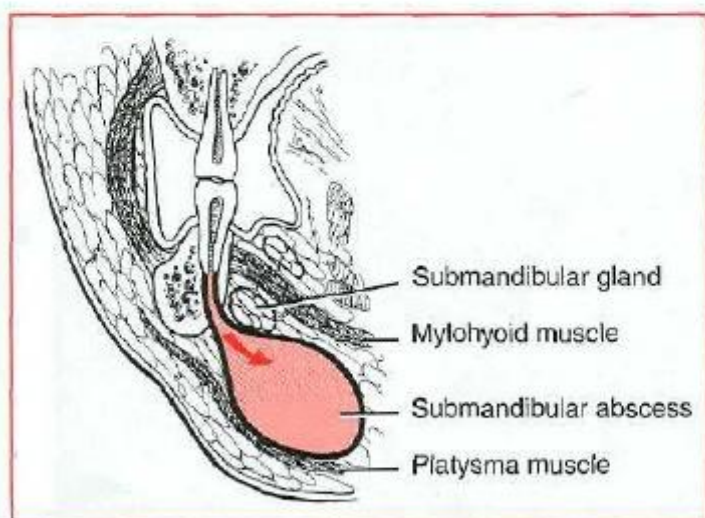
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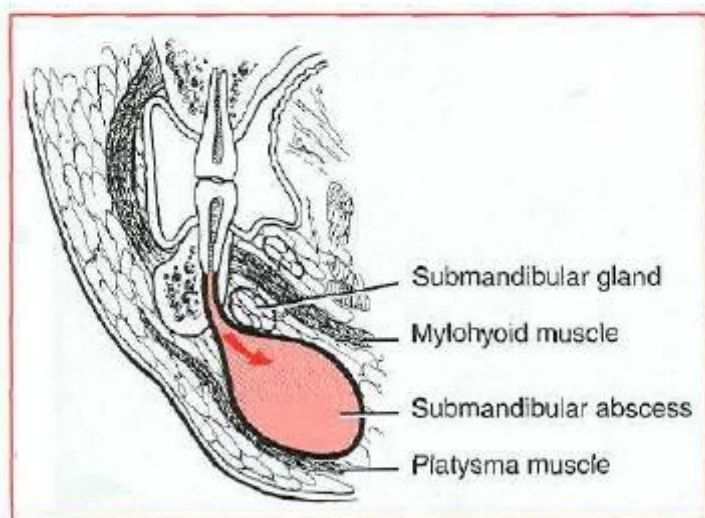
The buccal space can be infected as an extension of infection from mandibular teeth, similar to the way in which it is involved from the maxillary teeth (see Fig. 16-3). The buccal space is most commonly infected from maxillary teeth but can also be involved from the mandibular teeth.

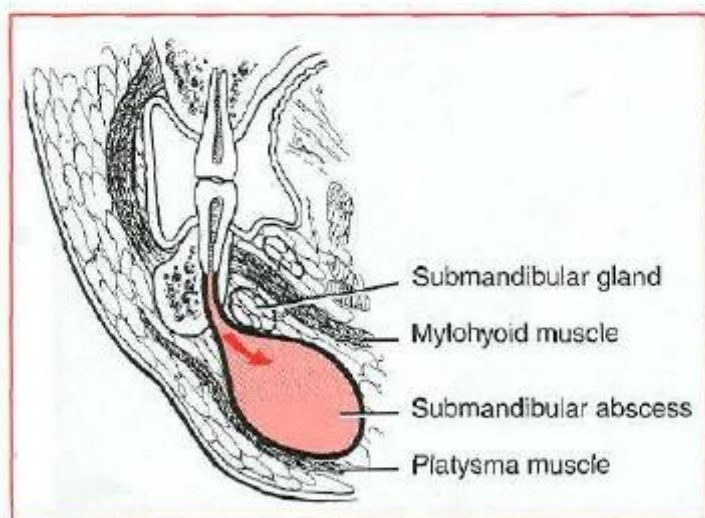
The sublingual and submandibular spaces have the medial border of the mandible as their lateral boundary. These two spaces are involved primarily by lingual perforation of infection from the mandibular molars, although they may be involved by premolars, as well. The factor that determines whether the infection is submandibular or sublingual is the attachment of the mylohyoid muscle on the mylohyoid ridge of the medial aspect of the mandible (Fig. 16-7). If the infection erodes through the medial aspect of the mandible above this line, the infection will be in the sublingual space and is most commonly seen with premolars and the first molar. If the infection erodes through the medial aspect of the mandible inferior to the mylohyoid line, the submandibular space will be involved. The mandibular third molar is the tooth that most commonly involves the submandibular space primarily. The second molar may involve either the sublingual or submandibular space, depending on the length of the individual roots, and may involve both spaces primarily.

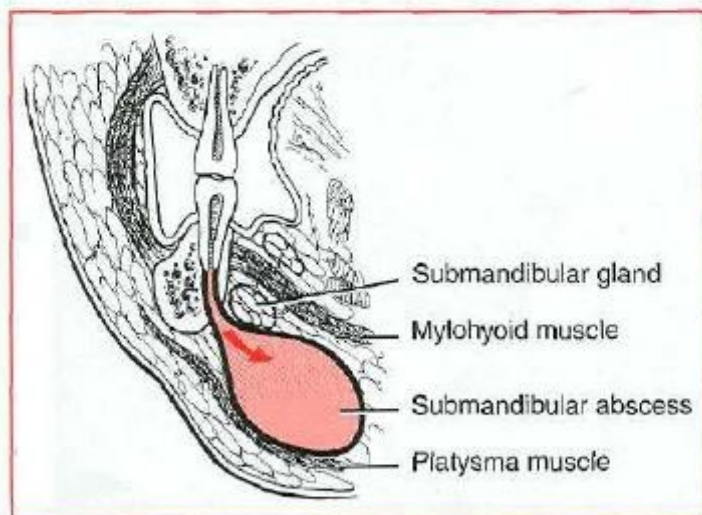
The sublingual space lies between the oral mucosa of the floor of the mouth and the mylohyoid muscle (Fig. 16-8,A). Its posterior border is open, and therefore it freely communicates with the submandibular space and the secondary spaces of the mandible to the posterior aspect. Clinically little or no extraoral swelling is produced by an infection of the sublingual space, but much intraoral swelling is seen in the floor of the mouth on the infected side (Fig. 16-8,B). The infection usually becomes bilateral, and the tongue becomes elevated.

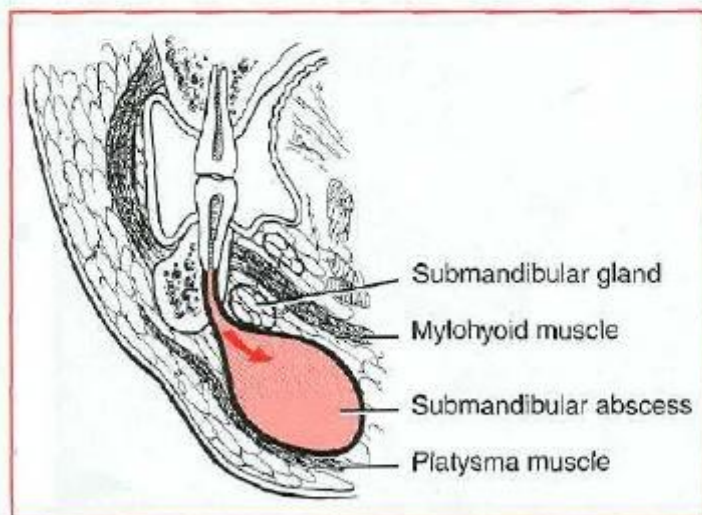
FIG. 16-8 A, Sublingual space between oral mucosa and mylohyoid muscle. It is primarily involved by infection from mandibular premolars and first molar. B, This isolated sublingual space infection produced unilateral swelling of floor of mouth. (From Cummings CW et al, editors: Otolaryngology: head and neck surgery, vol 3, St Louis, 1998, Mosby.)

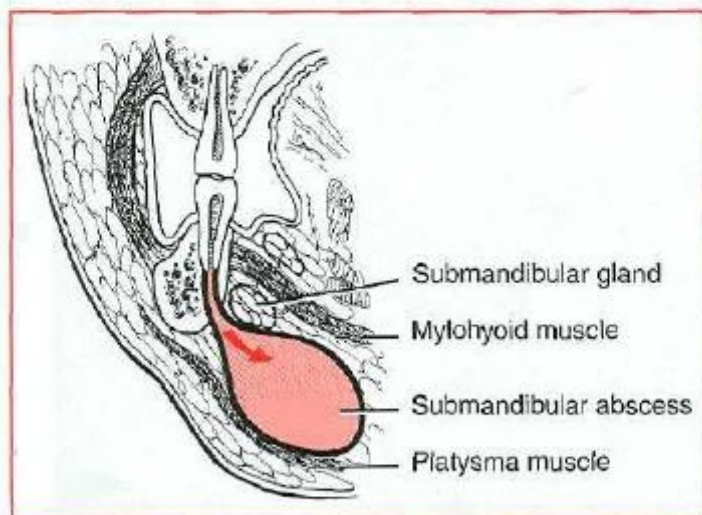












The submandibular space lies between the mylohyoid muscle and the overlying skin and superficial fascia (Fig. 16-9). The posterior boundary of the submandibular space communicates with the secondary spaces of the jaw posteriorly. Infection of the submandibular space causes swelling that begins at the inferior border of the mandible and extends medially to the digastric muscle and posteriorly to the hyoid bone (Fig. 16-10).

When bilateral submandibular, sublingual, and submental spaces become involved with an infection, it is known as Ludwig's angina. This infection is a rapidly spreading cellulitis that commonly spreads posteriorly to the secondary spaces of the mandible.

Severe swelling is almost always seen, with elevation and displacement of the tongue, and a tense, hard induration of the submandibular region superior to the hyoid bone.

The patient usually has trismus, drooling of saliva, and difficulty with swallowing and sometimes breathing. The patient often experiences severe anxiety concerning the inability to swallow and maintain an airway. This infection may progress with alarming speed and thus may produce upper airway obstruction that often leads to death. The most common cause of Ludwig's angina is an odontogenic infection, usually as the result of streptococci. This infection must be aggressively managed with vigorous I&D procedures and aggressive antibiotic therapy. Special attention must be given to maintenance of the airway.

Secondary Fascial Spaces

The primary spaces discussed so far are immediately adjacent to the tooth-bearing portions of the maxilla and mandible. If proper treatment is not received for infections of the primary spaces, the infections may extend posteriorly to involve the secondary fascial spaces. When these spaces are involved, the infections frequently become more severe, cause greater complications and greater morbidity, and are more difficult to treat. Because a connective tissue fascia that has a poor blood supply surrounds these spaces, infections involving these spaces are difficult to treat without surgical intervention to drain the purulent exudate.

The masseteric space exists between the lateral aspect of the mandible and the medial boundary of the masseter muscle (see Fig. 16-4). It is involved by infection most commonly as the result of spread from the buccal space or from soft tissue infection around the mandibular third molar. When the masseteric space is involved, the area overlying the angle of the jaw and ramus becomes swollen. Because of the involvement of the masseter muscle, the patient will also have moderate-to-severe trismus caused by inflammation of the masseter muscle.

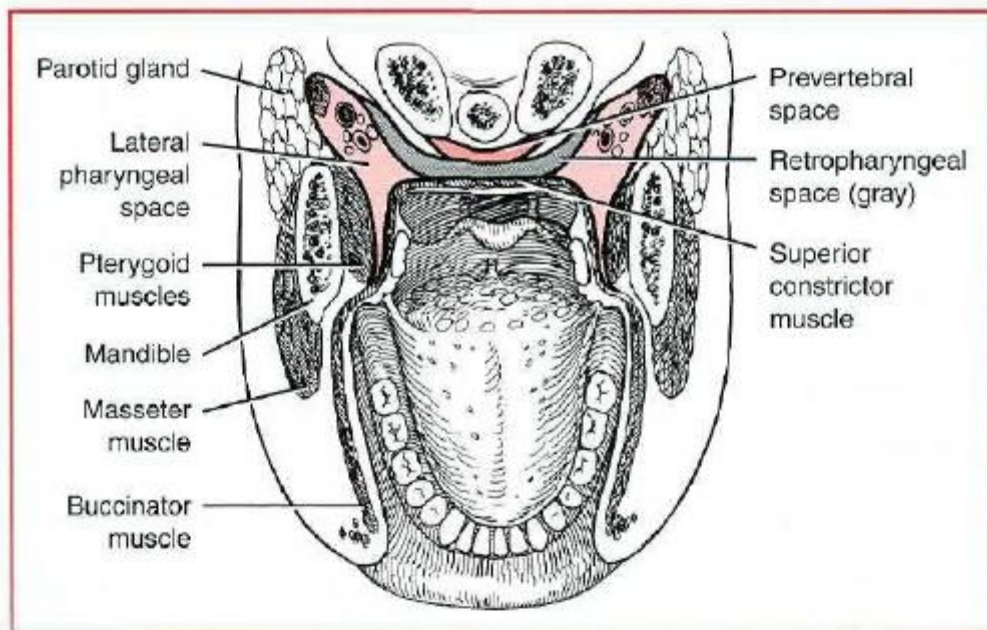
The pterygomandibular space lies medial to the mandible and lateral to the medial pterygoid muscle (see Fig. 16-4). This is the space into which local anesthetic solution is injected when an inferior alveolar nerve block is performed. Infections of this space spread primarily from the sublingual and submandibular spaces. When the pterygomandibular space alone is involved, little or no facial swelling is observed; however, the patient almost always has significant trismus. Therefore trismus without swelling is a valuable diagnostic clue for pterygomandibular space infection. The most common

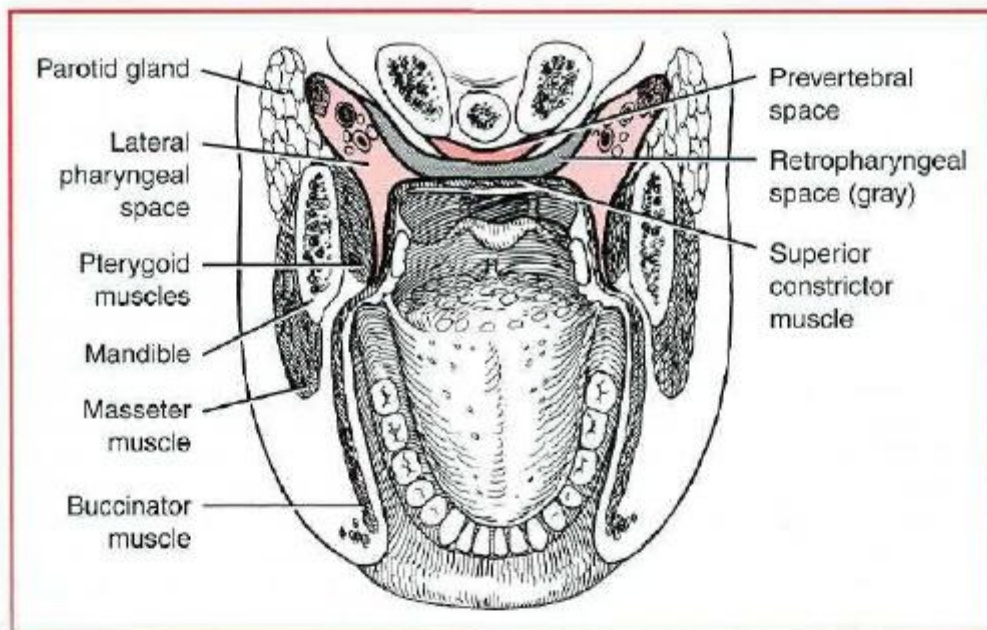
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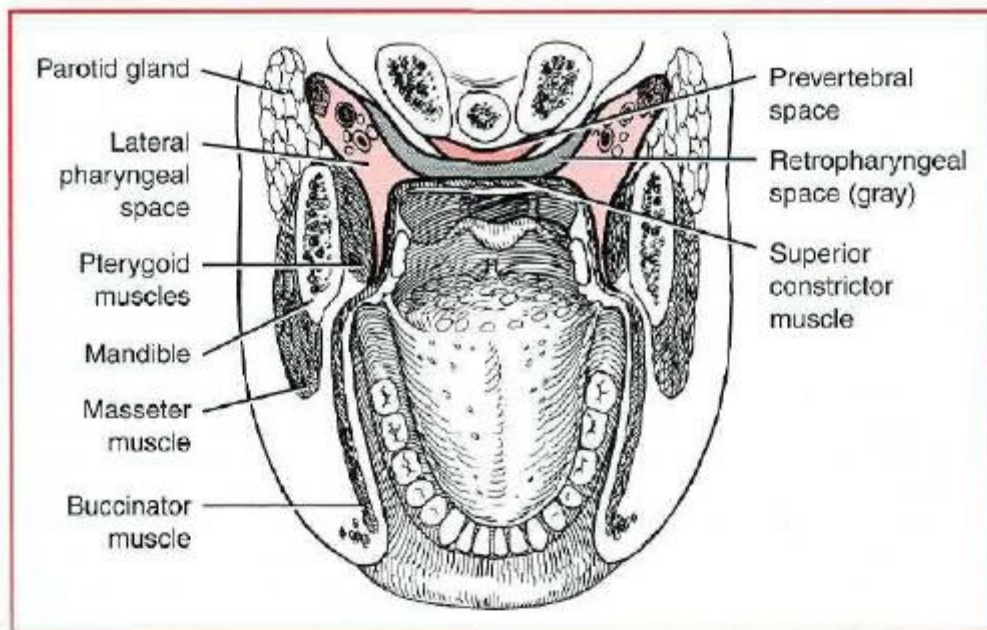
FIG. 16-9 Submandibular space lies between mylohyoid muscle

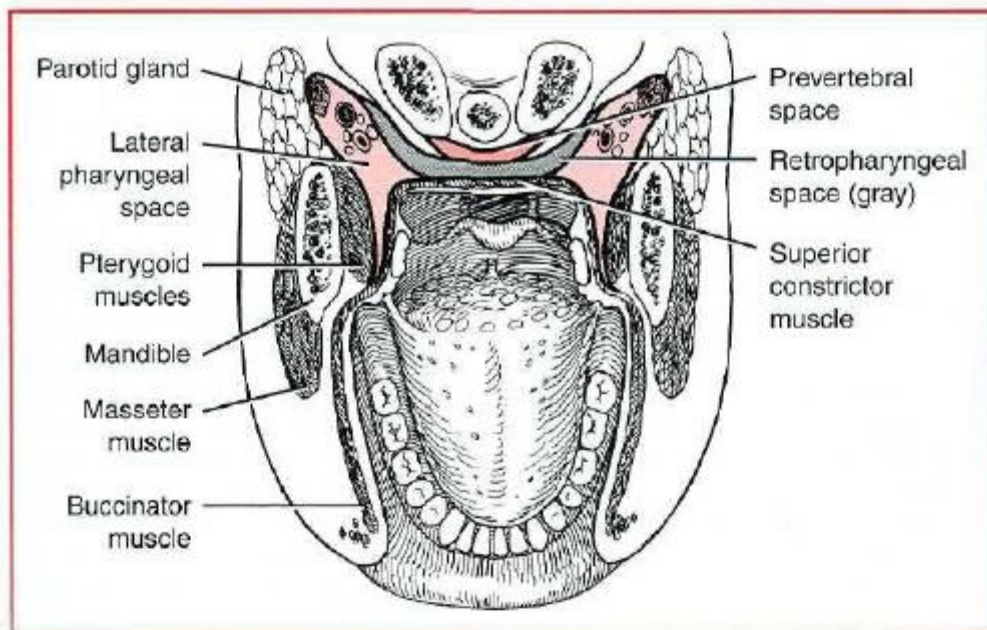
and skin and superficial fascia. Primarily second and third molars infect it. (From Cummings CW et al, editors: Otolaryngology: head and neck surgery, vol 3, St Louis, 1998, Mosby.)

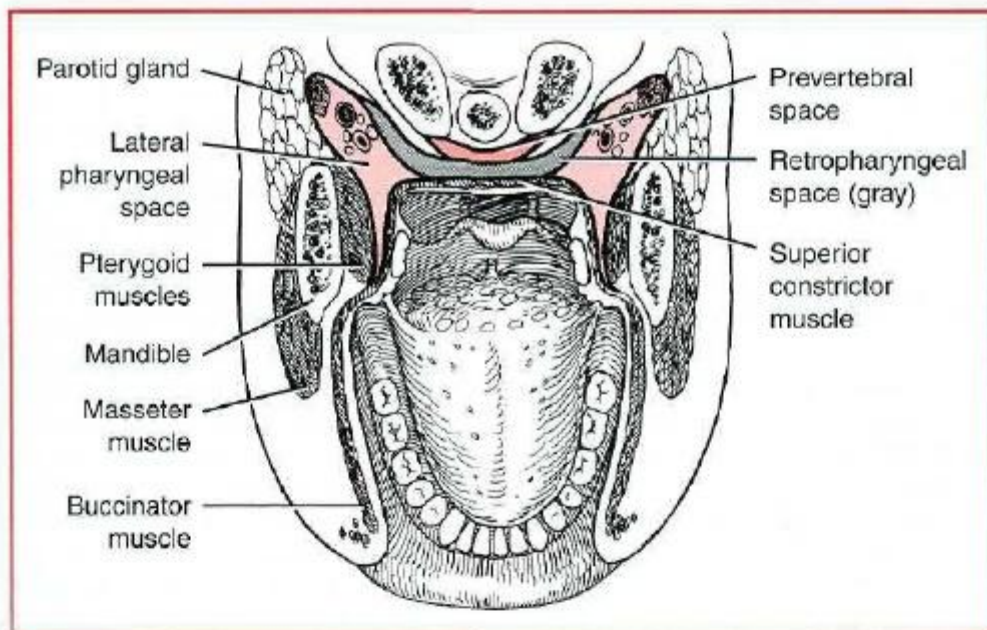
FIG. 16-10 This submandibular space infection produced large, indurated swelling of submandibular space. (From Cummings CW et al, editors: Otolaryngology: head and neck surgery, vol 3, St Louis, 1998, Mosby.)











rence of this clinical picture is caused by needle tract infection from a mandibular block.

The temporal space is posterior and superior to the masseteric and pterygomandibular spaces (see Fig. 16-4). It is divided into two portions by the temporalis muscle: (1) a superficial portion that extends to the temporal fascia and (2) a deep portion that is continuous with the infratemporal space. Rarely are the superficial and deep temporal spaces secondarily involved and usually only in severe infections. When these spaces are involved, the swelling that occurs is evident in the temporal area, superior to the zygomatic arch and posterior to the lateral orbital rim.

When taken as a group, the masseteric, pterygomandibular, and temporal spaces are known as the masticator space, because the muscles and fascia of mastication

bound them. These spaces communicate freely with one another, so when one becomes involved the others may also. The term masticator space does have some general clinical usefulness, but it lacks specificity and is therefore less useful than specific space designations.

Cervical Fascial Spaces

Extension of odontogenic infections beyond the primary and secondary mandibular spaces is an uncommon occurrence. However, when it does happen, spread to deep cervical spaces may have serious life-threatening sequelae. These sequelae may be the result of locally induced complications, such as upper airway obstructions, or of distant problems, such as mediastinitis.

Infection extending posteriorly from the pterygomandibular space first encounters the lateral pharyngeal

space. This space extends from the base of the skull at the sphenoid bone to the hyoid bone inferiorly. It is medial to the medial pterygoid muscle and lateral to the superior pharyngeal constrictor on the medial side (Fig. 16-11). It is bounded anteriorly by the pterygomandibular raphe and extends posteromedially to the prevertebral fascia. The styloid process and associated muscles and fascia divide the lateral pharyngeal space into an anterior compartment, which contains primarily muscles, and a posterior compartment, which contains the carotid sheath and several cranial nerves.

The clinical findings of lateral pharyngeal space infection include severe trismus as the result of involvement of the medial pterygoid muscle; lateral swelling of the neck, especially inferior to the angle of the mandible; and swelling of the lateral pharyngeal wall, toward the midline. Patients who have lateral pharyngeal space infections have difficulty swallowing and usually have a high temperature and become quite sick.

Patients who have infection of the lateral pharyngeal space have several serious potential problems. When the lateral pharyngeal space is involved, the odontogenic infection is severe and may be progressing at a rapid rate. Another possible problem is the direct effect of the infection on the contents of the space, especially those of the posterior compartment. These problems include thrombosis of the internal jugular vein, erosion of the carotid artery or its branches, and interference with cranial nerves IX through XII. A third serious complication arises if the infection progresses from the lateral pharyngeal space to the retropharyngeal space.

The retropharyngeal space lies behind the soft tissue of the posterior aspect of the pharynx. It is bounded anteriorly

FIG. 16-11 Lateral pharyngeal space is located between medial pterygoid muscle on lateral

aspect and superior pharyngeal constrictor on medial aspect. Retropharyngeal and prevertebral spaces lie between pharynx and vertebral column. Retropharyngeal space lies between superior constrictor muscle and alar portion of prevertebral fascia. Prevertebral spaces lie between alar layer and prevertebral fascia. (From

Cummings CW et al, editors: Otolaryngology: head and neck surgery, vol 3, St Louis, 1998, Mosby.)

only by the superior pharyngeal constrictor muscle and its investing fascia and posteriorly by the alar layer of prevertebral fascia (see Fig. 16-11).

The retropharyngeal space begins at the base of the skull and extends inferiorly to the level of vertebra C7 or T1, where the alar fascia fuses anteriorly with the buccopharyngeal fascia (Fig. 16-12). The retropharyngeal space has few contents, and therefore infection in this space does not carry some of the grave problems that involvement of the lateral pharyngeal space does. However, when the retropharyngeal space becomes involved, the major concern is that the infection can extend inferiorly to the posterosuperior mediastinum relatively rapidly. Should infection spread by this route, the result may be extension of the infection into the mediastinum, which is a serious complication.

When a patient has extension of infection into the cervical region, the retropharyngeal space must be evaluated with lateral radiographs of the neck to determine if the space is enlarged and thereby compromising the airway (Fig. 16-13).

A final danger of retropharyngeal space infection is progressive involvement of the prevertebral space. The prevertebral space is separated from the retropharyngeal space by the alar layer of prevertebral fascia. If this fascia is perforated, the prevertebral space can become involved. The prevertebral space extends from the pharyngeal tubercle on the base of the skull to the diaphragm. Infection of this space can extend rapidly inferior to the level of the diaphragm (see Fig. 16-12) and can involve the thorax and mediastinum along the way.

When the retropharyngeal or prevertebral fascial spaces (or both) are involved as a result of odontogenic infection, the patient is almost always seriously ill. The following are the three greatest potential complications: (1) the serious possibility of upper-airway obstruction as a result of anterior displacement of the posterior pharyngeal wall into the oral pharynx; (2) rupture of the retropharyngeal space abscess, with aspiration of pus into the lungs and subsequent asphyxiation; and (3) spread of the infection from the retropharyngeal spaces into the mediastinum, which results in severe infection in the thorax.

Management of Fascial Space Infections

Management of infections, mild or severe, always has five general goals: (1) medical support of the patient, with special attention to correcting host defense compromises where they exist; (2) administration of proper antibiotics in appropriate doses; (3) surgical removal of the source of infection as early as possible; (4) surgical drainage of the infection, with placement of proper drains; and (5) constant reevaluation of the resolution of the infection. The principles of surgical and medical management of fascial space infections are the same as those for less serious infections. However, fascial space infections require more extensive and aggressive treatment.

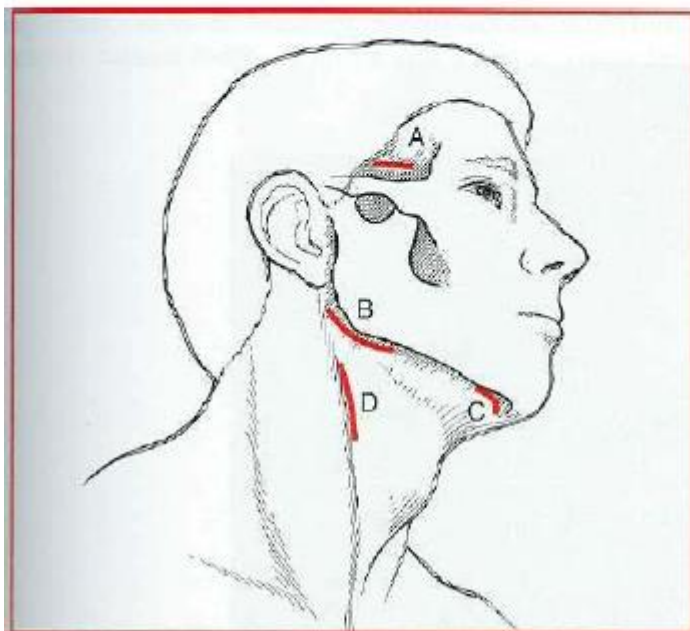
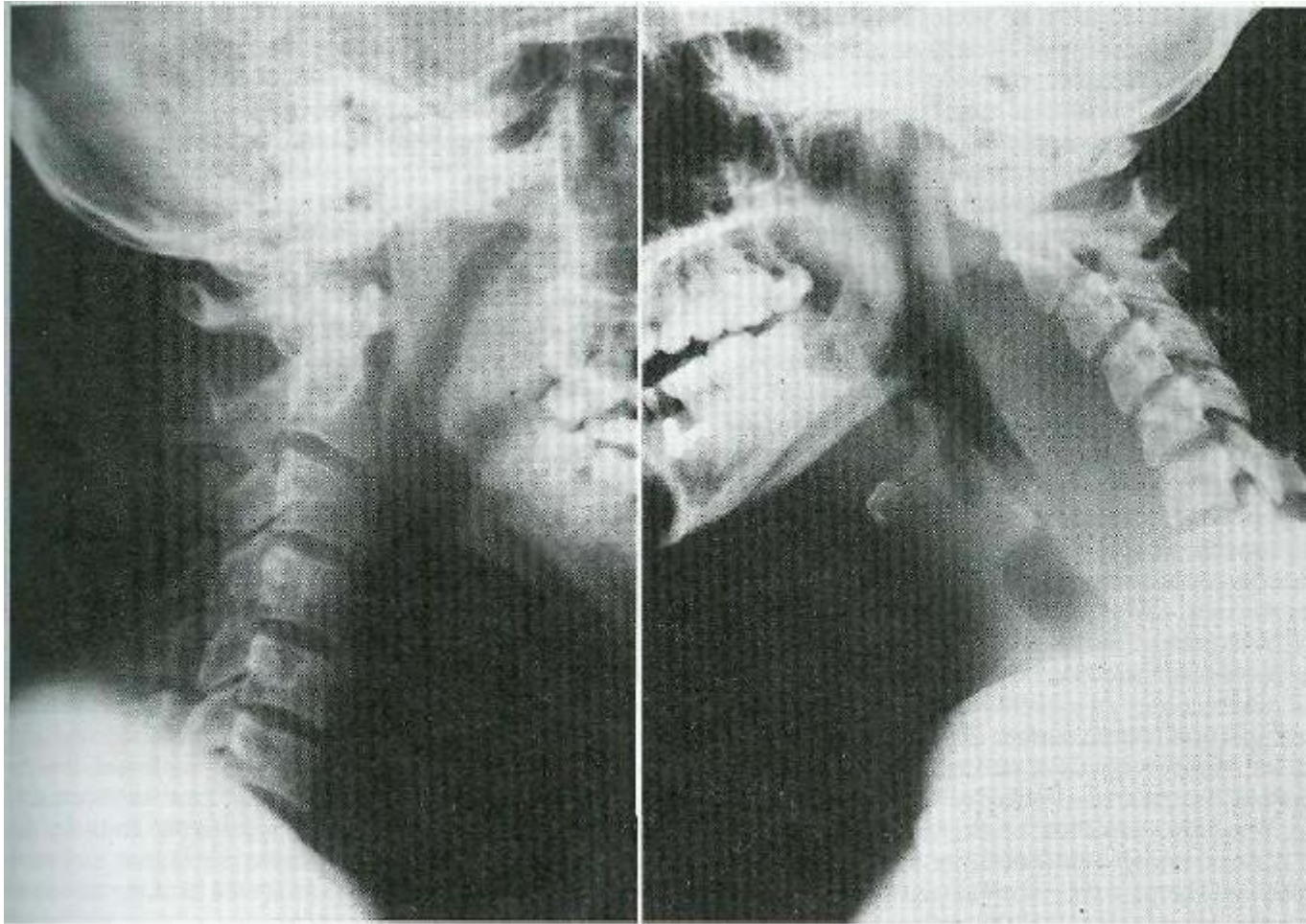
Medical management of the patient with a serious infection must include a thorough assessment and support of host defense mechanisms, including analgesics,

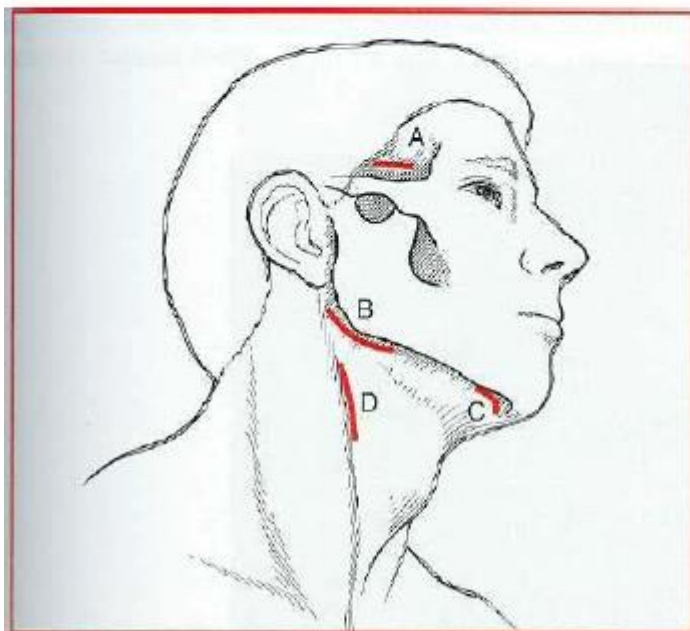
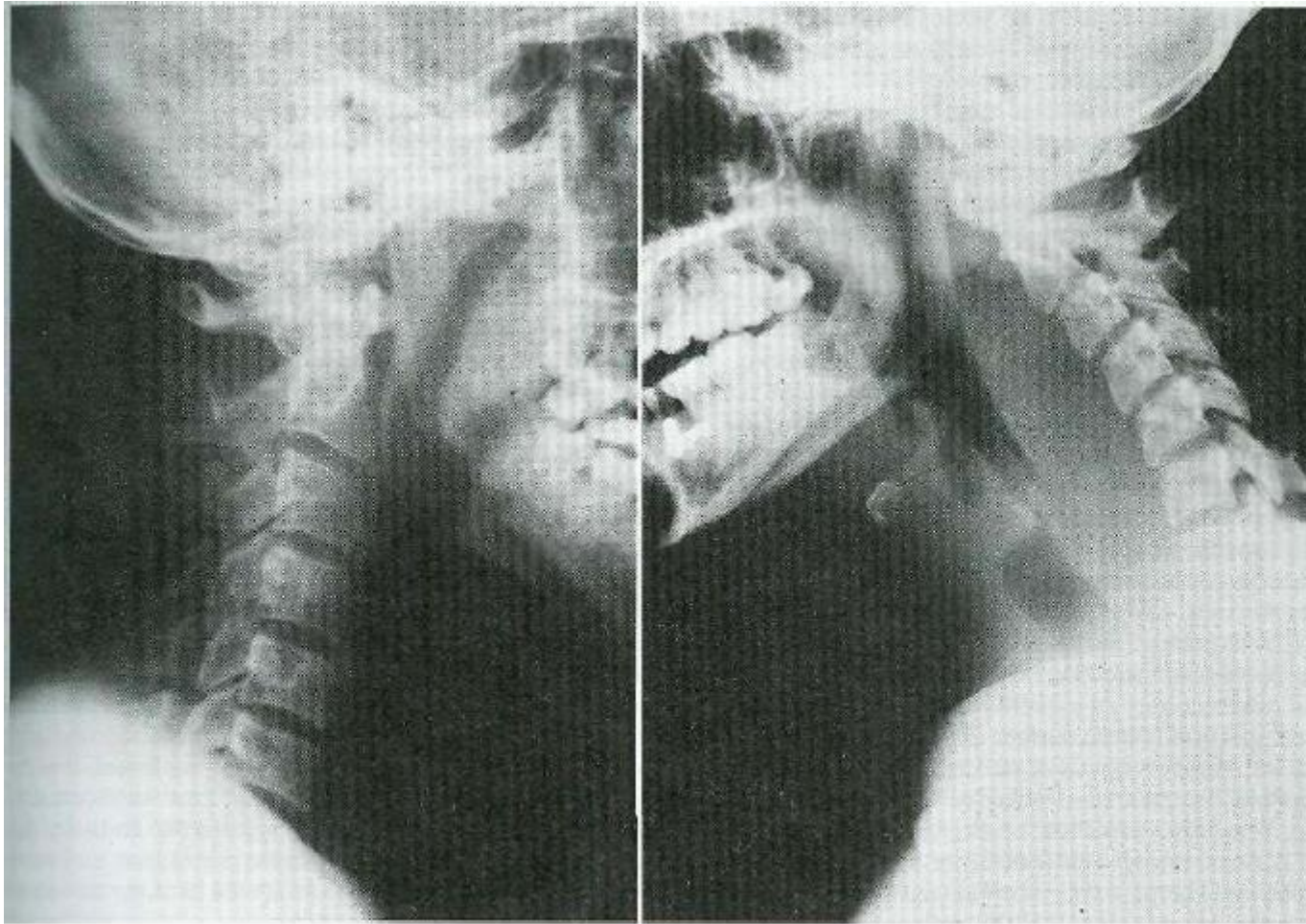
FIG. 16-12 If retropharyngeal space is involved, posterosuperior

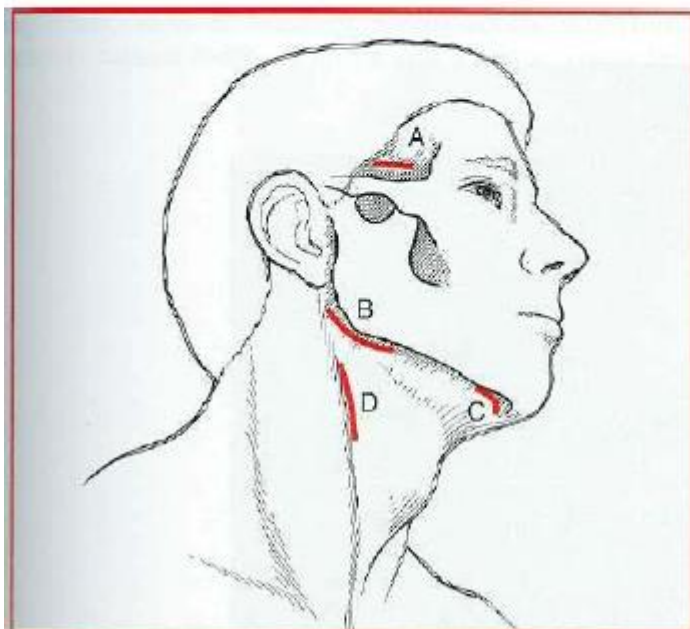
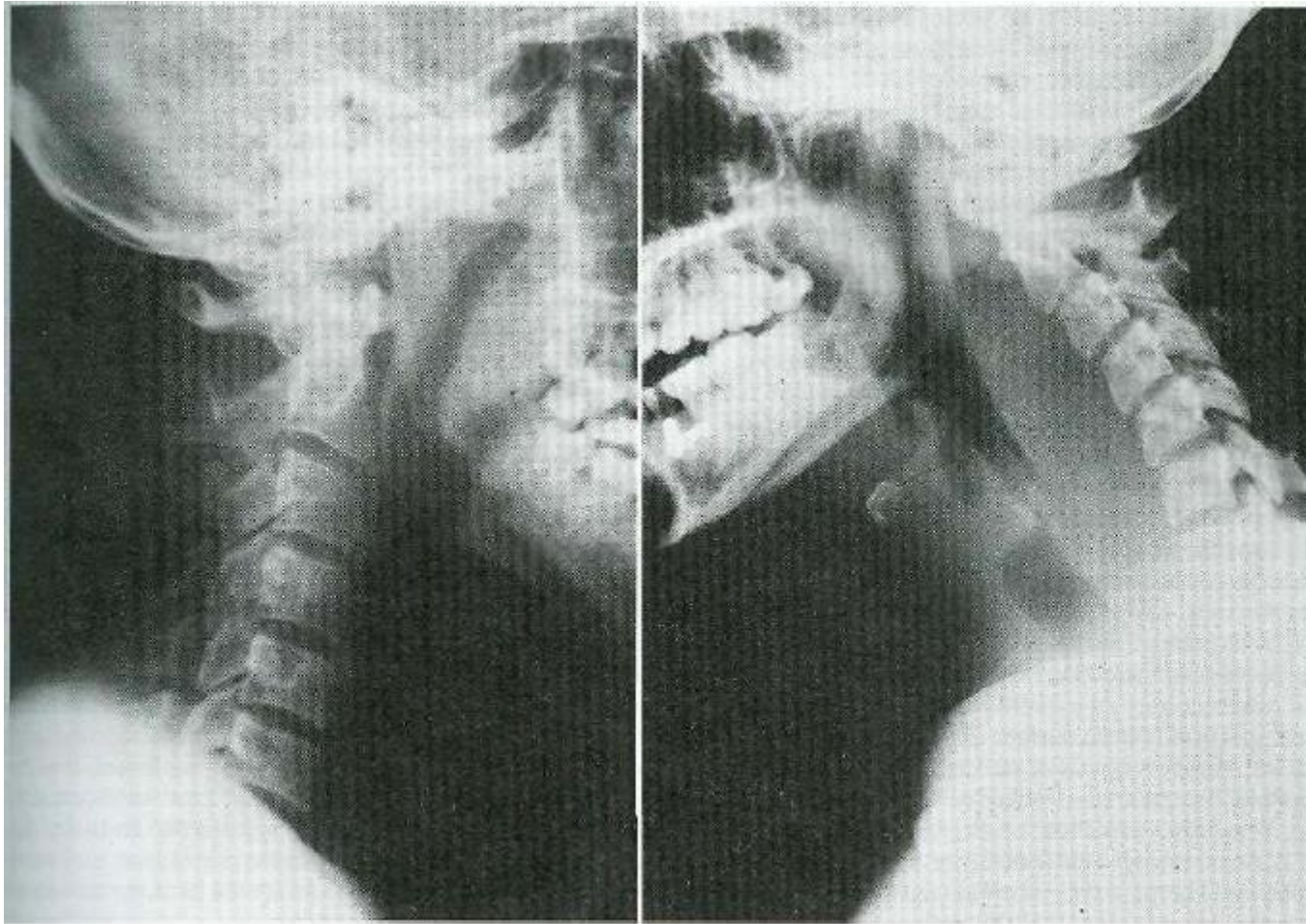
mediastinum may also become infected secondarily. If prevertebral space is infected, inferior boundary is diaphragm, so entire mediastinum is at risk. (From Cummings CW et al, editors: *Otolaryngology: head and neck surgery*, vol 3, St Louis, 1998, Mosby.)

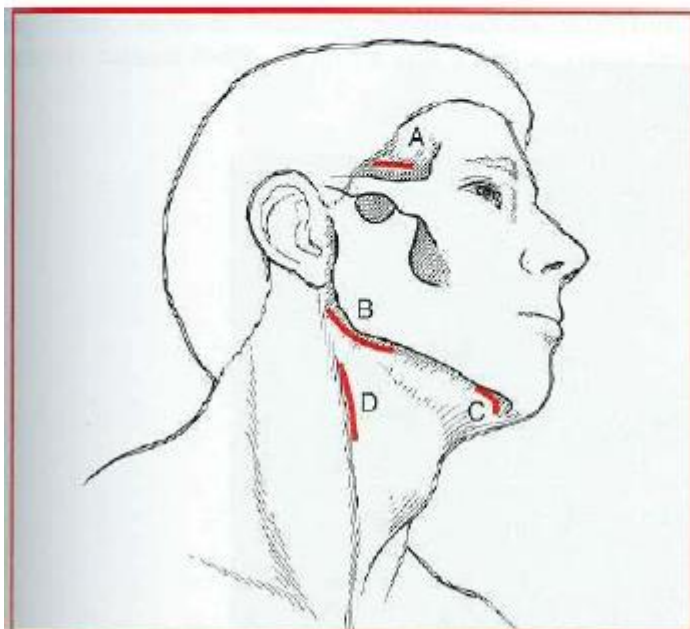
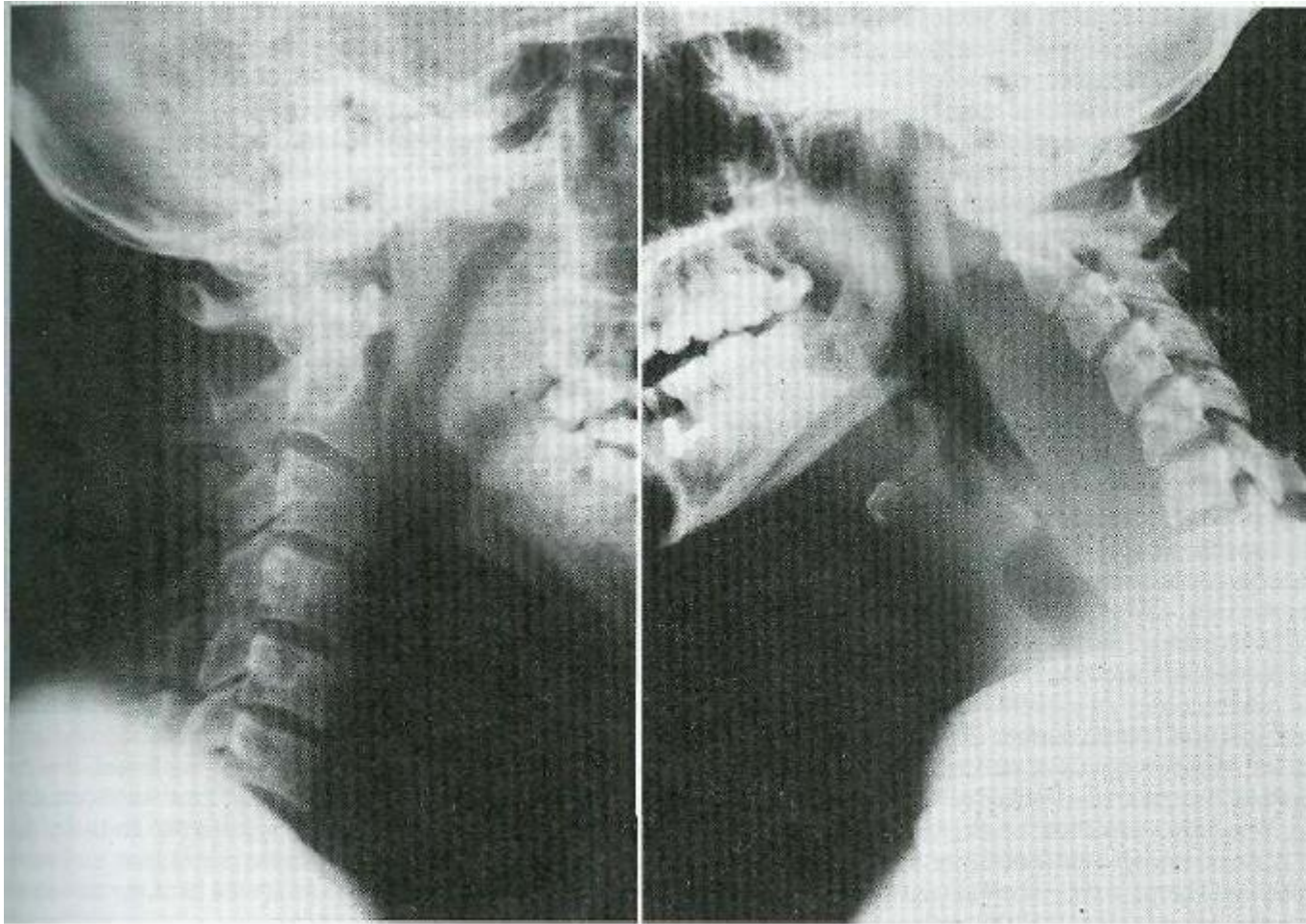
fluid requirements, and nutrition. High-dose bactericidal antibiotics are usually necessary and are almost always administered intravenously. Additionally the patient's airway must be continually monitored, and a surgical airway established if warranted.

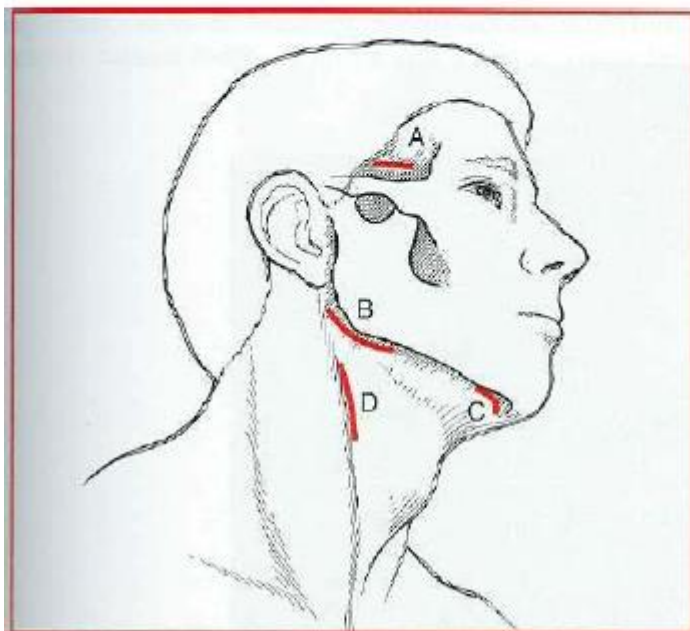
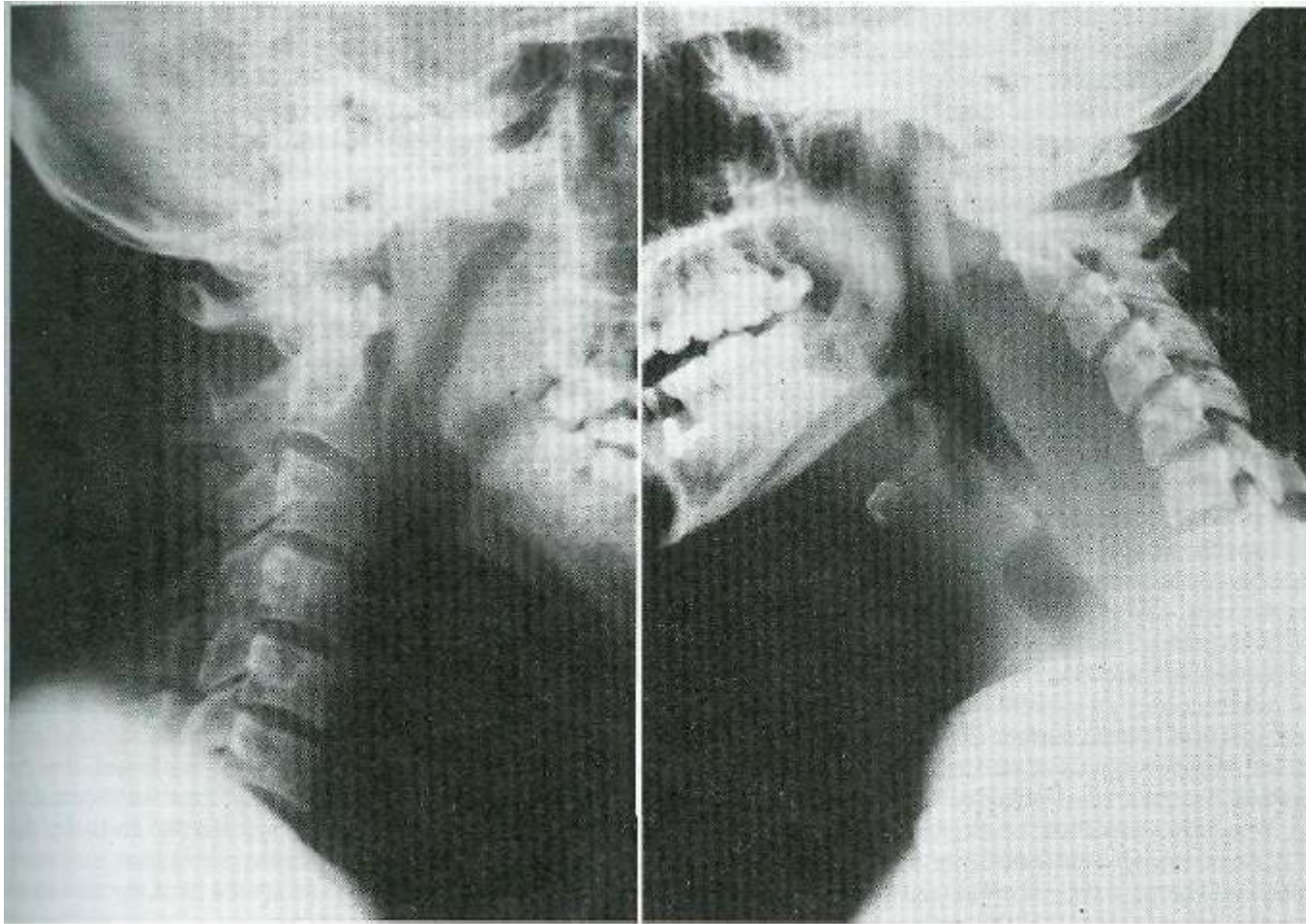
Surgical management of fascial space infections almost always requires a generous incision and aggressive exploration of the involved fascial spaces with a hemostat. One or more drains are usually required to provide adequate drainage and decompression of the infected area. Because I&D must be extensive, they are usually done in an operating room, with the patient under general anesthesia. The locations of various I&D sites are depicted in Fig. 16-14. Ample clinical experience and experimental evidence indicate that, although no pus formation can be detected by palpation or even by needle aspiration, even the serious cellulitis will resolve more rapidly if incised. The surgeon must not wait for unequivocal evidence of pus formation. In the preantibiotic era, surgical treatment was the only method of therapy for infections, and early and aggressive surgical therapy was frequently curative for these severe infections. It is important to remember that aggressive surgical exploration is still the primary method of therapy for serious odontogenic infections of the head and neck.











A
B

FIG. 16-13 A, Retropharyngeal soft tissue shadow is narrow (3 to 4 mm) and located at C2 and at C6. Retrotracheal soft tissue is usually 14 to 15 mm. B, When retropharyngeal space is involved, soft tissue becomes substantially thicker, and width of oropharyngeal air shadow decreases. (From Cummings CW et al, editors: Otolaryngology: head and neck surgery, vol 3, St Louis, 1998, Mosby.)

FIG. 16-14 Typical incision and drainage (I&D) sites for various

fascial space infections. A, Superficial and deep temporal space(A). Submandibular masseteric and pterygomandibular spaces(B). Sub- mental space(C). Lateral

pharyngeal and retropharyngeal spaces

(D). (From Cummings CW et al, editors: Otolaryngology: head and neck surgery, vol 3, St Louis, 1998, Mosby.)

OSTEOMYELITIS

The term *osteomyelitis* literally means inflammation of the bone marrow. Clinically, osteomyelitis usually implies an infection of the bone. It usually begins in the medullary cavity, involving the cancellous bone; then it extends and spreads to the cortical bone and eventually to the periosteum. Invasion of bacteria into the cancellous bone, which causes inflammation and edema in the marrow spaces, results in compression of the blood vessels in the bone and subsequent severe compromise of the blood supply. The failure of microcirculation in the cancellous bone is a critical factor in the establishment of osteomyelitis, because the involved area becomes ischemic and bone becomes necrotic. Bacteria can then proliferate, because normal blood-borne defenses do not reach the tissue, and the osteomyelitis spreads until it is stopped by medical and surgical therapy.

Although the maxilla can also become involved in osteomyelitis, it does so rarely compared with the mandible. The primary reason for this is that the blood supply to the maxilla is much richer and is derived from several arteries, which form a complex network of feeder vessels. Because the mandible tends to draw its primary blood supply from the inferior alveolar artery, and because the dense overlying cortical bone of the







mandible prevents penetration of periosteal blood vessels, the mandibular cancellous bone is more likely to become ischemic and therefore infected.

Considering the opportunities that bacteria have to enter into the cancellous bone, osteomyelitis of the mandible rarely occurs if the body's host defenses are reasonably intact. The major predisposing factors for osteomyelitis of the jaws are preceding odontogenic infections and fractures of the mandible (Fig. 16-15). Even these two events rarely cause infections of the bone unless the host defenses are suppressed by problems such as the alcoholism malnutritional syndrome, diabetes, intravenous illicit drug use, and myeloproliferative diseases, such as the leukemias, sickle cell disease, and chemotherapy-treated cancer.

Recent carefully performed investigations on the microbiology of osteomyelitis of the mandible have adequately demonstrated that the primary bacteria of concern are similar to those causing odontogenic infections, that is, streptococci, anaerobic cocci such as *Peptostreptococcus* spp., and gram-negative rods such as those of the genera *Fusobacterium* and *Prevotella*. Traditional investigation of the microbiology of osteomyelitis of the jaws has used culture specimens from surface drainage of pus (contaminated with *Staphylococcus* organisms) and not anaerobic culture techniques (and thereby have not grown anaerobes). Thus osteomyelitis of the mandible differs substantially from osteomyelitis of other bones in which staphylococci are the predominant bacteria.

Acute suppurative osteomyelitis shows little or no radiographic change, because 10 to 12 days are required for lost bone to be detectable radiographically. Chronic osteomyelitis usually demonstrates bony destruction in the area of infection. The appearance is one of increased radiolucency, which may be uniform in its pattern or patchy, with a "moth-eaten" appearance. There may also be areas of radiopacity within the radiolucency. These radiopaque areas represent islands of bone that have not been resorbed and are known as sequestra. In long-standing chronic osteomyelitis there may actually be an area of increased radiodensity surrounding the area of radiolucency. This is the result of an osteitis type of reaction in which bone production increases as a result of the inflammatory reaction.

Treatment of osteomyelitis is both medical and surgical. Because patients with osteomyelitis almost always have depressed host defense mechanisms, the clinician must take these compromises into account during the treatment and seek medical consultation when necessary.

Acute osteomyelitis of the jaws is primarily managed by the administration of appropriate antibiotics. The precipitating event, condition, or both must also be carefully managed. If the event is a fracture of the mandible, careful attention must be given to its treatment. The antibiotic of choice is clindamycin, because it is effective against streptococci and the anaerobes that are usually involved in osteomyelitis. If the patient has a serious acute osteomyelitis, hospitalization may be required for administration of IV antibiotics. Clindamycin is preferred because it is an excellent drug for both streptococci and the usual causative anaerobes. Surgical treatment of acute suppurative osteomyelitis is usually limited. It consists primarily of removing obviously nonvital teeth in the area of the infection, wires or bone plates that may have been used to stabilize a fracture in the area, or any obviously loose pieces of bone. For acute osteomyelitis that results from jaw fracture, the