Deep Neck Infections

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Behrad B. Aynehchi *Gady Har-El*

Deep neck space infections (DNSIs) are a relatively infrequent entity in the postpenicillin era. Their occurrence, however, poses considerable challenges in diagnosis and treatment and they may result in potentially serious or even fatal complications in the absence of timely recognition. The advent of antibiotics has led to a continuing evolution in etiology, presentation, clinical course, and antimicrobial resistance patterns. These trends combined with the complex anatomy of the head and neck underscore the importance of clinical suspicion and thorough diagnostic evaluation. Proper management of a recognized DNSI begins with securing the airway. Despite recent advances in imaging and conservative medical management, surgical drainage remains a mainstay in the treatment in many cases.

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ETIOLOGY

Knowledge of the portal of entry enables the surgeon to anticipate the pathway of extension within the neck, potential complications, and sites for drainage. In the preantibiotic era, the majority of deep neck infections in adults and children originated from the tonsils and pharynx, most commonly leading to parapharyngeal space infections (1). Acute rhinosinusitis in children may also cause retropharyngeal lymphadenitis. Suppuration of these inflamed nodes can eventually culminate in abscess formation. Early administration of antimicrobials in adult patients has led to a decreased incidence of upper respiratory tract infections and consequently significantly fewer DNSIs originating from this site. This trend has given way to infections of odontogenic sources becoming the primary source of deep neck infection in adults, recognizing a strong association with poor oral hygiene and lower socioeconomic status (2). Additional but less common origins of deep neck infections include salivary gland infections, penetrating trauma, surgical instrument trauma, spread from superficial infections, necrotic malignant nodes, mastoiditis with resultant Bezold abscess, and unknown causes (3–5). In inner cities, where intravenous drug abuse (IVDA) is more common, there is a higher prevalence of infections of the jugular vein and carotid sheath from contaminated needles (6–8). The emerging practice of "shotgunning" crack cocaine has been associated with retropharyngeal abscesses as well (9). These purulent collections from direct inoculation, however, seem to have a more benign clinical course compared to those spreading from inflamed tissue (10). Congenital anomalies including thyroglossal duct cysts and branchial cleft anomalies must also be considered, particularly in cases where no apparent source can be readily identified. Regardless of the etiology, infection and inflammation can spread throughout the various regions via arteries, veins, lymphatics, or direct extension along fascial planes. When confined to a certain area or space, this inflammatory process will eventually form a phlegmon or abscess.

FASCIAL ORGANIZATION OF THE DEEP NECK

An understanding of the applied anatomy of the neck includes a consideration of the layers of the deep cervical fascia and the compartments or spaces formed by the arrangement and attachments of these layers. This knowledge is crucial for planning treatment strategies and anticipating potential complications. The cervical fascia is divided into the superficial and deep fascia. The deep fascia is further subdivided into three layers or components: the superficial, middle, and deep. A summary of the organization of the cervical fascia is presented in Table 55.1. Figure 55.1 features a midsagittal visualization of the fascia and deep neck spaces. Table 55.1 Figure 55.1

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TABLE 55.1 CLASSIFICATION OF FASCIA IN THE NECK

- Superficial cervical fascia
- Deep cervical fascia
  - Superficial layer of the deep cervical fascia
  - Middle layer of the deep cervical fascia
    - Muscular layer
    - Visceral layer
  - Deep layer of the deep cervical fascia
    - Alar fascia
    - Prevertebral fascia
  - Carotid sheath formed by contributions of superficial, middle, and deep layers of deep cervical fascia

Superficial Cervical Fascia

The superficial cervical fascia lies beneath the skin of the head and neck, extending from the top of the head down to the shoulders, axilla, and thorax. This layer covers adipose tissue, sensory nerves, superficial vessels, lymphatics, the platysma muscle, and the muscles of facial expression. The platysma is absent in the midline. In contrast to the deep cervical fascia, which is composed of mainly fibrous connective tissue, the superficial cervical fascia is a layer of fibrofatty tissue connecting the overlying skin to the deeper fascial layers. Infections of this superficial space should be managed with appropriate antibiotic therapy in the case of cellulitis or extended to incision and drainage in the presence of an abscess (11).

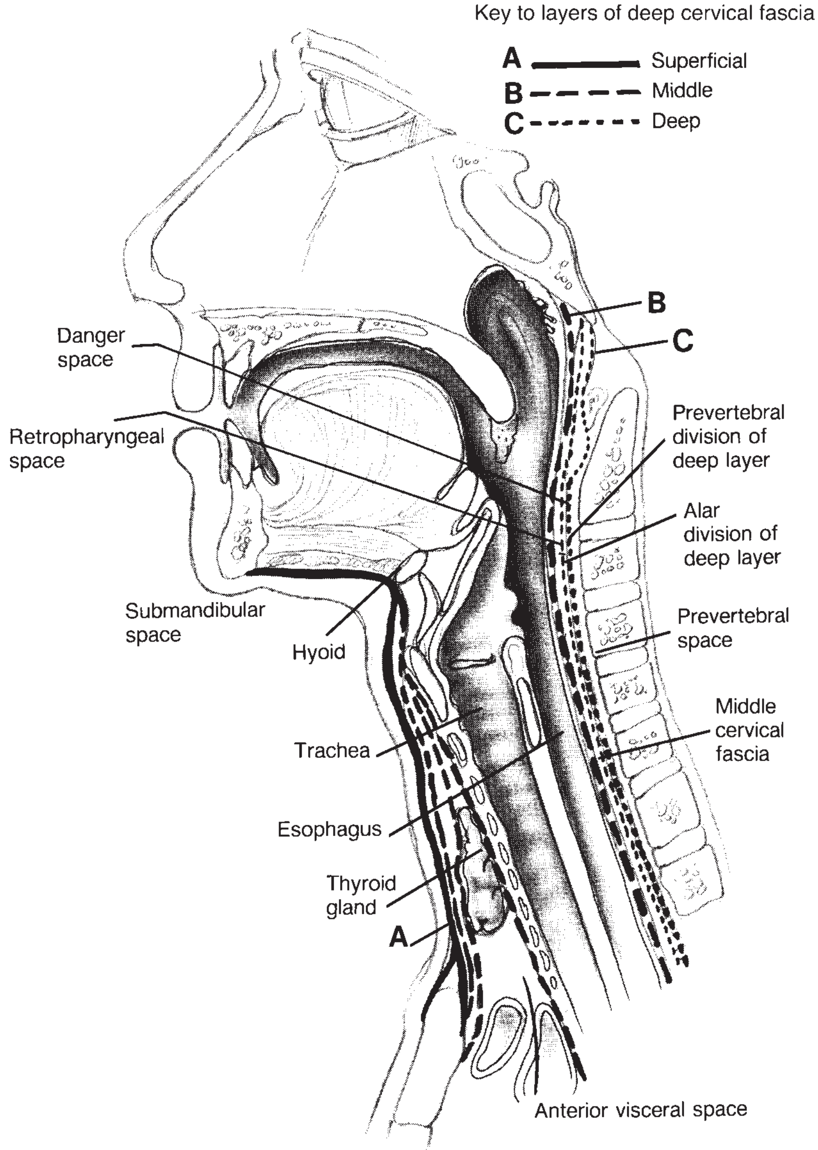


Figure 55.1 Midsagittal section of the neck shows the fascia and spaces of the neck.

Deep Cervical Fascia

As noted earlier, the deep cervical fascia is a fibrous connective tissue layer that is, for surgical purposes, subdivided into the superficial, middle, and deep components. The appropriate designation for each layer is as follows: the superficial layer of the deep cervical fascia, the middle layer of the deep cervical fascia, and the deep layer of the deep cervical fascia. A practical observation is that layers overlying nonexpansile components such as the sternocleidomastoid muscle (SCM) are well-developed membranes that can be sutured. On the other hand, fascia surrounding expansile visceral organs such as the pharynx and cheeks is a loose areolar tissue, not amenable to suture retention. Additionally, muscles and organs within these layers are generally free to glide upon contraction and relaxation.

The superficial layer of the deep cervical fascia, also referred to as the investing layer, completely surrounds the neck. The superior nuchal line, ligamentum nuchae of the cervical vertebrae, and the mastoid process are the posterior attachments. The fascia splits to envelope the sternocleidomastoid and trapezius muscles as it courses anteriorly. In the anterosuperior direction, an attachment is made to the inferior zygomatic arch. Moving inferiorly, the parotid gland is enveloped superficially, while the deep extent involves the carotid canal of the temporal bone. The stylomandibular ligament, which separates the parotid and submandibular glands, is formed as this investing fascia tracks anteriorly to cover the submandibular gland and muscles of mastication. The inferior extent includes attachments to the hyoid, acromion, clavicle, and scapular spine. The suprasternal space of Burns is formed as the fascia surrounds the intermediate tendon of the omohyoid muscle. This space may contain a lymph node along with a vessel bridging the two anterior jugular veins (12). A useful tool in understanding the contents of this plane is the "rule of two's," referring to the two muscles above the hyoid bone (masseter and anterior belly of the digastrics), two muscles that cross the neck (trapezius and SCM), two salivary glands (parotid and submandibular), and two fascial compartments (parotid and masticator spaces) (11).

The middle layer of the deep cervical fascia, also called the visceral fascia, is divided into a muscular and visceral division. The muscular division of the middle layer of the deep cervical fascia surrounds the sternohyoid, sternothyroid, thyrohyoid, and omohyoid strap muscles. Contents of the visceral division include the parathyroid glands, thyroid gland, esophagus, trachea, larynx, pharyngeal constrictor muscles, and buccinator muscle. This visceral division further contributes to two additional planes: the pretracheal fascia and buccopharyngeal fascia. The pretracheal fascia overlies the trachea. The buccopharyngeal fascia lies posterior to and separates the esophagus from the deep layer of the deep cervical fascia. This plane also marks the anterior border of the retropharyngeal space. The buccinators, pharyngeal constrictor muscles, and esophagus lie between the pharyngobasilar fascia anteriorly and the buccopharyngeal fascia posteriorly (12). The two raphes formed by the buccopharyngeal fascia include the posterior midline raphe, which attaches to the alar layer of the deep layer of the deep cervical fascia, and the pterygomandibular raphe within the lateral pharynx (11). Portions of the middle layer of the deep cervical fascia that surround the trachea and esophagus merge with the fibrous pericardium in the superior mediastinum, representing a possible portal of spread of infection.

The deep layer of the deep cervical fascia, also known as the prevertebral fascia, is composed of two divisions as well: the prevertebral and alar divisions. The prevertebral division contains the cervical vertebra, phrenic nerve, and paraspinous muscles. This fascia runs from the skull base to the coccyx, forming the anterior wall of the prevertebral space, with lateral and posterior attachments to the transverse spinous processes, respectively. The clinical significance of this boundary is the confinement of primary vertebral infections to the prevertebral space with very limited spread to the danger space. The alar division is situated between the prevertebral division posteriorly and the buccopharyngeal fascia of the visceral division of the middle layer of the deep cervical fascia anteriorly, separating the retropharyngeal and danger spaces. This layer extends from the skull base to the second thoracic vertebra. The notable structure within this plane is the cervical sympathetic trunk. In reviewing the deep fascial and special relationships within the neck, the following structures are encountered as one goes from anterior to posterior: the pharyngobasilar fascia, the esophageal or constrictor musculature, the buccopharyngeal fascia of the visceral division of the middle layer of the deep cervical fascia, the retropharyngeal space, the alar division of the deep layer of the deep cervical fascia, the danger space, the prevertebral division of the deep layer of the deep cervical fascia, the prevertebral space, and finally the vertebral body (12).

The carotid sheath is formed by contributions of all three layers of the deep cervical fascia, extending from the skull base to the thorax. Contents of this sheath include the common carotid artery, internal jugular vein (IJV), vagus nerve, and ansa cervicalis (11).

DEEP NECK SPACE ANATOMY

The above-mentioned planes of the deep cervical fascia form various real and potential spaces within the neck. These spaces though are not completely impermeable often communicate with each other in generally predictable routes. Strong fascial connections to the hyoid bone anteriorly that may function as a barrier to the inferior spread of infection have led to the classification of these spaces based on their relationship to this landmark. The spaces will be described as those involving the entire neck (retropharyngeal space, danger space, prevertebral space, and carotid space), those that lie above the hyoid bone (parapharyngeal space,

TABLE 55.2 DEEP NECK SPACES

- Spaces involving the entire length of the neck
  - Retropharyngeal space
  - Danger space
  - Prevertebral space
  - Carotid space
- Spaces limited to above the hyoid bone
  - Parapharyngeal space
  - Submandibular space
  - Parotid space
  - Masticator space
  - Peritonsillar space
  - Temporal space
- Spaces limited to below the hyoid bone
  - Anterior visceral space
  - Suprasternal space

submandibular space, sublingual space, parotid space, masticator space, peritonsillar space, and temporal space), and those that lie below the hyoid bone (anterior visceral space and suprasternal space). Table 55.2 outlines the classification of the aforementioned spaces.

Spaces Involving the Entire Neck

Retropharyngeal Space

Q2 The retropharyngeal space extends from the skull base to the tracheal bifurcation in the superior mediastinum (Figs. 55.2–55.4). The space is medial to the carotid sheath, anterior to the danger space, and posterior to the buccopharyngeal fascia of the visceral division of the middle layer of the deep cervical fascia. The nodes of Rouviere reside within this space and may cause abscess formation upon drainage from the paranasal sinuses or nasopharynx, especially in children. A midline raphe connecting the alar division of the deep layer of the deep cervical fascia to the buccopharyngeal fascia accounts the off-midline presentation of infections within this space, facilitating distinction from disease processes originating within the danger and prevertebral spaces, which generally lie in the midline. Routes of direct spread are mainly from the parapharyngeal space (12).

Danger Space

The danger space is flanked by the prevertebral and retropharyngeal spaces, extending from the skull base to the level of the diaphragm with minimal resistance (hence the name). It is bordered laterally by the transverse processes of the vertebrae. The most noteworthy structure within this space is the cervical sympathetic trunk. Common sources of infectious spread are from the retropharyngeal, parapharyngeal, and prevertebral spaces (12).

Prevertebral Space

This space runs from the skull base to down to the coccyx, bordered by the vertebral bodies posteriorly, danger space anteriorly, and transverse processes laterally. The dense areolar tissue within this space is in contrast to the loose counterpart found within the danger space. The main neurovascular constituents include the vertebral vessels,

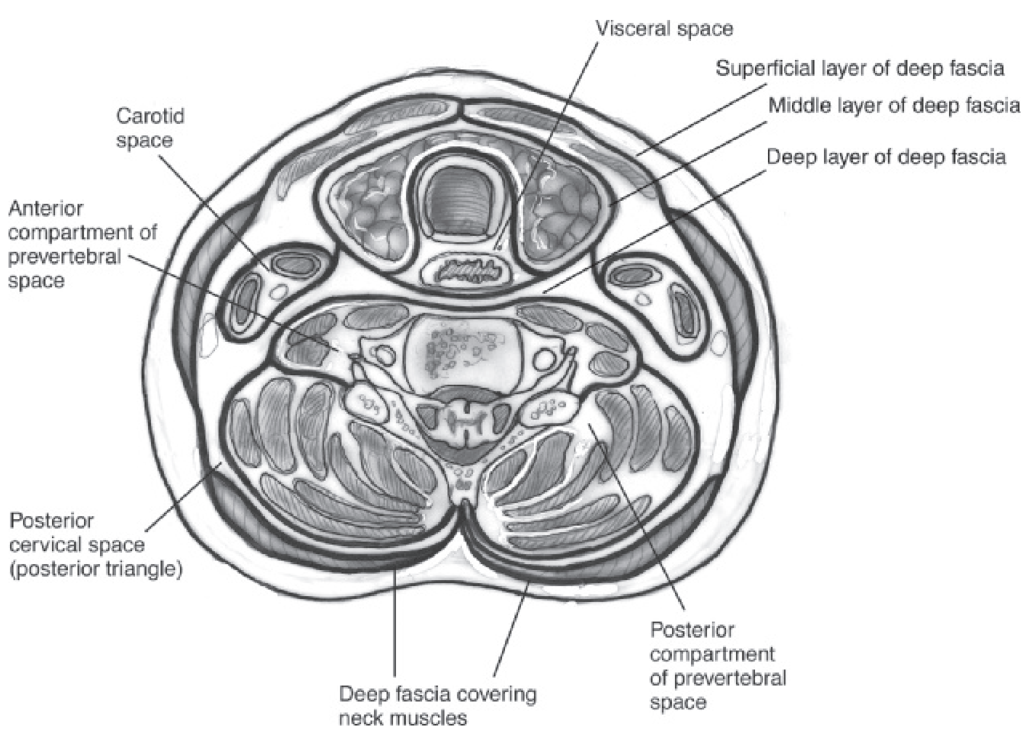


Figure 55.2 Cross section of the neck at the thyroid level.

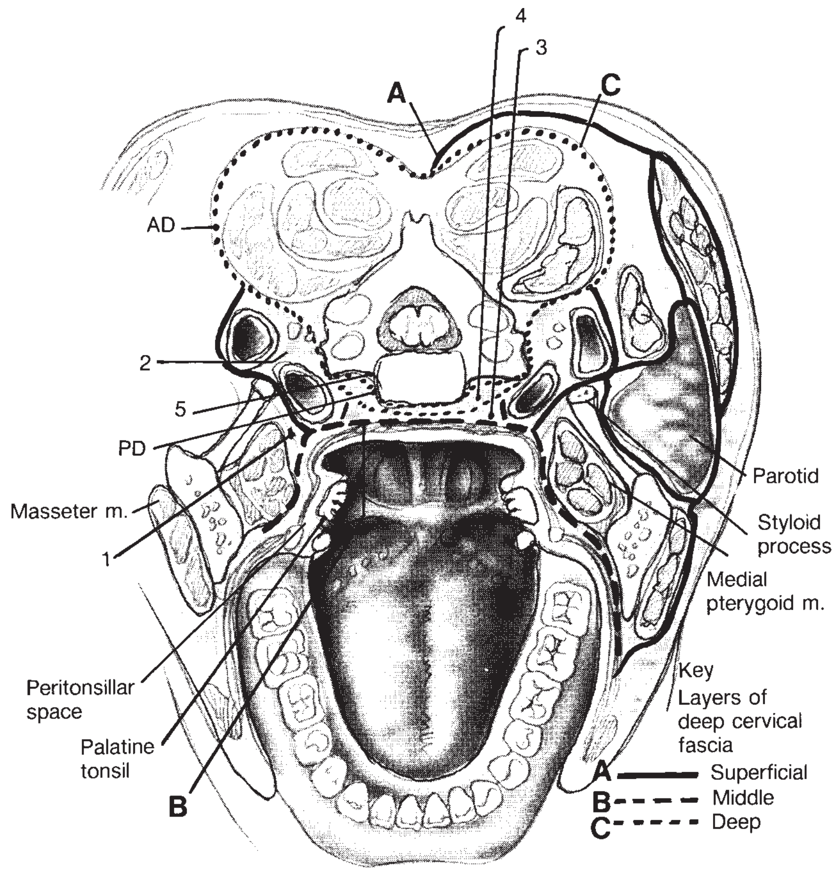


Figure 55.3 Cross section of the neck at the level of the oropharynx shows the anatomic relations of the deep neck spaces. *1*, parapharyngeal space; *2*, carotid space; *3*, retropharyngeal space; *4*, danger space; *5*, prevertebral space; AD, alar division of deep layer; PD, prevertebral division of deep layer.

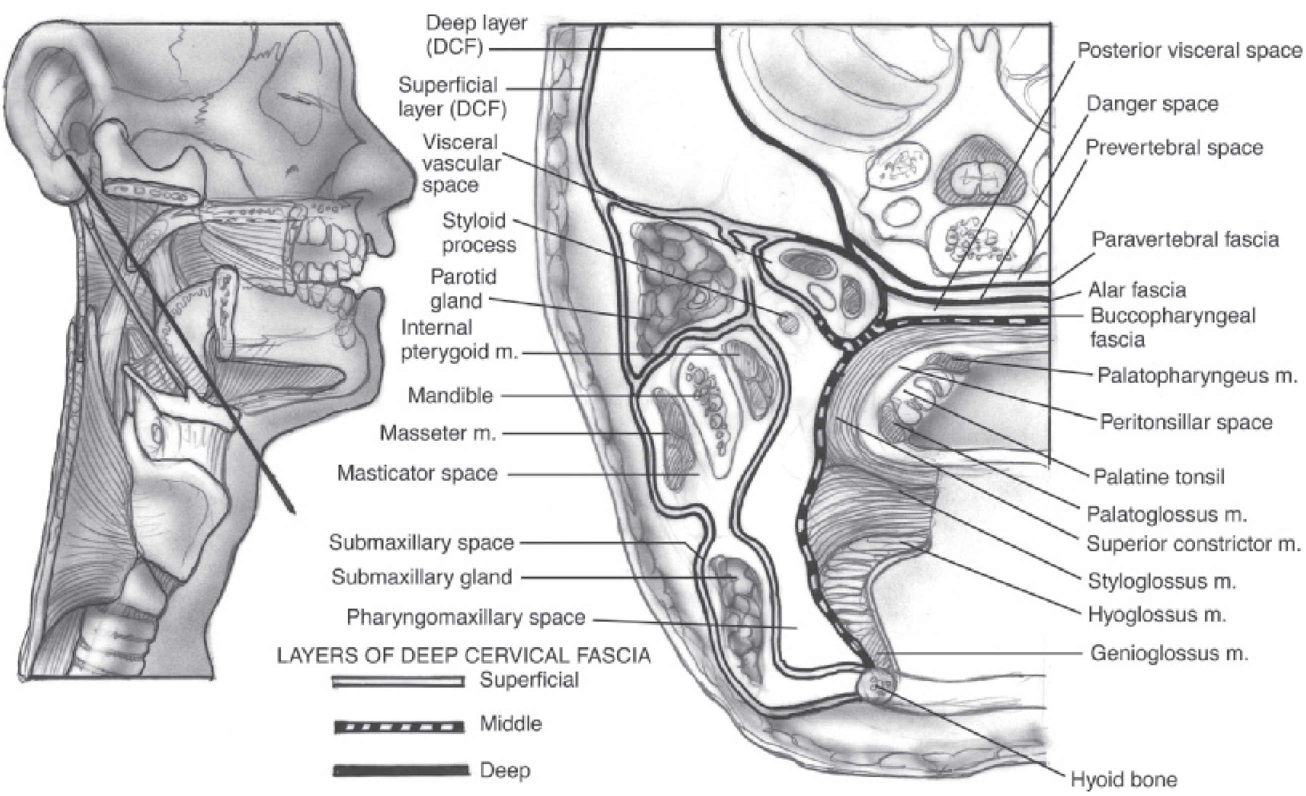


Figure 55.4 Oblique section through the neck shows the anatomic relations of the spaces limited to above the hyoid bone to the spaces that transverse the entire neck. The important relation between the parapharyngeal (pharyngomaxillary) space and the other spaces is evident.

phrenic nerve, and brachial plexus. The paraspinous, prevertebral, and scalene muscles are located within this space as well. Direct extensions of infection are from the vertebrae (e.g., Pott abscess) or penetrating injuries (12).

Carotid Space

Also referred to as the visceral vascular space, this is a potential space enclosed by the carotid sheath extending from the skull base to the thorax. Its contents include the carotid artery, IJV, vagus nerve (cranial nerve X), and sympathetic plexus. Spread is generally from the adjacent parapharyngeal space, penetrating trauma, or IVDA (12).

Spaces above the Hyoid Bone

Parapharyngeal Space

Also known as the lateral pharyngeal, peripharyngeal, or Q3 pharyngomaxillary space (Figs. 55.3–55.5). This has classically been described as an inverted pyramid with the base at the skull base superiorly, and the apex at the greater cornu of the hyoid bone inferiorly. The lateral borders are the lateral pterygoid muscle, mandible, and parotid gland. The medial boundaries include the superior constrictor and levator and tensor veli palatini muscles, all enveloped by the middle layer of the deep cervical fascia. It lies posterior to the medial pterygoid muscle (where involvement will result in trismus) and pterygomandibular raphe, and anterior to the prevertebral fascia. This space is further split into the prestyloid and poststyloid compartments by the styloid process, which are anterior and posterior to this landmark, respectively. The poststyloid compartment houses neurovascular structures including: cranial nerves IX, X, XI, XII, the sympathetic chain, the carotid artery, and the IJV. The prestyloid compartment contains fatty tissue, the styloglossus and stylopharyngeus muscles, the deep lobe of the parotid gland, and lymph nodes. Several notable neurovascular structures course through this compartment as well: the internal maxillary artery; and the auriculotemporal, lingual, and inferior alveolar nerves. The parapharyngeal space serves as a hub for infectious spread from several deep neck spaces. The carotid space travels through the parapharyngeal space en route to the mediastinum. Lateral spread of infection will communicate with the masticator space, inferior spread will reach the submandibular space, and posteromedial extension appears in the retropharyngeal space (12).

Submandibular and Sublingual Spaces

These two spaces communicate freely, and are hence presented together. It should be noted though that the terms submandibular or submaxillary space are commonly utilized in describing the combined submandibular and sublingual spaces. The superior border of these spaces is the mucosa of the floor of the mouth. They are limited by the hyoid bone posteroinferiorly, the mandible anteriorly and laterally, and the base of tongue posteriorly. The submandibular and sublingual spaces themselves are separated by the mylohyoid muscle, with the prior lying below and the latter lying above this landmark. Both spaces, however, communicate around the posterior edge of this muscle. It is for this reason that Ludwig angina will result in a generalized swelling of the submandibular area along with elevation of the floor of the mouth. While underlying the mylohyoid, the submandibular space is further separated

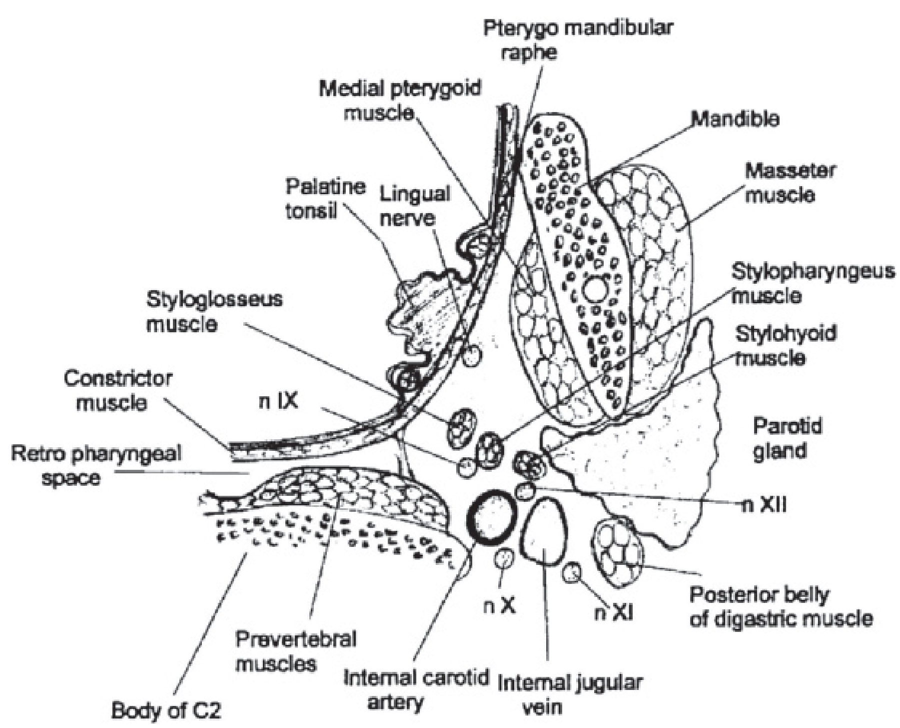


Figure 55.5 Schematic representation of the parapharyngeal space in an axial view at the C2 level.

from (but also freely communicates with) the submental space by the anterior belly of the digastric muscle. The sublingual space houses the hypoglossal nerve, the sublingual salivary gland, and Wharton duct. The submandibular gland sits in both the sublingual and submandibular spaces as it straddles the posterior edge of the mylohyoid muscle. The mylohyoid line is an oblique line along the mandible that aids in the evaluation of submandibular or sublingual space infections from odontogenic sources. The incisors to first molars lie above this line. Infections originating in the roots of these teeth generally present initially in the sublingual space. On the other hand, the second and third molars are situated below the mylohyoid line, with infectious processes of these tooth roots draining primarily to the submandibular or parapharyngeal space (12).

Parotid Space

This space, also known as the parotidomasseteric space, is created as the superficial layer of the deep cervical fascia envelopes the parotid gland, periparotid lymph nodes, facial nerve, posterior facial veins, and external carotid artery. The fascia adheres tightly to the gland laterally. The resultant firm capsule deems differentiation of an abscess versus cellulitis within this space virtually impossible on physical examination, despite the relatively superficial location. In contrast, deficiency of the fascia along the medial border allows for communication of the gland with the prestyloid parapharyngeal space (12).

Masticator Space

This space is also formed by an investment of the superficial layer of the deep cervical fascia. Its contents include the masseter, medial and lateral pterygoid muscles, body and ramus of the mandible, inferior alveolar vessels and nerves, buccal fat pad, and temporalis tendon. The masticator space may be divided into the masseteric space, between the mandibular ramus and masseter muscle; and the pterygoid space, between the mandibular ramus and pterygoid muscles. The masticator space is situated anterolateral to the parapharyngeal space and deep to the temporal space. Infections of this space are primarily from the third mandibular molar (12).

Peritonsillar Space

The peritonsillar space is sandwiched between the palatine tonsillar capsule medially, and the superior pharyngeal constrictor muscle laterally. The anterior and posterior limits are formed by the palatoglossus and palatopharyngeus muscles or anterior and posterior pillars, respectively. The posterior third of the tongue serves as the inferior boundary. Delayed drainage of purulent collections from this space may result in parapharyngeal space extension (12).

Temporal Space

The temporal space is enclosed by the squamous temporal bone medially and the superficial temporalis fascia laterally. This space is further split into superficial and deep components by the temporalis muscle. Notable contents include the internal maxillary artery and the third division of the trigeminal nerve (V3) (12).

Spaces below the Hyoid Bone

Anterior Visceral Space

This space runs from the thyroid cartilage down to the level of the fourth thoracic vertebra (Fig. 55.2). The pharynx, esophagus, trachea, thyroid and parathyroid glands are the most notable components, all enclosed by the visceral division of the middle layer of the deep cervical fascia and nested behind the strap muscles. The most common portals of infection into this space include perforation of the anterior esophageal wall by trauma, foreign bodies, and endoscopic instrumentation (12). Q4

Suprasternal Space

This is a potential space that sits just above the sternal notch, enveloped by the superficial layer of the deep cervical fascia. The suprasternal space of Burns features a small lymph node and bridging vessels between the anterior jugular veins (12).

BACTERIOLOGY

During the preantibiotic era, the organism most often isolated from deep neck space abscesses was *Staphylococcus aureus*. Since the introduction of antibiotics, aerobic Streptococcal species and non-Streptococcal anaerobes have become the chief offending agents in DNSI. Most infections, however, are polymicrobial (13,14). These organisms generally represent members of oral flora, reflecting the most common site of origin: odontogenic infections. Practically speaking though, the organisms isolated will vary with the initial portal of entry. Notable aerobic species include *Streptococcus viridans*, *Streptococcus pyogenes*, *Staphylococcus epidermis*, and *S. aureus* (14,15). Two important relationships are that of *S. viridans*, *S. pyogenes*, and *S. aureus* with IVDA and *S. aureus* with infants. Methicillin-resistant *Staphylococcus aureus* (MRSA) has been increasingly associated with IVDA, infants, and immunocompromised patients as well (16–22). Currently, the most frequently isolated anaerobes include *Peptostreptococcus*, *Fusobacterium*, and *Bacteriodes* (6,14,19,23), though their overall prevalence is likely underestimated in most reports due to difficulty in culture growth. Production of beta-lactamase has led to the growing resistance of anaerobic agents to penicillin (23,24). *Eikenella corrodens* is increasingly found in head and neck infections, bringing with it a very clinically relevant resistance to clindamycin and metronidazole.

Gram-negative rods, such as *Haemophilus*, *Escherichia*, *Pseudomonas*, and *Neisseria*, are usually only seen in hospitalized, debilitated, or immunocompromised patients (3). *Klebsiella pneumoniae* is found to have a predilection for poorly controlled diabetics. Atypical and granulomatous organisms, including *Actinomyces*, tuberculous and nontuberculous mycobacteria, cat scratch or *Bartonella henselae*, and tularemia (25,26), are seen far less frequently.

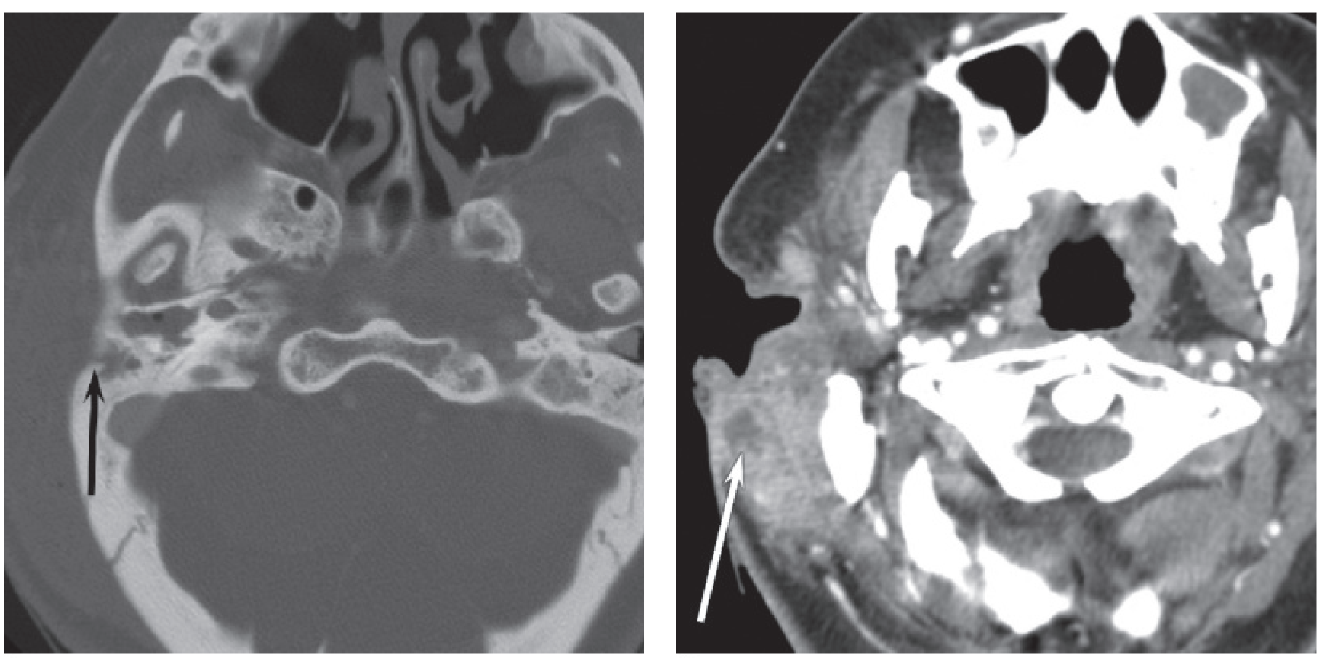
DIAGNOSIS

History, physical examination, laboratory tests, and diagnostic imaging yield vital information in diagnosing and managing patients with DNSI. The first priority, however, is expedient and aggressive management of potential respiratory compromise. Upon confirmation or achievement of a secure airway, a comprehensive and careful evaluation is necessary in elucidating possible sources of infection in order to direct optimal therapeutic approaches. It is also important to note that many patients presenting to an otolaryngologist with a possible DNSI have already been placed on an outpatient antibiotic regimen, possibly altering the typical presenting symptoms and findings, underscoring the importance of a thorough evaluation (1,27).

History and Physical Examination

As with any disease process, a thorough history of the present illness must be solicited. This starts with a survey of symptom onset, intensity, duration, and any systemic inflammatory symptoms and signs such as pain, fever, swelling, malaise, fatigue, or redness. Localizing complaints of dyspnea, odynophagia, dysphagia, voice changes, drooling, trismus, and otalgia direct the clinician toward a possible site of infection (13,28–31). Potential instigating events including recent dental infection or procedures, sinusitis, pharyngitis, otitis, upper aerodigestive tract surgery, intubation, IVDA, blunt or penetrating trauma, or skin infection should be inquired about as well. Immunocompromised patients, most commonly those with diabetes, human immunodeficiency virus (HIV), acquired immunodeficiency syndrome, autoimmune diseases, malignancy, chemoradiotherapy treatment, or steroid use must be identified and attended to with a higher level of vigilance, as they tend to be susceptible to more virulent and atypical organisms in addition to a much more aggressive disease process (7,32,33).

The physical examination of any patient with a potentially life-threatening diagnosis must be accomplished in a systematic and complete manner. A general overview of the patient may reveal respiratory distress, labored breathing, anxiety, signs of dehydration, weakness, photophobia, limited neck motion, lethargy, altered voice, track marks from IVDA (6), or cognitive deficits. Deficiencies on cranial nerve examination can assist in localizing the source of the infectious process. The facial skin and scalp must be inspected for any signs of superficial infection, inflammation, or swelling. The presence of purulence, inflammation, or tenderness on otoscopic examination may direct the physician toward the presence of a Bezold abscess (Fig. 55.6) or the rare occurrence of spread of a DNSI from an odontogenic source into the external auditory canal (34). While evaluation of the oral cavity will mainly focus on possible odontogenic sources of



A B

Figure 55.6 Coalescent mastoiditis with Bezold abscess. **A:** Axial contrast-enhanced CT on bone window shows complete opacification of underpneumatized right mastoid air cells with a lateral cortical breakthrough (*arrow*). The external auditory canal is also nearly completely opacified. **B:** More inferior image, on soft tissue windows, shows abscess (*arrow*) alongside the mastoid tip, involving the SCM (Bezold abscess).

infection, a survey for trismus, floor of mouth swelling, and salivary flow from Stensen and Wharton ducts is just as crucial. The oropharynx must be examined for signs of asymmetry, bulges, uvular deviation, inflammation, or swelling. The neck should be palpated for any crepitus, swelling, tenderness, or lymphadenopathy. The final component of the physical examination, awake fiberoptic laryngoscopy, is compulsory in any patient with signs of potential airway compromise such as dyspnea, dysphagia, stridor, odynophagia, hoarseness, and limited range of neck motion. The presence of deviation, swelling, or inflammation in the airway will obviously raise the level of urgency and shift the immediate priority from treatment of a potential DNSI to securing the airway. The most common symptoms and physical examination findings encountered in patients with specific DNSI are elaborated on the following sections.

Laboratory Tests

Laboratory tests should be obtained concurrently with the history and physical examination. In anticipation of a possible trip to the operating room (OR), routine preoperative labs along with a complete blood count with differential, and complete metabolic panel must be drawn. When past or current medical history indicates, HIV screening, blood glucose levels, and tuberculin skin testing should be obtained. Additionally, blood cultures and available aspirate cultures are recommended. Cultures with positive gram stain but without growth raise the suspicion for an anaerobic organism (11). Given the relatively increased frequency of atypical and aggressive organisms associated with immunocompromised patients, it would be prudent to obtain acid-fast and fungal cultures in this population (35). While the majority of patients with a DNSI demonstrate an elevated white blood cell (WBC) count, patients with HIV and tuberculosis who had drainable abscesses often exhibit persistent leukopenia (WBC count < 8000 per milliliter) (6). It is also important to note the presence of leukocytosis in the background of steroid administration, potentially confounding the clinical picture when attempting to follow the response to medical or surgical therapy with serial WBC counts.

Imaging

Computed Tomography

The ability to identify the specific spaces involved, early or potential complications, and the nature of DNSI has designated contrast-enhanced computed tomography (CECT) scanning as a critical component of the diagnostic work up (28). The scan itself is excellent for delineating both bony and soft tissue structures. The addition of intravenous contrast further assists in differentiating a well-formed abscess from a phlegmon or cellulitis and visualizing the great vessels. An abscess on CECT scan will demonstrate a central area of low attenuation or hypodensity with ring enhancement of its wall, surrounded by soft tissue edema. The presence of air on CECT scanning is also strongly predictive of an abscess (36). This modality does have certain noteworthy limitations however. Miller et al. (37) noted an improvement in accuracy from 77% to 89% when CECT scan was combined with a clinical examination, with similar findings in the pediatric population noted by Vural et al. (38). The quality of certain images can also be compromised by the presence of metal materials within the head and neck causing streak artifacts. Another drawback relates to the risk of radiation exposure, particularly in pediatric patients facing serial scans. Finally, intravenous contrast may be contraindicated in patients with allergies to these agents or with compromised renal function. Occasionally, with retropharyngeal abscesses, differentiation between a well-formed abscess and phlegmonous soft tissue edema may be difficult with CECT. In addition, although needle aspiration may be helpful with diagnosis in a questionable radiologic diagnosis, this procedure carries a false-positive rate of up to 25% (39).

Plain Film Radiography

While plain films have generally limited utility relative to other imaging modalities, they may be useful in the detection of certain types of DNSI. Panorex jaw films may reveal an odontogenic source for certain DNSI (11). Findings of tracheal deviation, subcutaneous emphysema, mediastinal widening, and pneumomediastinum on chest films are associated with possible thoracic collections or mediastinitis (29). In contrast, the usefulness of anteroposterior and lateral neck films in diagnosing retropharyngeal, prevertebral, and parapharyngeal abscesses has been questioned following the findings by Nagy and Backstrom (40) of a sensitivity of 83% for plain films versus 100% sensitivity with CECT scanning.

Magnetic Resonance Imaging

Relative to CECT scanning, magnetic resonance imaging (MRI) yields superior soft tissue differentiation, particularly in infections involving the prevertebral or parotid spaces, and intracranial cavity. Limitations of CECT scanning, including radiation exposure risk, streak artifacts, and intravenous dye allergies, are all circumvented with MRI (11). Additionally, magnetic resonance angiography is useful in the evaluation of potential vascular complications of DNSI including thrombi, vessel narrowing, aneurysm, rupture, and pseudoaneurysm (41). While this modality may complement CECT scanning in select cases, the vast majority of patients do not undergo MRI due to the high cost, contraindication with metal or electrical implants, and lengthy time requirement posing considerable discomfort and risk in patients with dyspnea, dysphagia, and children who require sedation (39).

Ultrasonography

Frequently used in Europe for the evaluation of DNSI, ultrasound is a less expensive and noninvasive alternative to CECT scanning that is gaining popularity in the United States.

Portability and the avoidance of radiation exposure in the pediatric population are additional advantages. Its major utility lies in guiding diagnostic or therapeutic needle aspirations in the setting of a stable airway (42,43). Due to the lack of anatomic detail needed for surgical planning, difficulty in interpretation and visualization of deeper lesions (39), the recommended role for ultrasound appears to be as an adjunct to CECT scanning or MRI (35).

MANAGEMENT

Successful management of DNSI can be achieved by prompt and adequate treatment, emphasizing control of the airway, effective antibiotic therapy, and timely aspiration or surgical intervention when indicated. In addition, a thorough search for the initial infectious source must be carried out in order to prevent a recurrence.

Airway

Safe and secure airway maintenance is the most important initial therapeutic objective in the management of DNSI (44). Hypoxia and asphyxia remain the most common causes of mortality rather than uncontrollable sepsis (45). Clear indications for watchful waiting versus intubation or tracheotomy do not always exist; therefore, each patient must be assessed individually. Keeping in mind the potential for rapid deterioration without warning, admission into a monitored unit with close and frequent observation by medical staff is critical. Signs of progressing stridor, dyspnea, or increased work of breathing are valuable clues of potential airway compromise. In the setting of clinical deterioration, early intubation or tracheotomy circumvents the performance of these procedures in more dire circumstances.

Options for managing the airway include conventional endotracheal intubation, awake fiberoptic intubation, and tracheotomy (46). Airway instrumentation during endotracheal intubation in an awake patient carries the risks of laryngospasm and possible abscess rupture with subsequent aspiration. Therefore, only an anesthesiologist or otolaryngologist with extensive experience should perform this procedure. The addition of nebulized epinephrine is helpful in reducing mucosal edema. Awake fiberoptic intubation, most commonly nasotracheal, has gained significant popularity as the availability of flexible fiberoptic scopes and subsequent experience level of operators have grown. The procedure requires the patient to sit in an upright position, preventing backward collapse of the tongue and pharyngeal walls. Inhaled nebulized lidocaine and nasopharyngeal "trumpets" coated with lidocaine jelly are generally effective in facilitating comfortable intubation in an awake patient. A tracheotomy set must be available should a surgical airway become necessary. It has been suggested that many retropharyngeal and true Ludwig abscesses be managed surgically from the outset in the interest of avoiding emergent "slash" tracheotomies in suboptimal settings (6,14,47). In patients with significant airway edema, sepsis, or extensive collections where extubation within 48 to 72 hours is questionable or not expected, elective tracheotomy following successful intubation or tracheotomy under monitored anesthesia care and local anesthetics should be performed in favor of shorter hospital and intensive care unit (ICU) stays (47).

Medical Management

The species of pathogens that cause the overwhelming majority of DNSI in immunologically sound or compromised individuals have been mentioned earlier in this chapter. This predictability in clinical circumstances allows for reasonable knowledge in administering appropriate empiric agents until cultures and sensitivities from aspirates or surgical drainage become available. Most cases involve mixed flora of gram-positive cocci and gram-negative rods along with beta-lactam–resistant anaerobes. Optimal coverage for these organisms is supplied by a penicillin in combination with a beta-lactamase–resistant antibiotic along with a drug effective against anaerobes (such as metronidazole or clindamycin). Patients susceptible to *Pseudomonas* should receive an anti-Pseudomonal penicillin (such as ticarcillin–clavulanate, piperacillin–tazobactam, or imipenem–cilastin), a quinolone (such as ciprofloxacin, or levofloxacin), or an aminoglycoside. Clindamycin or vancomycin should be administered to those at risk of a MRSA infection (7,23,48,49). Recent evidence (31,50) has shown that an uncomplicated abscess, particularly in a pediatric patient, contained within a lymph node (as seen on imaging) can be treated effectively with a 48- to 72-hour trial of antibiotics and close observation without surgical intervention. Concurrent treatment of predisposing comorbidities in adults and children will improve immune function as well. In cases where surgical drainage is required, parenteral antibiotics will be continued postoperatively until the patient is afebrile for 48 hours, and then switched to an oral agent for an additional 2 weeks. Supplemental intravenous hydration is also a vital component in supporting the host response to infection.

Surgical Drainage

The decision to institute surgical drainage is based on several factors. In questionable cases, a 48-hour period of careful observation and monitoring along with intravenous antibiotic therapy and hydration may be indicated prior to considering a trip to the operative suite. Progression of symptoms indicating surgical drainage can be manifest by persistent fevers, tenderness, swelling, and elevated WBC counts. This trial period must involve frequent examinations in order to accurately gauge the overall clinical status of the patient. Additional indications for drainage include potential airway compromise, critical condition from

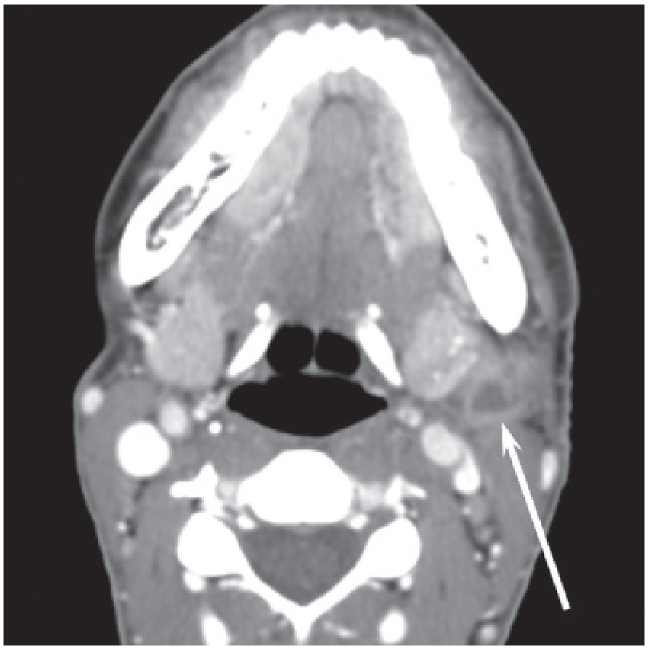


Figure 55.7 Tuberculous adenitis. Axial contrast-enhanced CT shows an abscessed lymph node (*arrow*) at the tail of the left parotid. TB-infected nodes may be of low density, or may become frankly abscessed.

complications or septicemia, and evidence of collections larger than 3 cm or involving multiple spaces (28,51). Surgical drainage can involve various approaches including transoral drainage, external cervical drainage, and less invasive methods such as needle aspiration or indwelling catheter placement (11). Upon accessing the cavity, a sample of purulent fluid or debrided tissue must be collected and submitted for culture and sensitivity. With regard to granulomatous diseases such as tuberculosis and atypical mycobacterial infections (Fig. 55.7), medical management, excisional biopsy, or needle aspiration is generally favored over incisional drainage in the interest of avoiding the potential for a persistently draining sinus tract.

Transoral and Intraoral Drainage

Peritonsillar space abscesses are approached transorally. Uncomplicated retropharyngeal abscesses are usually drained in this manner as well. Select parapharyngeal space infections lying immediately beneath the lateral pharyngeal wall may also be accessed transorally. Odontogenic collections limited to the alveolus can be addressed with simple tooth extraction and subsequent root drainage. Buccal space and shallow sublingual abscesses are entered through the intraoral mucosa. Finally, incision and dissection through the retromolar trigone and masseter muscle yields access to the masticator space (11). While spaces approached intraorally are amenable to drain placement, this practice is discouraged in more distal transoral routes (retropharyngeal, peritonsillar, or parapharyngeal) due to the risk of aspiration.

External Drainage

Collections within the anterior visceral, submandibular, parapharyngeal, prevertebral, and carotid spaces are generally drained with an external cervical approach. All involved spaces must be incised and drained with care taken to avoid injury to vital structures while utilizing the shortest route from the outside (35). Following access to the abscess cavity, loculations are broken and the space is thoroughly irrigated. Larger wounds undergoing considerable debridement will remain open and be packed with antimicrobial iodoform, eventually healing by secondary intention. Smaller cavities can be closed loosely with sutures and Penrose drain placement.

Needle Aspiration and Catheter Placement

Simple, unilocular collections in stable patients may be amendable to less invasive techniques. Palpable abscesses can be directly aspirated with a needle. Alternatively, introduction of an intravenous catheter permits irrigation within the cavity. Pigtail catheter placement with the Seldinger technique affords continued drainage and flushing (52). CECT or ultrasound guidance is usually necessary in localizing deeper collections (53,54). The main advantage of this modality is the avoidance of the potential morbidity associated with open surgical approaches including scarring, contamination with spread of infection, and neurovascular injury.

COMPLICATIONS

Despite expedient diagnosis, antibiotic administration, and surgical drainage, complications may occur. An important predisposing factor for a complicated DNSI is an immunocompromised host. Spread of infection to adjacent vital anatomic structures also occurs more commonly in the background of delayed presentation or diagnosis (30). Aggressive and vigilant management is vital in avoiding the potentially catastrophic outcomes associated with a complicated disease course.

Neurovascular Complications

Carotid artery pseudoaneurysm and rupture can occur with infectious spread to the carotid space. Patients most frequently present with a pulsatile neck mass (55). Additional findings include recurrent sentinel hemoptysis or bloody otorrhea, hematoma within the soft tissues of the neck, and hemodynamic collapse (11,56,57). Once recognized, the standard intervention is surgical ligation of the common carotid artery (56). If time permits, less invasive endovascular stenting or vessel occlusion in an interventional radiology suite may also be attempted (58,59).

Lemierre syndrome, or IJV thrombophlebitis (Fig. 55.8), is a rare but serious complication of DNSI (60,61). The anaerobe, *Fusobacterium necrophorum*, is the most common causative organism, with clinical manifestations of spiking fevers, neck stiffness, pulmonary and systemic

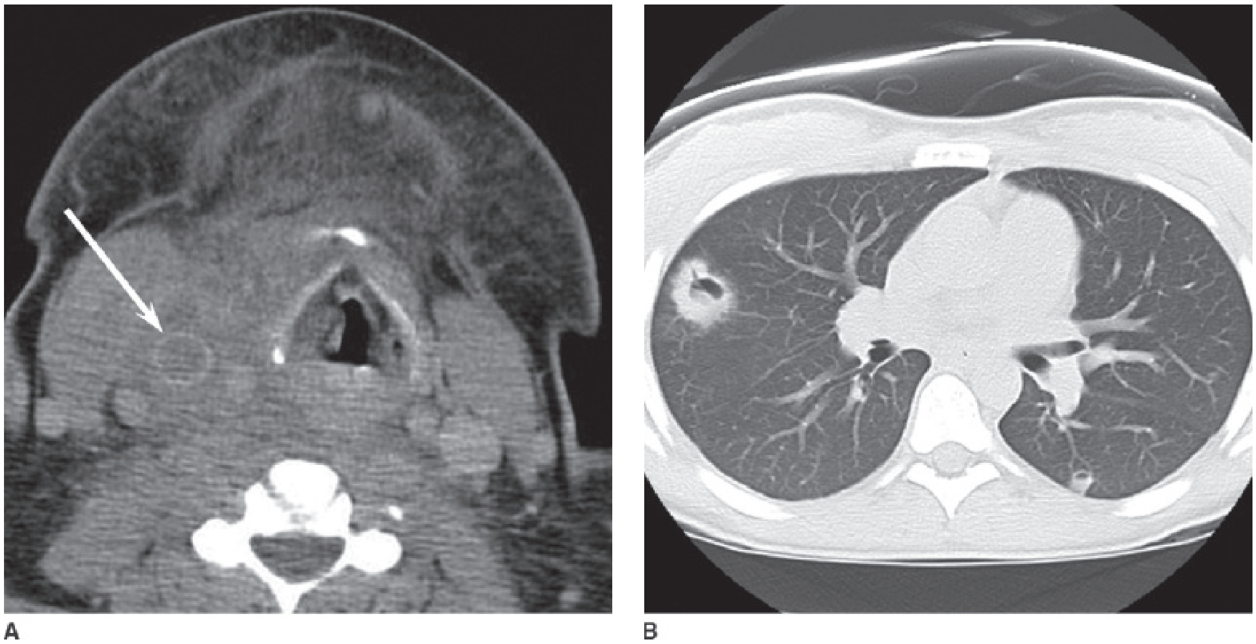


Figure 55.8 Internal jugular thrombophlebitis with Lemierre syndrome. **A:** Axial unenhanced CT shows hypodensity of the right IJV (*arrow*) with extensive surrounding fat infiltration. On contrast-enhanced CT, the vein would fail to enhance like the other vessels. Ultrasound may also be used to document disruption of venous flow. **B:** Axial CT on lung windows shows multiple cavitary lung masses with ill-defined borders, representing lung abscesses from infected emboli (Lemierre syndrome).

emboli, and tender swelling along the SCM and angle of the jaw (62). Diagnosis is confirmed with the finding of ring enhancement and a filling defect of the IJV due to a clot or purulence on CECT. Treatment involves beta-lactamase–resistant antibiotics with the addition of heparin anticoagulation in the presence of thrombus progression or septic emboli. Worsening symptoms or abscess formation in the setting of appropriate medical therapy is an indication for surgical ligation of the IJV (63). Retrograde spread of the thrombophlebitis may also result in a potentially fatal cavernous sinus thrombosis (64), which is managed with critical care support and intravenous antibiotics.

In addition to Lemierre syndrome, spread of infection to the upper carotid space and poststyloid parapharyngeal space may also lead to deficiencies in cranial nerves IX, X, XI, and XII (11). The classic triad of ptosis, anhydrosis, and miosis (Horner syndrome) will be observed with involvement of the postganglionic sympathetic nerves. Central nervous system complications of DNSI spread include meningitis and intracranial abscess.

Additional Complications

Rupture of an abscess into the airway can result in serious outcomes including aspiration pneumonia, lung abscess, empyema, and even asphyxiation. Deeper spread of infection may cause osteomyelitis of the cervical vertebrae and mandible, which are generally addressed with long-term intravenous antibiotics (65). Systemic consequences of DNSI include disseminated intravascular coagulation and sepsis, both of which carry high mortality rates despite intensive care management and resuscitative efforts (26,66).

SPECIAL CONSIDERATIONS

Mediastinitis

Extension of DNSI from the head and neck into the mediastinum is a relatively rare but dreaded complication, carrying a mortality rate of approximately 40% (67,68). Infectious spread generally traverses the retropharyngeal, danger, prevertebral, or anterior visceral spaces with a mix of aerobic and anaerobic offending agents (69,70). Characteristic findings on physical examination include progressive chest pain and dyspnea, along with neck swelling. The classic finding on plain film or CECT scan of the chest is a widened mediastinum. Fluid collections, pneumomediastinum, and even pneumothorax may be present as well (71). Medical therapy requires broad spectrum antibiotics and ICU support. Superior mediastinal collections can generally be treated through a deep transcervical approach. Involvement of more inferior structures, however, necessitates thoracotomy with chest tube insertion (72).

Necrotizing Cervical Fasciitis

Necrotizing cervical fasciitis (NCF) is a rapid and diffuse spread of infection throughout multiple fascial planes associated with significant morbidity, and a mortality

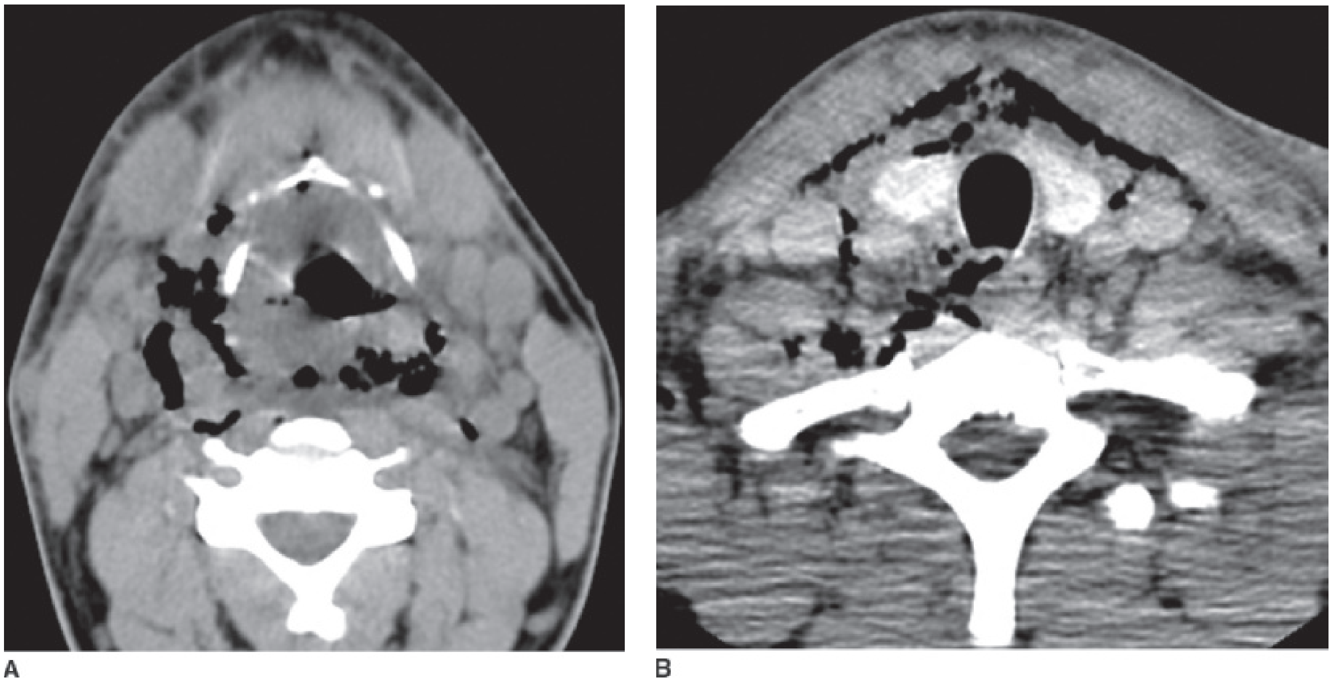


Figure 55.9 Necrotizing fasciitis. Axial unenhanced CT images at the level of the hyoid bone **(A)** and thyroid gland **(B)** show extensive gas formation throughout the deep fascial compartments of the neck. There is also extensive infiltration of the fat planes, which distinguishes this case of necrotizing fasciitis from perforation of the upper aerodigestive tract.

Q5 rate of approximately 30% (Fig. 55.9). Local extension with mediastinitis or systemic spread with sepsis is associated with an even poorer prognosis (73,74). As with most DNSI, the predominant source is a polymicrobial odontogenic infection with a mixture of aerobes, anaerobes, *Clostridium*, and MRSA (74–76). Patients will have an extremely toxic appearance with spiking fevers. Striking ischemic discoloration of the skin, with erythema, crepitus, edema, and tenderness are observed on physical examination. Progression of the disease process may evolve into anesthetic and pale skin with blistering and sloughing (11). In addition to tissue gas, notable findings on CECT that distinguish this liquefaction necrosis from conventional cellulitis, abscess, or phlegmon include hypodense regions lacking loculations or peripheral enhancement (77). NCF is a potentially lethal entity that mandates intravenous broad-spectrum antibiotics within an ICU setting along with multiple trips to the OR for surgical debridement of nonviable tissue. Any correctible causes of immunocompromise leading to susceptibility of NCF must be addressed as well. Many patients with comorbidities including diabetes mellitus and cirrhosis succumbed to NCF, while those without these conditions usually recover (78). Adjuvant hyperbaric oxygen may be considered as an adjunctive treatment (79). Reconstruction with skin grafts or local and free tissue flaps can take place once the infectious process has resolved.

SPECIFIC DEEP NECK SPACE INFECTIONS

Retropharyngeal, Danger, and Prevertebral Spaces

The retropharyngeal space houses the nodes of Rouviere that lie just off the midline and receive drainage from the posterior two-thirds of the nose, paranasal sinuses, adenoids, pharynx, and eustachian tube. These lymphatics are rarely the cause of retropharyngeal space infections (RPSI) in children older than 5 years due to their involution by this age. Other causes, generally found in the older population, include penetrating or blunt trauma; instrumentation; intubation; placement of feeding tubes; and infection from neighboring spaces, most notably the parapharyngeal and prevertebral spaces (80).

Diagnosis of this entity may be challenging in its early stages, particularly in children. Sore throat may not be a typical complaint, but the child may refuse to eat due to discomfort. Trismus is not expected to be associated with RPSI, and its presence should raise the suspicion of parapharyngeal space extension. Swelling in the posterior nasopharynx may be confused with inflammation of the adenoids. Swelling below the nasopharynx will present along the posterior pharyngeal wall, usually seen off the midline. Additional findings include cervical adenopathy, slight elevation of temperature, and a muffled voice secondary to supraglottic swelling. Children may also feature irritability and nuchal

Figure 55.10 Retropharyngeal abscess. Axial contrast-enhanced CT shows a round abscess (*asterisk*) with an enhancing rim in the lateral retropharyngeal space. There is substantial surrounding edema. A lateral abscess such as this is likely the result of a suppurated node, whereas medial collections arise from direct inoculation.

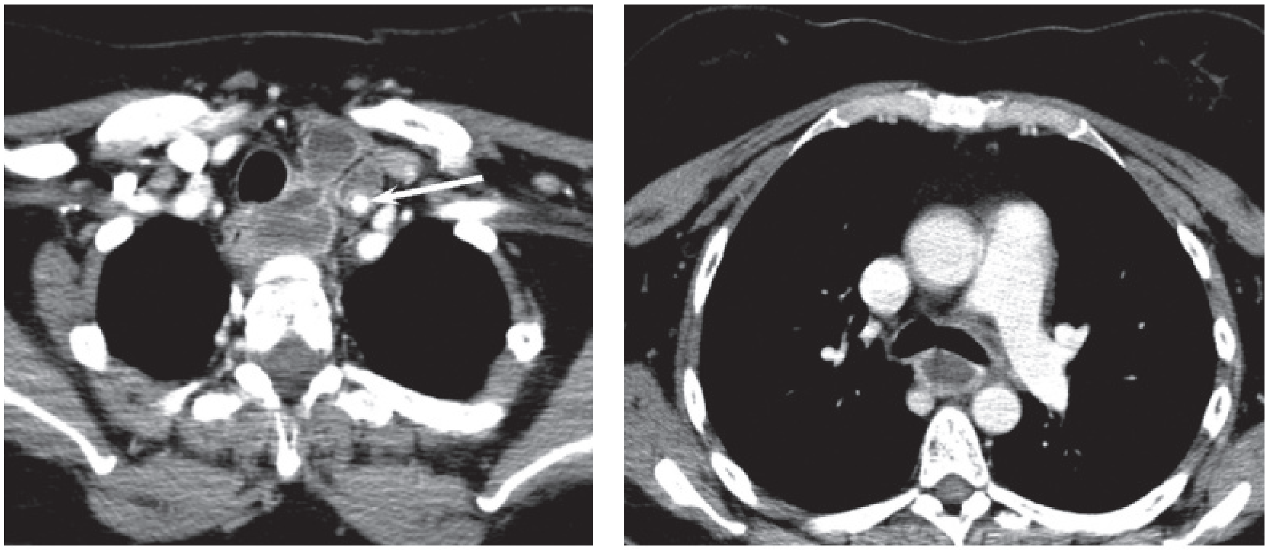
rigidity. Mediastinal extension must be considered in the setting of respiratory distress. Lateral neck radiographs help confirm the diagnosis, with the classic measurement of the retropharyngeal space at level C-2 in adults or children of greater than 7 mm denoting an abnormality. At level C-6, retropharyngeal thickness greater than 22 mm in adults or 14 mm in children also denotes an abnormality. However, due to difficulty in positioning, interpretation of this area in infants is less reliable. CECT (Fig. 55.10), when possible, will help delineate the extent of the infection and possible spread to neighboring spaces (80,81). The workup will be augmented by aspiration of possible purulent fluid and culture specimens from the mass with an 18-gauge spinal needle.

Control of the airway prior to drainage of an RPSI can be accomplished with endotracheal intubation in uncomplicated cases. However, tracheostomy is recommended in the presence of an urgent need for airway control and large abscess due to the risk of rupture and subsequent purulent aspiration during intubation. With collections that are limited to the retropharyngeal space, above the hyoid bone, and easily visualized; a transoral approach to drainage can be undertaken (82,83). This procedure is performed with the patient in the Rose position in order to keep any drainage within the nasopharynx. RPSI that involve multiple spaces are located below the hyoid bone, and/or are difficult to visualize, are to be drained externally. A vertical incision can be made along the anterior border of the SCM muscle, or a horizontal curvilinear incision can be utilized. Dissection is carried down through the platysma muscle and superficial layer of the deep cervical fascia. The abscess cavity is then exposed following medialization of the trachea, and esophagus, and lateral retraction of the carotid sheath and SCM (83). Based on CECT findings, spread of infection below the clavicle into the mediastinum to the level of the fourth thoracic vertebra is an indication for a thoracic surgery consultation. Thoracic surgical intervention can range from superior mediastinotomy for upper mediastinal infections, to external lateral thoracotomy in the presence of significant extension into the chest cavity.

Prevertebral space infections may have a clinical course that differs from RPSI. Possible causes of prevertebral space and danger space infections include tuberculous Pott abscesses, posterior extension of RPSI, trauma, previous spinal surgery, and extension of osteomyelitis. If located within the high-cervical area, an intraoral midline bulge may be seen. In contrast to RPSI, these infections usually demonstrate a more indolent course, with patients consequently having less striking complaints. Vague neck or shoulder pain, dysphagia, or respiratory distress is inconsistently reported. Typical CECT features of a danger space abscess are demonstrated in Figure 55.11. Management of these entities is generally similar to the approach to RPSI. In addition to the typical organisms previously described, infections caused by *Mycobacterium tuberculosis* or atypical mycobacterium should be considered in patients who fail to respond to the usual antimicrobial agents. While transoral drainage of high-cervical (C1–C3) collections is possible, it may be limited by the inability to adequately remove infected bone. Access to the prevertebral and danger spaces can be achieved through incisions made anterior or posterior to the SCM. Adequate tissue and fluid sampling from these collections is of particular importance given the relative frequency of atypical organisms (81,84).

Submandibular Space and Ludwig Angina

As elaborated on earlier in this chapter, the submandibular and sublingual spaces communicate freely behind the posterior edge of the mylohyoid muscle and are generally described together as the submandibular space. Infectious processes, however, can involve each subcompartment individually or together. Radiographically, spaces within the submandibular region can also be distinguished by their relationship to the anterior belly of the digastric muscle (Figs. 55.12 and 55.13). Although a number of infections are caused by sialadenitis or lymphadenitis (85), 70% of cases originate from dental or periodontal disease (67). As outlined earlier, and based on the mylohyoid line orientation, infections involving the incisors to first molars will present initially in the sublingual space, while the second and third molars will drain primarily to the submandibular space. The latter process is not common in children owing to delayed eruption of the third molar. The most severe manifestation of this entity, Ludwig angina (Fig. 55.14), is defined as having: (a) all the tissues and



A B

Figure 55.11 Danger space abscess. **A:** Axial contrast-enhanced CT shows a multilocular abscess of the lower neck involving the central compartment, the retropharyngeal space, and carotid sheath, with abscess surrounding the common carotid artery (*arrow*). **B:** More inferior image shows the retropharyngeal component of the abscess extending deep into the mediastinum, below the level of the T4 vertebra. Because the retropharyngeal space extends only to T2–T4, this infection must be located in the danger space, which extends to the diaphragm.

compartments of the floor of the mouth swollen and inflamed, (b) displacement of the tongue superoposteriorly toward the soft palate, (c) firm induration of the submandibular area and anterior neck, (d) trismus, and (e) voice changes and dyspnea (81).

Given that asphyxia is the most common cause of death in Ludwig angina, airway protection is of paramount concern. Furthermore, with displacement of intraoral structures and rapid disease progression, tracheostomy is utilized much more frequently relative to other DNSI (6,14).

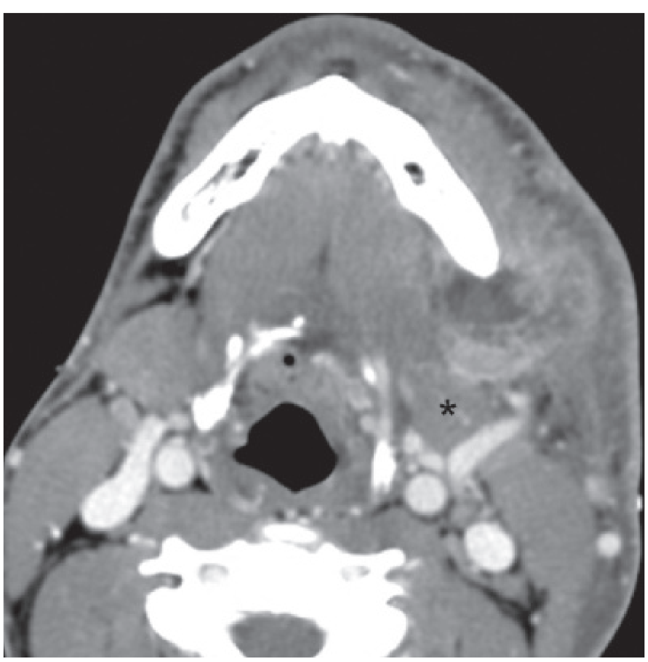


Figure 55.12 Submandibular abscess. Axial contrast-enhanced CT shows an abscess within the submandibular triangle, displacing the submandibular gland (*asterisk*) posteriorly. The abscess wraps around the inferior mandible, so it likely arose from infection in a posterior molar tooth.

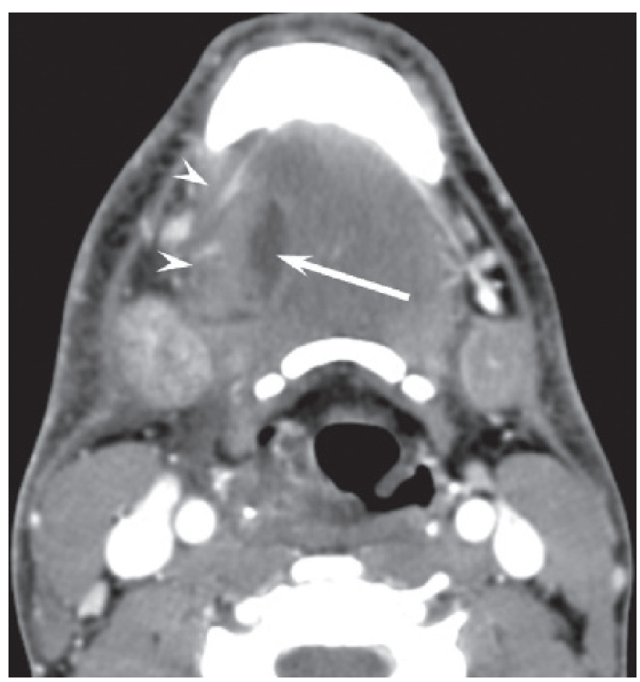


Figure 55.13 Submental abscess. Axial contrast-enhanced CT shows an ovoid abscess (*arrow*) medial to the anterior belly of the digastric muscle (*arrowheads*), with copious surrounding edema. Extensive fat infiltration and submandibular gland inflammation are restricted to the right side of the face and neck. Reactive edema is seen even into the right side of the larynx.

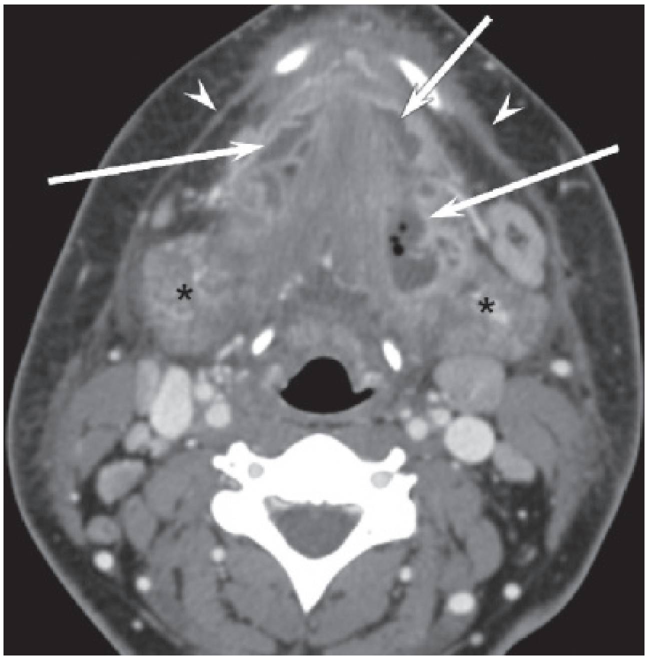


Figure 55.14 Ludwig angina. Axial contrast-enhanced CT shows diffuse infiltration of the fat planes in the submandibular, submental, and subcutaneous spaces. The platysma muscles (*arrowheads*) are thickened. The submandibular glands (*asterisks*) are inflamed. There is an extensive abscess (*arrows*) throughout the submandibular and submental spaces, with air locules indicating anaerobic infection.

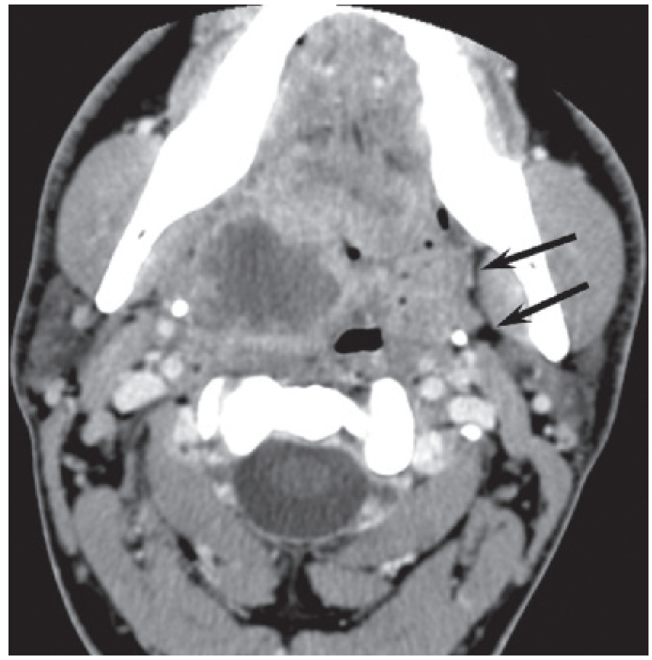


Figure 55.15 Parapharyngeal abscess. Axial contrast-enhanced CT shows a large abscess involving both the peritonsillar space and the parapharyngeal space, with replacement of the parapharyngeal fat. The abscess extends laterally to the styloid process. The normal contralateral parapharyngeal fat is still visible (*arrows*).

A number of patients with confirmed Ludwig abscess undergoing attempted fiberoptic intubation may require unplanned "slash" tracheostomies. Following control of the airway, surgical incision and drainage is indicated in the face of worsening symptoms despite the administration of appropriate antibiotics (86,87). Uncomplicated collections limited to the sublingual space can be approached intraorally. The surgical approach for Ludwig angina, however, is accomplished with a horizontal submental incision 1 cm superior to the hyoid bone extending laterally in each direction to 3 cm below the angle of the mandible. Dissection is carried out from the hyoid bone to the mandibular symphysis through the platysma muscle and into the sublingual tissues. The cavity will generally contain a malodorous liquid material and/or frank pus. Since a true purulent collection is not always present, it is important to note that the need for surgical drainage and decompression should be dictated by physical examination findings rather than CECT scan (81).

Parapharyngeal Space

The relatively central location of the parapharyngeal space allows for the direct spread of infection from multiple neighboring deep neck spaces (Figs. 55.5 and 55.15). Common routes of extension include laterally from the peritonsillar space, posteriorly from the submandibular space, anteriorly from the retropharyngeal space, and medially from the parotid or masticator space. Consequently, a comprehensive evaluation must be carried out in order to exclude the involvement of any other spaces. The predominant organisms will also vary based on the portal of entry as discussed earlier in this chapter.

Infections of the prestyloid and poststyloid compartments will differ in presentation. The prestyloid compartment normally contains fat, connective tissue, lymph nodes, and muscle, while the poststyloid compartment houses the carotid sheath and cranial nerves IX to XII (11). Prestyloid infections typically present 7 to 10 days after an episode of tonsillitis or pharyngitis with the classic signs of trismus, swelling at the angle of the mandible, medial bulging of the pharyngeal wall, and systemic toxicity. Without involvement of the pterygoid musculature, trismus is generally absent in poststyloid infections. The medial bulge of the pharyngeal wall is not always seen in poststyloid infections, sometimes leading to a misdiagnosis such as fever of unknown origin. Potentially catastrophic neurovascular complications may be associated with poststyloid infections. Involvement of the carotid sheath can lead to IJV thrombosis, and carotid artery erosion or pseudoaneurysm. Ipsilateral Horner syndrome or other cranial neuropathies are also possible (88).

Indications for incision and drainage of a parapharyngeal space infection include disease progression despite medical care, a demonstrable collection on imaging, or evidence of a neurologic and/or vascular complication (28,51,89). Despite the prominence of the lateral pharyngeal wall, a transoral incision is not advised due to the risk of uncontrollable hemorrhage from the carotid sheath vessels. The functional status of all cranial nerves prior to surgical exploration should be documented to avoid attributing any preexisting deficits to the operation. The external approach is initiated with a horizontal incision two fingerbreadths inferior to the lower border of the mandible going from the lateral aspect of the hyoid tip to the anterior border of the SCM. The superficial layer of the deep cervical fascia is entered as the SCM is retracted posteriorly. The parapharyngeal space is then entered using blunt finger dissection up to the styloid process. Two additional landmarks must be noted. The tip of the greater cornu of the hyoid bone defines the inferior border of this space. Additionally, all the important neurovascular structures housed within the parapharyngeal space lie deep to the posterior belly of the digastric muscle (88).

Parotid Space

As described earlier, the parotid space is formed as the superficial layer of the deep cervical fascia envelopes the parotid gland. Diagnosis of an abscess may be difficult on physical examination alone due to the firm, adherent capsule lateral to the gland. However, medial extension of infection to the neighboring prestyloid parapharyngeal space can be observed intraorally. The infection is generally secondary to salivary stasis leading to parotitis in patients who are debilitated, postoperative, dehydrated, or have poor oral hygiene. The typical presentation is facial swelling overlying the parotid region without fluctuance or trismus. Purulent fluid may or may not be expressed from Stensen duct (81). Parotitis is managed with rehydration and antimicrobials targeted against *S. aureus*. When a collection is evident on imaging, the abscess can be accessed through two different routes. An incision can be made through the skin over the prominence of the swelling parallel to the branches of the facial nerve. If the swelling is extensive, a Furstenberg incision can be made. This consists of a vertical preauricular incision extending from the zygoma and curving around the lobule onto the mastoid. The fascia overlying the gland is then widely exposed. Small stab incisions are then made through the fascia followed by bluntly spreading parallel to the facial nerve branches. Penrose drains can be placed for several days allowing the incision to close by secondary intention. Delayed scar revision can be done if desired (90,91).

Masticator Space

Masticator space infections generally involve the fascial sling containing the muscles of mastication: the temporalis, masseter, and pterygoids. Delay in diagnosis and treatment can lead to mandibular osteomyelitis. The most frequent infectious source is odontogenic, usually from the third molar teeth. Patients usually present with trismus and painful swelling over the angle and posterior mandible. Posterolateral swelling within the mouth may mimic a prestyloid parapharyngeal space infection (81). When imaging masticator space infections, MRI can be advantageous over CECT scan due to the lack of dental amalgam artifact (92). Management of the airway in these patients is a priority given the potential for obstruction. Severe trismus and swelling mandate awake fiberoptic intubation or tracheostomy prior to further management. Four approaches may be taken in draining masticator space collections: (a) Drainage can be performed externally. (b) An intraoral route through an incision into the alveolar–buccal groove below the third molar followed by subperiosteal dissection posteriorly deep to the masseter muscle. (c) Collections may also be drained through the offending dental socket following tooth extraction. (d) Select cases can be managed with needle aspiration and antibiotic coverage (90).

HIGHLIGHTS

- The majority of DNSIs in adults are of odontogenic origin, whereas acute pharyngitis and rhinosinusitis leading to retropharyngeal and parapharyngeal lymphadenitis is a common infectious source in children.
- Intravenous drug abuse, particularly in an inner-city environment, is a relatively common cause of DNSIs. However, it has been shown that abscesses caused by direct intravenous drug use seem to have a more favorable clinical course compared to those spreading from inflamed tissue.
- The majority of abscesses are polymicrobial. Due to differences in the portal of entry, offending microorganisms in adults and children will vary. Additionally, Methicillin-resistant Staphylococcus aureus has been increasingly associated with intravenous drug abusers, infants, and immunocompromised patients.
- Inflammation of surrounding deep neck structures will manifest with associated signs and symptoms including pain, fever, swelling, dysphagia, odynophagia, trismus, respiratory difficulty, and toothache. The presence or absence of certain complaints will aid in identifying the specific site of infection.
- Ultrasonography is gaining popularity in the United States as an adjunct to CECT, especially in children undergoing serial image-guided therapeutic aspirations of infectious neck collections.
- Hypoxia and asphyxia remain the most common causes of mortality in DNSIs. When presented with signs of airway compromise, early intubation or tracheostomy circumvent the performance of these procedures under more dire circumstances. In situations where extubation within 48 to 72 hours is questionable or not expected, tracheotomy should be performed in favor of shorter hospital and ICU stays.

- Immunologically sound individuals should be empirically administered a beta-lactamase–resistant penicillin combined with an agent effective against anaerobes. Antibiotics targeting specific organisms can be given once cultures and sensitivities are available.
- In most cases, immediate need for surgical drainage is obvious. In questionable cases, progression of symptoms such as fever, tenderness, swelling, and elevated leukocyte count despite 48 hours of medical management is an indication for surgical drainage or exploration. Additional indications include potential airway compromise, impending complications or septicemia, evidence of collections larger than 3 cm, or the involvement of multiple spaces.
- Complications are more common in immunocompromised hosts and in cases of a delayed presentation or diagnosis. Infections of certain spaces can lead to multiple neurovascular complications including carotid artery pseudoaneurysm or rupture, Lemierre syndrome, or Horner syndrome. Mediastinitis and NCF are potentially lethal entities that must be considered when managing any DNSI.
- Tracheostomy is the preferred approach to controlling the airway in Ludwig angina and extensive masticator space infections due to the presence of obstructive tongue elevation and trismus, respectively. A surgical airway is also recommended in an urgent setting for patients with retropharyngeal collections due to the risk of abscess rupture and aspiration during intubation.

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Queries

[Q1] Please check and confirm if the headlevels are appropriate as identified throughout the chapter.
[Q2] The citation of Figures 55.2 to 55.4 in the heading "Spaces Involving the Entire Neck" has been moved to the paragraph beginning "The retropharyngeal space…". Please check.
[Q3] The citation of Figures 55.3 to 55.5 in the heading "Space above the Hyoid Bone" has been moved to the paragraph beginning "Also known as the lateral…". Please check.
[Q4] The citation of Figure 55.2 in the heading "Spaces below the Hyoid Bone" has been moved to the paragraph beginning "This space runs from…". Please check.
[Q5] The citation of figure 55.9 from the heading "Necrotizing Cervical Fasciitis" has been moved to the following paragraph.