AJNR

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V D Nguyen, J L Potter and M R Hersh-Schick

AJNR Am J Neuroradiol 1992, 13 (1) 215-219
http://www.ajnr.org/content/13/1/215.citation

Ludwig Angina: An Uncommon and Potentially Lethal Neck Infection

Vung D. Nguyen,[1] Janet L. Potter,[1] and Marla R. Hersh-Schick[1]

Summary: The authors review the pathophysiology and assess the role of radiologic studies in the evaluation of four patients with acute cellulitis of the mandibular spaces—Ludwig angina.

Index terms: Neck, infection; Neck, computed tomography

Ludwig angina (LA) is a potentially lethal acute cellulitis of the floor of the mouth and submandibular space. It rapidly spreads to infiltrate the soft tissues of the neck, producing a suprahyoid brawny induration with posterior and superior displacement of the tongue. Although LA is an uncommon entity, it is a clinical emergency. Unless recognized promptly and treated vigorously, it may progress to a fatal outcome due to suffocation. The role of radiologic imaging in the clinical management of LA is to evaluate airway narrowing, localize any drainable abscess, identify the presence of air from gas producing organisms, and search for underlying odontogenic abscess. We report the radiologic, clinical, and etiologic findings in four recent cases of LA and discuss a possible pitfall in radiologic interpretation.

Case Reports

Case 1

A 54-year-old man experienced submental and submandibular swelling and pain on swallowing for 2 days. On admission to the hospital his temperature was 100.1°F and the white blood cell (WBC) count was 15,800 with a left shift. A lateral neck radiograph revealed marked airway narrowing and soft-tissue swelling (Fig. 1). The swelling became more firm and tender after several hours of antibiotic therapy and an emergency tracheotomy was performed. Approximately 15 cc of serosanguinous material were aspirated from several passes in the submandibular area and cultures grew coagulase negative staphylococci and *Streptococcus viridans.* The tracheotomy was closed 6 days later and the patient recovered slowly on antibiotic therapy.

Case 2

A 56-year-old man was admitted with a 5-day history of facial swelling and toothache. After 24 hr of antibiotic therapy, there was marked worsening of his condition with submandibular and sublingual edema, dysphagia, odynophagia, and inability to control secretions. A lateral neck radiograph revealed air in the soft tissues of the upper neck (Fig. 2). He was intubated and underwent surgical drainage and tooth extractions. Anaerobic cultures grew *Bacteroides* spp and coagulase negative staphylococci. He was extubated after 5 days and slowly improved on antibiotic therapy.

Case 3

A 21-year-old man who had both lower third molars extracted 1 week earlier presented with increasing pain, swelling, and decreased range of tongue motion. He had a temperature of 101°F and a WBC count of 16,300 with a left shift. Aggressive antibiotic therapy and intravenous steroids were begun, but a few hours later an emergency tracheotomy was necessitated by impending airway obstruction. Cultures of a small amount of serosanguinous fluid aspirated from the submandibular area grew *S. viridans* and coagulase negative staphylococci. A computed tomography (CT) scan (Fig. 3) was obtained 24 hr after placement of the tracheotomy because a laternal neck radiograph revealed new soft-tissue air, raising concern for a drainable abscess or progressive infection. The patient slowly improved and the tracheotomy was removed after 6 days.

Case 4

An 18-month-old boy developed pain and submandibular swelling for 1 day. On admission, there was swelling of the floor of the mouth, lower face, and submandibular areas. The facial swelling extended to the postauricular

Received December 13, 1990; revision requested March 20, 1991; revision received July 5; final acceptance August 1.

[1] All authors: Department of Radiology, University of Texas Health Science Center, 7703 Floyd Curl Drive, San Antonio, TX 78284-7800. Address reprint requests to J. L. Potter.

AJNR 13:215–219, Jan/Feb 1992 0195-6108/92/1301-0215 © American Society of Neuroradiology

Fig. 1. Case 1: Lateral neck radiograph shows marked thickening of the suprahyoid soft tissues, a consistent finding in Ludwig's angina, but shows no indication of gas-producing organism or localized abscess.

region. His temperature was 102°F and the WBC count was 22,100. Swelling increased over 24 hr despite antibiotic therapy. A CT scan revealed soft-tissue edema with ill-defined low-density areas, but no focal abscess collection (Fig. 4). The child was intubated and a small amount of purulent material was obtained by aspiration from the left submandibular area. *Streptococcus* spp were cultured from the aspirate. He was extubated 24 hr later and recovered slowly on antibiotic treatment.

Discussion

Review of the Literature

Deep neck infections have been mentioned by Hippocrates, Galen, and others under ancient names including morbus strangulatorius, cynanche (Greek for suffocation), garotilla (Spanish for the loop used by a hangman), and angina maligna (1–6). In 1836 von Ludwig defined a form of cellulitis arising in the tissues around the mandibular glands (4). He noted that it involved the neck and floor of the mouth with a symmetric induration that resulted in difficulty with speech, respiration, and deglutition. Lymph nodes were unaffected. Ludwig reported a 60% mortality rate with death in 10 to 12 days, or a prolonged recovery.

Knowledge of neck anatomy is basic to understanding the clinical manifestations, pathogenesis, progression, and complications of LA. The mandibular space lies above the hyoid bone. It is subdivided into two compartments by the mylohyoid muscle: 1) the sublingual space, located between the oral mucosa and the mylohyoid muscle, and 2) the submandibular space, located between the mylohyoid muscle and the skin and superficial fascia. There is communication between these two spaces around the posterior free border of the mylohyoid muscle (6, 7). Infection in the mandibular space may subsequently spread into adjacent areas including the pterygomandibular, masseteric, and temporal spaces (7, 8).

Based on a thorough review of the anatomy and case literature, Grodinsky, in 1939, established strict criteria that are still used to establish the diagnosis of LA (9). The criteria define LA as a cellulitis, not a focal abscess, of the mandibular space that: 1) always involves both the sublingual

Fig. 2. Case 2: Air within the thickened soft tissues of the upper neck is secondary to anaerobic *Bacteroides* spp.

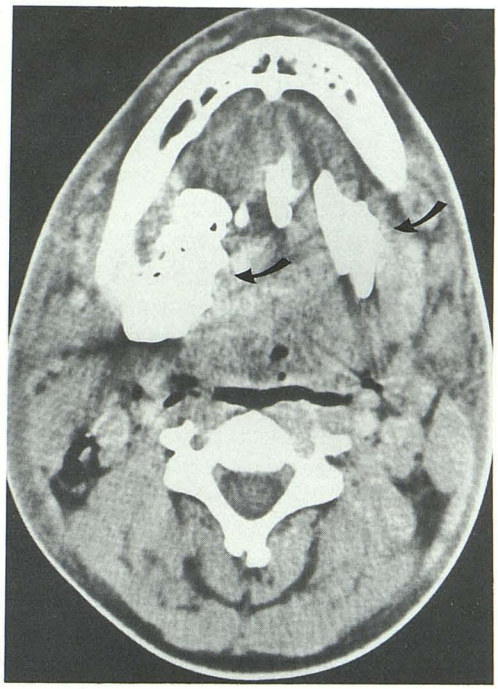

Fig. 3. Case 3: CT scan at the level of the floor of the mouth demonstrates the air from the tracheotomy procedure that has dissected along fascial planes into the retropharyngeal and carotid spaces. There is no soft-tissue edema associated with the air tracking into these spaces. However, there is edema of the subcutaneous tissues and fat planes around the submandibular glands, secondary to the cellulitis. The *curved arrows* denote drains from the prior surgical procedure.

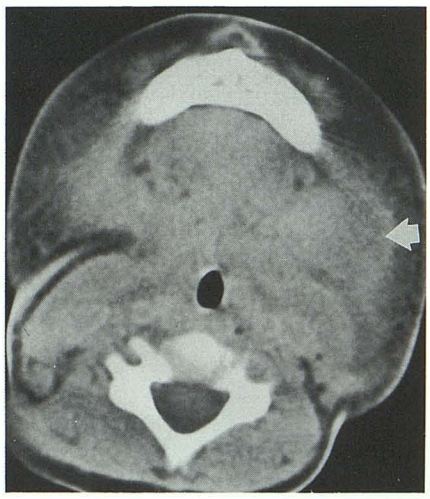

Fig. 4. Case 4: CT scan at the level of the submandibular space reveals findings of LA. The airway is narrowed. Soft tissues are thickened with low attenuation phlegmon on the left (*arrowhead*) and edematous subcutaneous tissues. There is no abscess.

and submandibular spaces and is almost always bilateral; 2) produces gangrene or serosanguinous phlegmon but little or no frank pus; 3) involves connective tissue, fascia, and muscles, but not glandular structures; and 4) is spread by contiguity, not by lymphatics.

The most common cause of LA is infection of the mandibular molars, accounting for up to 90% of reported cases (6, 10–12). Tschiassny (13), in 1943, demonstrated the relationship of molar roots to the mandibular mylohyoid ridge, along which the mylohyoid muscle attaches to the mandible. The roots of the lower second and third molars reach below the mylohyoid attachment. Consequently a root abscess may break through the thin lingual cortex into the submandibular space. Infection of the first or premolar root apices, which are located above the mylohyoid attachment, spreads initially into the sublingual space (13). Other reported causes of LA include laceration, peritonsillar abscess, osteomyelitis, otitis media, and mandibular fracture (14). Because the infection starts in the mouth, oral flora (especially *Streptococcus* and *Staphylococcus*) predominate in cultures. The infections are usually mixed and anaerobic bacteria are frequent (12).

Ludwig angina is most commonly seen between ages 20 and 60 yr but has been reported as young as 12 days and as old as 84 yr (15, 16). The incidence in males is three to four times that in females. Most patients are otherwise healthy, although LA may be seen as a complication of systemic lupus erythematosus, glomerulonephritis, immunodeficient states (especially in children), and diabetes mellitus (12).

Clinical symptoms of LA reflect the progressive involvement of the mandibular spaces by the rapidly expanding phlegmon. Edema within the submandibular space produces a brawny painful induration confined to the suprahyoid area externally. Involvement of the sublingual space produces elevation and backward displacement of the tongue, compromising the airway. There is little clinical evidence of fluctuance and generally no drainable abscess. If pus forms, it is usually in deep, localized pockets (14, 17, 18). When untreated, the infection may track along fascial planes to involve the parapharyngeal and retropharyngeal spaces, carotid sheath, and rarely the mediastinum and subphrenic areas (17, 19). Clinical symptoms include pain, restricted neck mobility, dysphagia, dysphonia ("hot potato mouth"), odynophagia, drooling, and trismus. Airway compromise forces the anxious patient into a semierect position. These symptoms are rapidly progressive and accompanied by tachycardia, fever, dyspnea, and stridor. Laryngospasm may be trig-

gered by the supine position or an attempt to intubate or visualize the hypopharynx (14, 17).

Because of the risk of laryngospasm, the plain neck radiograph is relied upon to evaluate the airway. Neck radiographs may also reveal periodontal abscess and bone erosion and can demonstrate the presence of gas-forming anaerobic infection. Initial radiography requested by the treating physician also frequently include a Panorex to assess dental disease (12, 16, 17). In general, CT has not been performed as part of the initial evaluation but has been reserved for those patients who are not responding to antibiotic therapy or whose diagnosis is uncertain. CT is most helpful in demonstrating anatomic planes and defining a drainable abscess. On both plain radiographs and CT the presence of air can be secondary to tracheotomy rather than the result of gas-forming anaerobic infection. This can be a difficult distinction to make on plain film, but the pitfall is easily avoided with CT, on which air from tracheotomy placement can be seen tracking along fascial planes without associated soft-tissue edema (See case 3).

Review of Case Histories

The four patients presented here demonstrated the characteristic clinical and radiologic features of LA. All were males, and three of the four had odontogenic etiology. Three were in the age group of highest incidence. The fourth patient, at age 18 months, was well under the normal incidence range for LA and a source of infection was never established. Failure to identify an etiology is not uncommon in the small number of young children who present with LA (12). Tracheotomy was required in two of the four patients, a rate somewhat higher than the 7% to 35% reported in other recent series (11, 16, 17). The other two patients were supported with intubation. Recovery in all four was quite slow, especially during the first few days. Slow improvement, however, is a common phenomenon in LA, even with appropriate antibiotic therapy and surgical drainage (14, 16, 17).

All four patients had neck radiographs on admission and all revealed marked edema of the submental and submandibular soft tissues (Fig. 1). The radiograph of case 2 additionally showed air in the soft tissues from gas-producing organisms (Fig. 2). In cases 2 and 4, documentation of only minimal airway-narrowing on the plain film enabled the surgeon to attempt intubation rather than tracheotomy when respiratory distress increased. A recent review suggests that a large majority of LA patients can be managed with intubation and aggressive medical therapy, obviating the need for both tracheotomy and surgical drainage procedures (16).

CT scans were performed in two patients, both because of lack of improvement or deterioration on appropriate therapy. In case 3, a follow-up neck radiograph on postoperative day 2 revealed soft-tissue air. This finding raised clinical concern for an undrained abscess and prompted the CT request. The CT scan demonstrated that the air was in fascial planes, secondary to the tracheotomy and not to gas-forming infection (Fig. 3). Case 4 had a CT scan because no underlying dental infection could be found and the child's condition worsened over the first two days of antibiotic therapy. This scan (Fig. 4) revealed soft-tissue changes consistent with LA, including scattered low-density areas of phlegmon, but no focal abscess.

The choice of radiologic imaging modalities is determined by the emergency room physician who first assesses the severity of the respiratory distress. Because plain film radiography is readily available, easily demonstrates airway narrowing, and can be performed with the patient sitting, it is routinely obtained. CT in the initial evaluation of these critically ill patients is often impossible because the anxious patient cannot breathe adequately in a supine position and is frequently agitated. The compromised patient must be closely monitored by the clinician during any imaging procedure because of the potential for laryngospasm. Consequently, transport to a CT scanner outside the emergency department is generally contraindicated. However, as intubation rather than emergency tracheotomy is increasingly relied upon, CT may be more frequently used to determine need for surgical intervention, especially in the first critical days when there may be few if any signs of clinical response to antibiotic therapy. Follow-up neck radiographs after the airway has been artificially maintained are usually not helpful, because there is no need to assess airway patency and postsurgical changes and air may create a false impression of progression of infection (see case 3). When there is clinical suspicion for developing abscess once the airway is stabilized, CT scanning effectively demonstrates drainable abscesses and displays surgical anatomy. Magnetic resonance (MR) imaging, because of its excellent soft-tissue contrast

and depiction of fascial compartments, is an ideal tool for evaluating neck infection (20). It was not utilized in any of the four LA patients presented here. For the same reasons given above for CT, initial evaluation by MR may be degraded by patient motion. In addition, CT scanning can accurately demonstrate the presence of a drainable abscess at considerably less cost. However, as more surgeons utilize MR for preoperative evaluation of all types of head and neck disease, MR may become the imaging modality of choice for LA patients whose diagnosis is in question or in whom a drainable abscess is suspected.

In summary, LA is a diffuse, rapidly spreading phlegmonous infection of the soft tissues of the neck and floor of the mouth. It always involves both the sublingual and submandibular spaces. Although its incidence has declined with improvement in dental care, it remains a serious and potentially lethal clinical entity that requires prompt management to avoid serious morbidity or death from airway compromise. The radiologist's role in the clinical management of LA is to evaluate airway narrowing and document the presence of gas-producing organisms, underlying dental abscess and possible drainable neck abscess. The soft-tissue neck radiograph is the initial screening modality and easily demonstrates narrowing of the airway. If an emergency tracheotomy is performed prior to the initial neck radiograph, air dissecting in fascial planes from the tracheotomy procedure may mimic gas-producing infection. CT, which is usually difficult to perform prior to stabilization of the airway, is generally reserved for those patients whose diagnosis is equivocal or in whom an abscess is suspected.

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