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TREATMENT OF DESCENDING NECROTIZING MEDIASTINITIS ASSOCIATED WITH DEEP NECK INFECTIONS: AN ACCOUNT OF THE MOST CURRENT DATA

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ABSTRACT

Deep neck infections (DNIs) are life-threatening diseases that represent the crossroads between maxillofacial surgery and otorhinolaryngology. A DNS has the potential to extend into the mediastinum, where it can trigger a very dangerous disease known as descending necrotizing mediastinitis (DNM), which has a high mortality rate. This article reviews the etiology, bacteriology, clinical manifestations, diagnostic techniques, and management approaches for DNIs and DNM. We emphasize the importance of early diagnosis by imaging studies, such as computed tomography (CT), and a multidisciplinary approach utilizing antibiotics coupled with surgical intervention for the management of these life-threatening diseases.

KEYWORDS: *Deep neck infection, descending necrotizing mediastinitis, diagnosis, multidisciplinary treatment, surgical treatment*

INTRODUCTION

Deep neck infections (DNIs) are significant emergencies that can easily spread to the mediastinum, a complication referred to as descending necrotizing mediastinitis (DNM). The cervical fascial planes play a crucial role in the spread of these DNIs (1,2). Thus, knowledge of the anatomy of these fascial planes is crucial for the successful diagnosis and treatment of DNIs.

DNIs can be caused by odontogenic infections, pharyngitis, salivary gland infections, trauma, or foreign bodies (3-5). These latter infections spread into the mediastinum when they overcome the natural resistance of the fascial planes. Cellulitis, abscess, and phlegmon are different stages of the infection and each has a different management approach (4,5).

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The cervical fascia can be superficial and deep, creating retropharyngeal and parapharyngeal spaces, among others, that may become infected and serve as pathways for the dissemination of infection. Knowledge of such structures is important to the clinicians for the planning of appropriate treatment modalities and preventing further complications (5,6).

DISCUSSION

Etiopathology

Odontogenic and pharyngeal infections are the most common causes of DNIs, though there are other causes too, including trauma, cancer, and iatrogenesis following operations such as endoscopy (7-9). The infection usually extends to the salivary gland, buccal, pharyngeal, and dental mucosa from the initial site by hematogenous or lymphatic routes of dissemination (10,11). The submandibular space is reported to be the most commonly affected space, followed by the parotid and sublingual spaces in many cases (11,12).

DNI usually presents with a mixed bacterial flora comprising both aerobic and anaerobic bacteria (13-15). The most common pathogens found are *Streptococcus viridans* and *Staphylococcus aureus*, but in immunocompromised hosts, like in the case of diabetics, and human immunodeficiency virus (HIV) and cancer patients, *Klebsiella* and other Gram-negative bacteria are also prevalent (16,17). Because these diseases are serious and take root with rapid growth, affected patients must be admitted to a medical facility immediately. DNM is a condition that is present in 3% of DNI cases and comes with a mortality rate of 50%, which is due to inadequate drainage and delayed diagnosis following untreated DNIs (18-21) (Table I).

Table I. *A literature review of the etiological factors of mediastinal involvement of deep neck infection (DNI).*

	Mithos et al. 2007	Roccia et al. 2007	Ridder et al. 2010	Kocher et al. 2012	Celakovsky et al. 2014	Kimura et al. 2020	Gehrke et al. 2022	Ho et al. 2022
Odontogenic	63%	39,1%	11,1%	5,9%	40%	5%	15,56%	38%
Pharyngo-tonsillar	37%	60,9%	46,7%	82,3%	33,5%	33%	55,56%	19,1%
Retropharyngeal abscess	-	-	-	-	-	5 %	-	19,1%
Other	-	-	42%	-	6,5%	18%	28,88%	-
Unknown	-	-	-	11,8%	20%	39%	-	23,8%

Clinical Diagnosis

The most common symptoms of deep throat infections include neck pain and swelling, although fever and odynophagia are frequent in diverse studies (22,23). Otalgia, dysphonia, dysphagia, trismus, and dyspnea are some symptoms that are specific to the affected area. Pain, often dental or swallow-related, is an early symptom. Acute pain and dysphagia occur when the infection is at an advanced stage (24-26). Dysphonia and dyspnea may accompany pharyngeal and laryngeal infections with a sudden decline in the patient's status. More severe cases can also demand tracheotomy because limited mobility and trismus occur as a result of swelling and infiltration of neck tissues. Fever is also commonly present, although immunocompromised patients may show no fever despite significant invasion of tissue (26-28).

It is commonly observed that inadequately treated infections of the cervico-mediastinal may result in serious sequelae like dyspnea, spontaneous fistulization, and mediastinitis. Mediastinum infection produces symptoms such as erythema of the skin, respiratory distress, and toxic-septic shock. Other adverse effects include low oxygen saturation, tachycardia, hypertension or hypotension, and sweating (29,30). If left untreated, many fascial spaces involved in cervical suppuration can result in severe pneumonia, cardiac issues, and renal failure, all of which carry a significant mortality rate.

A physical examination is done by examining the neck and palpating it to observe soreness, edema, and erythema (31,32). A buccopharyngoscopy evaluates the airway, throat, and mouth. The examination can diagnose edema, erythema, and dental problems; the airway can only be evaluated with fiberoptic laryngoscopy. Tracheotomy or cricothyroidotomy may be necessary in severe cases due to the possibility of respiratory arrest, which causes symptoms such as dysphagia,

toxicity, fever, and stiff neck. If the infection extends to the mediastinum, mediastinitis with excruciating chest pain could lead to mortality (32-34).

Symptoms related to infections in the lateral pharyngeal spaces include fever, pain, rigidity, and possibly trismus, depending on the compartment involved. While the posterior compartment has mild swelling, the anterior compartment is infected, producing symptoms of infection and neck pain from muscle spasms. Common systemic manifestations are results of infection of the parotid gland (eg. swelling), while severe ones can include jugular vein thrombosis and erosion of the carotid artery, among others. If left untreated, necrotizing fasciitis is a dangerous infection which can spread along the plane of a tissue and cause tissue death and a sepsis systemically (35-37).

Dysphagia, chest pain, and fever are the early symptoms most frequently encountered in case of perforations from trauma of the crico-pharynx. Other signs such as subcutaneous emphysema, tachycardia, and respiratory distress may be encountered during the clinical examination (38-40). Although the initial symptoms in deep throat infection are moderate, diagnosis management must consider the presence of comorbid conditions such as diabetes, HIV, cancer, and autoimmune diseases. These are the groups of patients with increased risk of serious complications (41-45).

Paraclinical Diagnosis

Laboratory tests include leukocyte count, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and renal function, all of which are very important in delineating the extent of infection and guiding treatment. Imaging techniques are necessary to identify the extent of DNI, especially computed tomography (CT) (45-47). Compared with CT, magnetic resonance imaging (MRI) has the disadvantage of being more expensive and having longer scanning times. However, it yields high-resolution soft tissue images (48-50). CT scans also have their own shortcomings, with a false positive rate of about 10%, and a false negative rate of about 13%. MRI is preferred in complicated cases that might involve vascular abnormalities. Although chest X-rays are useful in the differential diagnosis of conditions like pneumonia and pleural effusion, CT remains the standard when mediastinal involvement is to be reviewed (50,51).

Treatment of Deep Neck Infection (DNI) Associated with Descending Necrotizing Mediastinitis (DNM)

1. *Airway Management*

   One of the major issues in DNI is the acute obstruction of the airways; this is particularly critical when more than one site is involved with the infection (52-54). Many times, tracheotomy or orotracheal intubation is required (55,56). When this is not possible by any of the above methods, emergency cricothyrotomy is the method of choice for securing the airway. Due to the inherent risks involved for the airway, the management of these conditions requires a multidisciplinary team of physicians specializing in ear, nose, and throat (ENT), anesthesia, and critical care (57-60).

2. *Medical Treatment*

   As soon as possible, empirical antibiotic therapy should begin, taking a broad spectrum of bacteria in consideration, until the results of the culture allow for a more focused approach (61-63).

   Generally used regimes include penicillin plus beta-lactamase inhibitors or cephalosporins plus metronidazole or clindamycin for anaerobic coverage. In cases suspected to involve methicillin-resistant *Staphylococcus aureus* (MRSA) or when the patient is immunocompromised, the addition of Vancomycin is suggested (64). Gentamicin is often added to cover for Gram-negative bacteria such as *Klebsiella* in diabetic patients. Dosages of antibiotics are modified once the culture and sensitivity results are available (65).

3. *Directed Antibiotic Therapy*

   Short-term use of steroids is utilized to control airway inflammation and reduce edema (66). Generally, this is not advisable for diabetic patients due to the risk of hyperglycemia. Supportive care treatment in a critical care setting includes oxygen therapy, fluid control, and monitoring (66-68).

4. *Systemic Therapy*

   As soon as possible, empirical antibiotic therapy must begin with a broad spectrum of bacteria in mind, until the results of the culture lead to a narrower approach (61-63).

5. *Surgical Treatment*

   The appropriate surgical intervention in DNIs, which can be life-threatening, requires an understanding of the complex anatomy of the neck spaces (68,69).

The site of infection gives indications about the microorganisms involved and the source of infection, thereby helping aid empirical antibiotic therapy. The extension of infection to many cervical compartments necessitates aggressive surgical draining and debridement. Drainage usually entails incisions in the area of the sternocleidomastoid muscle (64); CT imaging studies are necessary to position the tissues that are involved. If the disease process involves the muscles of the peripharynx or perilarynx, drainage must be very carefully carried out with the fingers (70).

6. Minimally Invasive Surgical Treatment

The role of minimally invasive procedures like drainage and radiologically guided aspiration versus non-surgical treatment remains controversial (70-72).

For patients who have a well-defined unilocular abscess with no compromised airway, the percutaneous echo-guided drainage is a useful treatment modality. Some of the advantages of minimally invasive procedures such as ultrasonography and CT-guided needle aspiration include less scarring and faster healing. This approach is more frequent in cases involving minors (73). However, in adults, if the surgery is delayed longer than two days after admission to the hospital, the morbidity and mortality rate is higher (74-76).

7. Surgical Treatment by External Incisional Approach

The external cervical route is usually followed, especially in deep infections of the retropharyngeal space. Reasons to perform surgery include obstruction to the airway, septicemia, and failure of improvement after 48 hours of antibiotic treatment (77,78). Deep space infections are subjected to surgical drainage from the outside; single-space abscesses are treated with minimum surgery. Tracheal compression causing severe respiratory failure may require tracheotomy with local anesthetic (79-81).

Saline irrigation inhibits infection when the infected areas are left open for investigation and further debridement after the surgery. Extensive incisions and drainage may facilitate the creation of a more favorable site for healing in cellulitis cases which present various spaces. Some authors also propose that independent incisions be carried out only for drainage, as well as tracheotomy, to prevent the extension of infection to the mediastinum (82-84) (Table II).

Table II. *Comparison of Surgical Techniques.*

Technique	Indication	Advantage	Disadvantage
Open Drainage	Multi-space involvement	Thorough exploration	Invasive
Minimally invasive	Single, localized abscess	Faster recovery	Limited application

Multidisciplinary Approach and Complications

The management of DNIs, especially complicated cases or in patients with comorbidities, involves input from experts in ENT, maxillofacial surgery, infectious diseases, radiology, thoracic surgery, and intensive care (84,85). The experts almost all agree that surgical drainage is indicated in the effective management of these infections for the procurement of microbiological samples for further treatment (86,87).

Laryngeal infections can extend to involve the thyroid gland and may require surgical drainage. In Ludwig's angina, securing the airway and commencing antibiotics often requires tracheotomy. If there are no collections noted on a CT, then it is possible to manage this condition with antibiotic therapy alone; otherwise, surgery becomes necessary (87,88).

In cases of lateral pharyngeal infections, drainage is usually performed in order to avoid further complications. Retropharyngeal infections may need a transcervical approach or may require a joint ENT-thoracic team for their surgical management. Such infections tend to extend to vital structures such as the meninges or lungs. Therefore, the mortality rate associated with them can be quite high if there is any delay in management (88-90).

Descending Necrotizing Mediastinitis (DNM)

Failure to drain DNIs may lead to rapid deterioration and sepsis. DNM necessitates urgent multidisciplinary management involving ENT, thoracic surgery, and intensive care specialists. Early interventions, including airway protection and drainage, are critical to reduce complications (90-93). There are various approaches to mediastinal drainage; the video assisted thoracic surgery (VATS) approach is always preferred because it gives a very good view and is minimally traumatic, though at the cost of some risk of pleural contamination (53,93-97) (Table III).

Table III. *Classification and Treatment of Deep Neck Infections (DNIs).*

Type of infection	Description	Treatment
Cellulitis	Inflammation without suppuration	Antibiotics and monitoring
Abscess	Localized suppurative infection	Surgical drainage and antibiotic therapy
Phlegmon	Diffuse infection without boundaries	Surgical drainage and antibiotic therapy

CONCLUSIONS

Most DNI and DNM lesions originate in the otorhinolaryngological (ORL) and oro-maxillofacial (OMF) areas. Mucosal contamination, which is mucosal damage due to endoscopic procedures or orotracheal intubations, results primarily from dental, buccal, pharyngeal, laryngeal, submaxillary, or parotid glandular inflammatory origins but also from iatrogenic sources. A lymphatic or hematogenous route spreads the infection.

Airway evaluation must be performed first, and any sign of respiratory distress or imminent airway compromise must be considered an emergency to be aggressively treated. This is followed by empirical broad range antibiotic treatment, with adjustments based on the reports of bacterial culture and sensitivity. Because of advances in anesthesia, antibiotics, surgery, diagnostic techniques, and intensive care protocols, the death rate among patients with DNI and DNM has been significantly reduced within the past 20 years.

Appropriate intensive and early therapy can be initiated from the findings in CT to prevent the infection from spreading into DNM. This may be followed by a dynamic CT follow-up at 48–72 hours after the initial surgical operation, which may show the need for a secondary procedure to drain any residual abscess or to remove devitalized tissue. When DNM is treated with DNI treatment by a multidisciplinary team, sepsis, death, and major sequelae are reduced.

Author Contributions

Conceptualization, A.M., F.I., A.M.I., D.C. and G.D.; methodology, A.M.I., D.C., G.D., and A.M. software, F.I., G.D., A.M.I., D.C. and A.M.; validation, F.I., A.M.I., G.D., A.M. and D.C. formal analysis, A.D.I., A.M.I., A.M., D.C. and F.I.; investigation, A.M., D.C., A.M.I., F.I. and G.D.; resources, A.M., A.M.I., D.C., F.I. and G.D.; data curation, G.D., D.C., A.M., A.M.I. and F.I.; writing original draft preparation, A.M., A.M.I., D.C. and F.I.; writing review and editing, F.I., A.M., D.C., A.M.I. and G.D.; visualization, D.C., A.M., A.M.I., F.I. and A.M.I.; supervision, G.D, F.I., A.M., A.M.I. and D.C.; project administration, A.M., D.C., F.I., A.M.I. and G.D.. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

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