Descending necrotizing mediastinitis

Advantage of mediastinal drainage with thoracotomy

Descending necrotizing mediastinitis can occur as a complication of oropharyngeal and cervical infections that spread to the mediastinum via the cervical spaces. Delayed diagnosis and inadequate mediastinal drainage through a cervical or minor thoracic approach are the primary causes of a high published mortality rate (near 40 %). Between 1985 and 1992, six men (mean age, 49 years) with descending necrotizing mediastinitis were surgically treated at our institution. The primary oropharyngeal infection was peritonsillar abscess (three cases) and odontogenic abscess (three cases). In all cases, occurrence of respiratory insufficiency associated with serious cervical infection suggested the mediastinitis diagnosis. Computed tomographic scans confirmed the mediastinitis, showing mediastinal abscess and mediastinal emphysema. All patients underwent surgical drainage of the deep neck infection combined with mediastinal drainage through a thoracic approach. The outcome was favorable in five patients who had mediastinal drainage through a thoracotomy; the patient who had mediastinal drainage through a minor thoracic approach (anterior mediastinotomy) died of tracheal fistula on postoperative day 18. In our experience, aggressive mediastinal drainage by a thoracotomy approach regardless of the level of mediastinal involvement led to improvement in survival of these patients, with a 17% mortality rate. (J THORAC CARDIOVASC SURG 1994;107:55-61)

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Acute mediastinitis is a serious infection involving the connective mediastinal tissue that fills the interpleural space and surrounds the median thoracic organs. The most common causes of mediastinitis are esophageal perforation and postoperative infection after operation through a sternotomy incision. Acute mediastinitis occasionally occurs as a complication of oropharyngeal infections resulting in neck sepsis, which spreads to the mediastinum via the cervical fascial planes, and this is best referred to as descending necrotizing mediastinitis (DNM).

Criteria adopted for the diagnosis of DNM were accu-

rately defined by Estrera and associates.¹ Although rare, the diffuse necrotizing variety is a highly lethal disease and the most lethal form of mediastinitis according to Pearse,² who reported a mortality rate of greater than 50% in 21 cases of mediastinitis secondary to oropharynx infections. In a review of this subject, Estrera and associates¹ noted a 40% mortality rate in the postantibiotic era. The diagnosis is usually delayed and made when the sepsis spreads despite cervical drainage. Wheatley, Stirling, and Kirsh³ recently emphasized that in most patients mediastinal transcervical drainage is an inadequate procedure.

We recently reviewed our experience with DNM at our institution in view of defining the optimal surgical treatment, with special reference to the type of mediastinal drainage. Routine use of a thoracotomy in the surgical drainage of the mediastinum allowed us to obtain some encouraging results.

Patients and methods

Between 1985 and 1992, six patients with DNM were treated at our institution and, in all of these cases, the criteria of Estrera and associates¹ were fulfilled. These criteria include (1) clinical manifestation of severe oropharyngeal infection; (2) demonstration of characteristic roentgenographic features of

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Received for publication Feb. 22, 1993.

Accepted for publication April 12, 1993.

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0022-5223/94 \$1.00 + .10 12/1/48796

Table I. Summary of the six patients with DNM

Case No.	Age (yr)	Origin	Diffusion of infection	Surgical drainage	Outcome
1	59	Peritonsillar abscess	Bilateral cervical abscess, anterior mediastinitis, purulent pericarditis, right empyema	Bilateral cervicotomy, anterior mediastinotomy, subxiphoid drainage	Death on day 18, tracheal fistula
2	39	Dental abscess	Right cervical abscess, posterior mediastinal abscess, right empyema	Right cervicotomy, posterior mediastinotomy, right thoracotomy	Doing well 64 months postop.
3	63	Peritonsillar abscess	Bilateral cervical cellulitis, anterior and posterior mediastinitis, right empyema	Bilateral cervicotomy, right thoracotomy	Doing well 50 months postop.
4	43	Peritonsillar abscess	Bilateral cervical cellulitis, jugular vein thrombosis, thyroid necrosis, anterior and posterior mediastinitis, bilateral empyema	Bilateral cervicotomy, right thoracotomy	Doing well 32 months postop.
5	51	Dental abscess	Right cervical abscess, anterior and posterior mediastinitis, right empyema	Right cervicotomy, right thoracotomy	Doing well 17 months postop.
6	40	Dental abscess	Left cervical abscess, anterior mediastinitis, bilateral empyema, purulent pericarditis	Bilateral cervicotomy, right thoracotomy, second thoracotomy on postop. day 7	Doing well 6 months postop.

mediastinitis; (3) documentation of the necrotizing mediastinal infection at operation or postmortem examination or both; and (4) establishment of the relationship of oropharyngeal infection with the development of the necrotizing mediastinal process.

The patients included six men, with an age range of 39 years to 63 years (mean: 49 years). The primary oropharyngeal infection was peritonsillar abscess in three cases and odontogenic abscess in three cases. All patients had received antibiotic therapy, which was modified four times in one case, twice in one case, and once in another. In three patients the antibiotic therapy was associated with corticotherapy. Two of our patients were alcoholic and had a history of heavy smoking; another patient had diabetes and a chronic obstructive pulmonary disease. The delay between onset of primary infection and hospitalization varied from 5 to 15 days (mean: 8 days). Preoperative and postoperative cervicothoracic computed tomographic (CT) scanning was performed in all patients.

In each case, surgical treatment consisted of one or several cervical drainages followed by drainage of the mediastinum through a thoracic approach. Open drainage of the mediastinum was performed with multiple (four to six) large-bore chest

tubes (Argyle 28 or 32; Sherwood Medical Company, St. Louis, Mo.) that allowed irrigation with 0.5 povidone-iodine solution instilled through an ingress tube at a rate of 150 to 200 ml per hour and aspirated from the egress tubes by continuous suction. The duration of irrigation and drainage was dependent on clinical evolution, return to a normal CT scanning aspect, and results of the cultures of fluids aspirated from the mediastinal tubes after 24 hours of sterile serum saline irrigation.

Results

Diagnosis. The delay between hospitalization and diagnosis varied from 1 day to 5 days (mean: 2.6 days). Diagnosis of cervical infection was clinically obvious, inasmuch as the physical examination revealed a diffuse painful cervical swelling in all cases, with subcutaneous emphysema in four patients. In all patients, occurrence of respiratory insufficiency (dyspnea and hypoxia) with increasing infectious symptoms suggested a mediastinitis

diagnosis. Chest roentgenograms showed a widening of the mediastinal shadow associated with pneumomediastinum in three patients. In each case the CT scan confirmed the DNM diagnosis, displaying mediastinal abscesses with air-fluid level or mediastinal emphysema, or both.

Surgical drainage. Operative findings and surgical procedures are described in Table I. The duration of mediastinal drainage varied from 13 to 25 days (mean: 16 days).

Bacteriologic results. In all cases, bacteriologic features revealed polymicrobial infection, with mixed aerobic and anaerobic organisms in five patients.

The microbiologic features are summarized in Table II. The most frequent isolated organisms were *Staphylococcus*, aerobic streptococci, *Pseudomonas aeruginosa*, and *Bacteroides*.

Outcome. The first patient in our series who had mediastinal drainage through a minor thoracic approach (anterior mediastinotomy) without thoracotomy died on postoperative day 18 of tracheal fistula and respiratory distress syndrome. Another patient (case 2) insufficiently treated through a posterior mediastinotomy was reoperated on 20 days after operation and new mediastinal drainage was performed through posterolateral thoracotomy. In the latter patient (case 6), further mediastinal drainage through a second thoracotomy was performed on postoperative day 7 because the patient remained febrile and the CT scan control showed persistence of anterior mediastinitis.

The outcome was favorable in five patients, who were discharged without major sequelae (Table I). Control thoracic CT scans done before discharge were normal. Hospitalization (first case excluded) varied from 63 to 157 days (mean: 89 days). The five surviving patients were doing well 6, 17, 32, 50, and 64 months postoperatively. The mortality rate in this series was 16.5%.

Literature review and comment

DNM is an uncommon clinical entity in the suppurative mediastinitis group in which the most frequent underlying cause is esophageal perforation. In a literature review, Wheatley, Stirling, and Kirsh³ reported only 43 cases of DNM since 1960. In the preantibiotic era, Pearse² recorded 100 patients with mediastinitis from descending cervical infection among which 21 cases were secondary to oropharyngeal infection. DNM diagnosis implies that the criteria of Estrera and associates¹ are fulfilled and the relationship between mediastinitis and oropharyngeal infection are clearly established.

Knowledge of the cervical fascial planes is essential in the understanding of propagation pathways, symptoms, and thoracic complications of cervical infections.⁴ The

Table II. Microbiologic features in patients with DNM

Case No.	Aerobes	Anaerobes
1	<i>Streptococcus salivarius</i> <i>Staphylococcus aureus</i> * <i>Pseudomonas aeruginosa</i> <i>Enterobacter</i> spp., <i>Acinetobacter</i> spp.*	<i>Fusobacterium</i> <i>Veillonella</i>
2	<i>Staphylococcus epidermidis</i> ,* Streptococci <i>Serratia marcescens</i> , <i>Escherichia coli</i>	
3	<i>Staphylococcus aureus</i>	<i>Bacteroides melaninogenicus</i>
4	<i>Pseudomonas aeruginosa</i> <i>Streptococcus milleri</i>	<i>Bacteroides melaninogenicus</i>
5	<i>Enterobacter</i> spp.,* <i>Pseudomonas aeruginosa</i> <i>Staphylococcus epidermidis</i> *	<i>Bacteroides intermedius</i>
6	Streptococci <i>Enterobacter</i> spp., <i>Escherichia coli</i> <i>Pseudomonas aeruginosa</i> <i>Staphylococcus epidermidis</i> *	Anaerobic gram-positive rods (not identified)
	<i>Streptococcus milleri</i> <i>Enterococcus</i> , <i>Serratia marcescens</i> <i>Pseudomonas aeruginosa</i> , <i>Acinetobacter</i> spp.	

From materials obtained from the neck, pleura, mediastinum, pericardium, and blood.

*From blood cultures.

clinically potential spaces in the neck are divided into three sections on the basis of their relationship to the hyoid bone (Figs. 1 and 2).

Spaces involving the entire length of the neck

The retropharyngeal space or retrovisceral space, limited anteriorly by the middle layer of the deep cervical fascia and alar fascia posteriorly (deep layer of the deep cervical fascia), lies behind the hypopharynx and esophagus from the base of the skull to the superior mediastinum. This space is a main route for the spread of oropharyngeal infections to the mediastinum. Infections of the retropharyngeal space are dangerous because its relationships allow great potential expansion (Fig. 3), especially directly to the anterior and posterior part of the superior mediastinum.

The dangerous space between the alar and prevertebral layers of the deep cervical fascia extends from the base of the skull into the posterior mediastinum to the dia-

Fig. 1. 1, Anterior visceral space; 2, retropharyngeal space; 3, danger space.

phragm. Infections of this space are often the result of extension from a retropharyngeal space abscess or from a lateropharyngeal space abscess and may descend directly in the posterior mediastinum to the diaphragm level.

The visceral vascular space is located within the carotid sheath, which is connected to the three layers of the deep cervical fascia and therefore can be involved in neck infections regardless of the origin. However, infections of this space rarely tend to travel down the carotid sheath to the mediastinum and usually remain localized. Infections of vascular space occasionally result in serious complications such as thrombosis of the internal jugular vein or erosion of the carotid artery.

Spaces limited to above the hyoid bone

Submandibular space infections are most often from dental or periodontal origin. Extension of the sepsis results in cellulitis of the floor of the mouth (Ludwig's angina).

The lateral pharyngeal space (pharyngomaxillary space) communicates with several spaces in the neck (submandibular, retropharyngeal space, parotid and masticator space, carotid sheath) and is commonly involved in infections of the pharynx, teeth, tonsils, or parotid.

The masticator space is commonly infected by an abscess arising from the third molar teeth.

The parotid space communicates directly with the lateral pharyngeal space and danger space; this relationship explains the potential seriousness of parotids.

Spaces limited to below the hyoid bone

The anterior visceral space (pretracheal space) is the anterior part of the visceral compartment and lies in continuity with the posterior part, which is the retropharyngeal space. This space extends from the hyoid bone superiorly to the anterior portion of the mediastinum inferiorly, surrounds the trachea, and lies against the anterior wall of the esophagus. Infections involving this space are always secondary to tracheal perforation, esophageal disruption, or hypopharynx trauma and may result in extension into the mediastinum. Attachment of the pretracheal fascia on the pericardium and parietal pleura explains the occurrence of pericarditis and empyema associated with mediastinitis.

Any cervical infection may potentially result in DNM because virulent bacteria can spread through or along the cervical fascias. Moncada, Warphea, and Pickelman⁵ noted that 70% of cervical infections extend into the mediastinum via the retropharyngeal space. Gravity, breathing, and negative intrathoracic pressure increase the spread of infection downward. In the review reported by Wheatley, Stirling, and Kirsh,³ the most common primary oropharyngeal infection was odontogenic (25 of 43 cases) with mandibular second or third molar abscess. There is a marked male predominance in DNM. The group of 43 patients reported by Wheatley, Stirling, and Kirsh³ consisted of 32 men and 9 women, and all patients in our series were male. The patient's medical condition often explains the rapidity of the spread of infection, because most patients have impaired immune status and the mediastinitis develops from a common oropharyngeal infection. In our series, many changes in the initial antibiotic therapy and associated corticotherapy almost certainly increased the risk of diffusion of the infection.

Delay of diagnosis is one of the primary reasons for high mortality in DNM. The diagnosis of cervical abscess or cellulitis is clinically obvious, especially if associated with crepitus. Diagnosis of DNM must be suspected clinically with the occurrence of respiratory symptoms such as chest pain, dyspnea, or respiratory distress. Chest x-ray films usually demonstrate widening of the superior mediastinal shadow, a pneumomediastinum, or an abscess that obliterates the retrosternal or retrocardiac clarity, but often these findings appear too late in the course of the disease. In addition, previous drainage procedures, tracheostomy, and technical conditions of intensive care make interpretation of the results difficult.⁶

CT scanning is useful for early diagnosis of DNM showing soft-tissue infiltration with loss of the normal fat planes that surround the mediastinal structures and collection of fluid density revealing clear mediastinal abscess with or without the presence of gas bubbles (Figs. 3 and

Fig. 2. 1, Visceral fascia (surrounding thyroid gland, trachea, and esophagus); 2, posterior visceral space (or retropharyngeal space); 3, carotid sheath; 4, anterior visceral space; 5, danger space.

Fig. 3. Chest CT scan showing gas collections involving anterior, middle, and posterior compartments of mediastinum.

4). Preoperative cervicothoracic CT scanning provides accurate information on the extent of the necrotizing process and determines the optimal thoracic approach for efficient surgical drainage.⁷ Postoperatively, the CT scan is a useful tool in follow-up for assessing the duration of irrigation or drainage or the time for possible reoperation. The last patient of this series remained febrile despite the fact that a first surgical drainage and control CT scan showed persistent anterior mediastinitis, which required

further mediastinal drainage through a second thoracotomy on postoperative day 7. We do not report any cases of rapid unfavorable outcome, as in the review of Wheatley, Stirling, and Kirsh,³ who noted 6 of 43 cases that resulted in fulminant course and death before treatment, with the diagnosis being made by postmortem examination.

Most of these infections are polymicrobial and mixed, caused by a combination of aerobic and anaerobic orga-

Fig. 4. CT scan disclosing large mediastinal abscess in right paratracheal area and presence of mediastinal emphysema in upper and anterior mediastinum.

nisms reflecting the oropharyngeal flora. In the experience of Chow, Roser, and Brady,⁸ anaerobes were recovered from 94% of patients, 52% of patients had mixed infections, and 88% had polymicrobial infections. In neck infections, Wills and Vernon⁹ reported an average of three or four different anaerobic organisms in the same culture. In the review of Wheatley, Stirling, and Kirsh,³ 30 of the 43 patients had mixed infections. Estrera and associates¹ reported that the most common anaerobes are *Streptococcus anaerobius*, *Bacteroides*, and *Fusobacterium*. In our experience, *Bacteroides* were the most frequent anaerobic organism (three cases) and *Staphylococcus* (five cases), aerobic streptococci (five cases), and *Pseudomonas* (five cases) were the most frequently isolated aerobic germs. Economopoulos, Scherzer, and Gryboski,¹⁰ Stone and Martin,¹¹ and Estrera and associates¹ emphasized the symbiosis between anaerobic and gram-negative aerobic bacteria that results in increased virulence and spreading of infection, leading to a fulminant necrotizing process. Alteration of redox potential by aerobic function and development in a closed, contained space along fascias of the neck and chest provide an excellent milieu for germ growth, especially anaerobes. The polymicrobial symbiotic infection must be treated rapidly by antibiotic combination therapy, without waiting for the results of culture and sensitivity studies; the treatment can then be changed later according to the results of the antibiotic sensitivity studies.

Antibiotic therapy alone is inadequate and the mainstay of treatment is aggressive surgical drainage through cervical and thoracic approaches. The neck is usually approached through an incision anterior to the sternomastoid muscle and the involved cervical spaces are opened, drained, and débrided of necrotic tissue. The anterior mediastinum can be entered transcervically through the pretracheal space and opened by blunt finger dissection to the level of the tracheal bifurcation; the posterior mediastinum is entered by extending the dissection of the retropharyngeal space downward. This transcervical mediastinal drainage is the most commonly used approach in DNM.² Drainage of the mediastinum can also be done through a minor thoracic approach (in addition to cervical drainage) on the basis of the predominance of the infection determined from CT scan findings. Anterior mediastinotomy (using a parasternal extrapleural incision) in combination with subxiphoid drainage (allowing blunt retrosternal manual dissection) may, in some cases, provide adequate drainage when mediastinitis predominantly involves the anterior mediastinum. Posterior mediastinal abscess can be drained through a posterior mediastinotomy using extrapleural dissection. Standard posterolateral thoracotomy has the main advantage of providing a good approach to all compartments of the mediastinum, the pleural cavity, and the pericardium; all mediastinal spaces can be widely opened from the upper chest to the diaphragm.

Various authors^{2, 3, 12, 13} state that the optimal surgical approach for mediastinal drainage in patients with DNM is dependent on the level of diffusion of the necrotizing process. If infection involves only the superior mediastinum above the level of the carina, standard transcervical mediastinal drainage may be adequate. In more extensive processes, patients are best treated by subxiphoid or thoracic incision. Estrera and associates¹ stated that if the mediastinitis spreads below the tracheal bifurcation anteriorly or the fourth thoracic vertebra posteriorly mediastinal drainage is best accomplished through a transthoracic approach. In our opinion, adequate mediastinal drainage in DNM requires a more aggressive surgical procedure that systematically includes a transthoracic approach through a standard thoracotomy, regardless of the level of involvement into the mediastinum. In our study, two patients had drainage through a minor thoracic approach (parasternal and subxiphoid incision in one case, posterior mediastinotomy in the other case). The first died on postoperative day 18 of tracheal fistula and the second underwent new drainage through a thoracotomy on postoperative day 20 because the initial procedure was inadequate. Thoracotomy provides easier access to all mediastinal compartments, allowing radical surgical débridement and complete excision of tissue necrosis and drainage of the pericardial and pleural cavities. Moreover, thoracotomy allows suitable positioning of multiple large-bore chest tubes for mediastinopleural irrigation, which provides a better balance between irrigation and aspiration and avoids accumulation of fluids in the chest.

Despite the progress in antibiotic therapy and the increased use of CT scanning in patients with serious cervical infections, the mortality rate of DNM remains very high, nearly 40%.^{1-3, 6, 12, 14-16} Inadequate drainage procedures are main factors contributing to this high mortality, because transcervical mediastinal drainage, the most commonly used procedure, is inappropriate in DNM. The other minor thoracic approaches (mediastinotomy, subxiphoid drainage) provide a confined access that excludes extensive débridement and wide irrigation. Pleural contamination caused by transpleural drainage through a standard thoracotomy³ is not, in our opinion, a real disadvantage because empyema is often associated with mediastinitis (all patients in our series) and thoracotomy also allows irrigation of the pleural cavity. Trans-thoracotomy mediastinal drainage must first be performed without attempting transcervical drainage alone,¹³ because this could delay more crucial operations, leading to fatal complications such as irreversible multiple injuries or vessel erosion with exsanguination. In our experience, this aggressive surgical therapy provided improved results with an 83% survival rate.

Delayed diagnosis and inadequate surgical drainage are the primary causes of lethal DNM. At present, CT scanning is a valuable tool for early diagnosis of DNM and we agree with the recommendation of Estrera and associates¹ for its routine use in all patients with deep neck infections to determine the presence of mediastinal involvement. Improved survival of patients with DNM implies early and radical surgical drainage via a cervical and thoracic approach including thoracotomy.

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