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Drainage of Severe Descending Mediastinitis: 5-Year Experience in a Single Tertiary Institution

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ABSTRACT

Objective: Descending necrotizing mediastinitis is caused by the spread of the infection to the mediastinum from the deep and superficial cervical fascial planes. Surgical drainage of severe descending necrotizing mediastinitis was done through an invasive transthoracic and transcervical approach. In this study, we described a series of severe descending necrotizing mediastinitis treated with the only transcervical approach with or without vacuum-assisted dressing.

Methods: A retrospective, single-institution study was performed to evaluate the outcome of patients with descending necrotizing mediastinitis managed from June 2015 until March 2020.

Results: A total of 5 patients were identified. All subjects underwent transcervical drainage of descending necrotizing mediastinitis. Vacuum-assisted dressing was applied to 3 patients.

One subject belonged to type I, and there were 2 each for type IIa and IIb according to Endo et al's3 computed tomography classification. All patients survived with only transcervical drainage, without the invasive transthoracic approach. The mean duration from the time of admission to surgical drainage was 10.3 hours. The mean length of the vacuum-assisted dressing application was 11 days. All patients were discharged from the hospital, with complete resolution of disease.

Conclusion: Less invasive transcervical drainage may be adequate in treating severe descending necrotizing mediastinitis, as long as early treatment is recognized and initiated. Incorporating vacuum-assisted dressing in the treatment course may open the door for a new algorithm.

Keywords: Case series, deep neck space infection, descending mediastinitis, transcervical, vacuum-assisted dressing

Introduction

Deep neck space infection is a common, serious, and potentially life-threatening disease with a mortality rate as high as 40%.[1,2] Frequently, it gives rise to multiple complications such as airway obstruction, venous thrombosis, and sepsis if not identified early. Descending necrotizing mediastinitis (DNM) is a rare complication due to the spread of the infection to the mediastinum from the deep and superficial cervical fascial planes, most commonly from an oropharyngeal or odontogenic focus. It is a rapidly progressive condition that must be identified early for urgent intervention.

Traditionally, surgical drainage of severe DNM was through an invasive transthoracic and transcervical approach. Here, we present the effectiveness of treating severe DNM via minimally invasive techniques (transcervical drainage with or without vacuum dressing) over the past 5 years in a single institution. We describe the steps of applying the vacuum-assisted closure(VAC) dressing after the drainage procedure and the current intervention outcome.

Methods

A retrospective, single-institution study was performed to evaluate the outcome of patients with DNM managed surgically over 5 years, from June 2015 until March 2020. A total of 5 patients were identified from the hospital database who met the inclusion criteria for DNM as established by Estrera et al.[2] which includes: (1) clinical manifestation of severe oropharyngeal infection, (2) demonstration of characteristic radiographic features of mediastinitis, (3) documentation of necrotizing mediastinal infection at operation or postmortem examination, and (4) establishment of a relationship between oropharyngeal infection and development of the necrotizing mediastinal process.

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Medical charts were carefully reviewed to obtain patients' demographic data, symptoms, and clinical findings at presentation, the primary source of infection, bacteriological findings, radiological features, the interval between diagnosis and operation, operative records, hospital course, morbidity, and mortality. The anatomical extent of infection and DNM was classified according to Endo et al[3]: type I, infection localized to the upper mediastinum above the tracheal bifurcation (localized form) and type II, diffuse infection below the tracheal bifurcation (diffuse form). Type II is further subclassified: type IIA, infection of the lower anterior mediastinum and type IIB, infection of the anterior and posterior lower mediastinum.[3] The institutional review board of University Malaya approved the study, IRB 20201025-9163. Written informed consent was obtained from the patients who agreed to take part in the study.

Surgical Drainage Procedure

Preoperatively, patients were given empirical intravenous antibiotics as soon as DNM was suspected, and subsequently, treatment was altered according to bacteriological culture and sensitivity test result. All subjects underwent transcervical drainage of DNM under general anesthesia. The neck incision anterior to the sternocleidomastoid muscle of the involved side(s) was approached. The involved cervical spaces (superficial and deep spaces included peritonsillar, parapharyngeal, and retropharyngeal) were opened, drained, and debrided of necrotic tissue. Intraoperative swabs and surgical site tissue samples were sent for bacteriological culture.

Postoperative Care

Vacuum-assisted closure dressing was applied to selected patients without contraindications, which included an absence of coagulopathy and fully conscious patient. Vacuum-assisted closuredressing was applied with continuous negative pressure of 120 mmHg, and it was changed every 48 hours, or earlier if the foam was soaked. Vacuum-assisted closure dressing was withheld when the pus drainage was less than 20 mL over 24 hours. After primary surgery, a follow-up computed tomography (CT) scan was performed after 48 hours to assess the adequacy of therapy.

In cases of clinical deterioration with residual or worsening abscess formation, confirmed by CT scan, further surgical drainage through the same incision was performed.

Main Points

- Descending necrotizing mediastinitis (DNM) is a rare complication and is rapidly fatal if not treated early.
- Prompt recognition of the mediastinal involvement can be challenging due to vague clinical signs and symptoms, compared to more noticeable signs at the cervical region.
- Computed tomography (CT) has become an integral part of DNM management and has been a reliable diagnostic tool for early detection.
- Traditionally, surgical drainage of severe DNM was through an invasive transthoracic and
- transcervical approach. Less invasive transcervical alone drainage may be adequate in treating severe DNM, as long as early treatment is recognized and initiated.

A routine wound care dressing using diluted povidone and saline water was done daily for those without VAC or after weaning off VAC.

Results

Our study comprises of 3 males and 2 females. All subjects underwent transcervical only drainage, and VAC was applied in 3 of the selected patients. Delay between the onset of primary infection to hospitalization was between 3 and 5 days (mean: 4 days).

As shown in Table 1, the mean age of our study population was 60.4 years, ranging from 53 to 69 years old. Most of the subjects (80%) had comorbidities such as end-stage renal failure, diabetes mellitus, stroke, and hypertension, and all of them presented to us with features of systemic sepsis, in addition to neck swelling and dysphagia. Other features included fever and odynophagia. Based on the CT diagnosis, 1 subject belonged to type I, and there were 2 each for type IIa and IIb of Endo et al's[3] CT classification [Figure 1-3]. All of our subjects survived the DNM with only transcervical drainage. Three of them needed tracheostomy during the first surgical intervention because of severe airway edema and obstruction. The mean duration from the time of admission to the emergency department to surgical drainage was 10.3 hours. Sixty percent of them had odontogenic foci identified as the source of infection, while the other 2 had quinsy and cervical skin necrotizing fasciitis.

The characteristics, treatment course, and outcome of patients with DNM are listed in Table 2. Three patients were selected for VAC dressing [Figure 4], while 2 other subjects were excluded from VAC due to the presence of contraindications, such as stroke and antiplatelet medication. We considered stroke as a contraindication as the subject might not be able to call for help in time in case complications happen. Case 5 suffered from wound edge hemorrhage likely due to antiplatelet, and bleeding was controlled in the operation theatre with the cessation of aspirin. There were no major VAC-related complications reported. The mean length of the VAC application was 11 days. None of our cohorts required re-exploration and drainage.

The average duration of intensive care unit (ICU) and hospital stay was 7.8 and 38.6 days, respectively. In this study, bacterial isolates found were mainly polymicrobial, included *Streptococcus constellatus* (2 subjects), *Klebsiella* sp. (2 subjects), *Pseudomonas* sp. (1), and *Bacteroides* sp. (1).

A combination of empirical antibiotics used in this situation included piperacillin–tazobactam, ceftazidime, co-amoxiclav, meropenem, cefuroxime, and clindamycin. The mean duration of inpatient and outpatient antibiotic usage was 31.7 and 14.8 days, respectively. During the treatment course, all subjects encountered systemic complications such as pneumonia (3), acute kidney failure (2), pleural and pericardial effusion (2), and hematoma (1). All patients are back to their pre-morbid status after discharge from the hospital, with complete resolution of disease evidenced by CT. Furthermore, all 3 patients with tracheostomy are decannulated successfully.

Table 1. The Clinical Characteristics of Patients with DNM

Patients' demographic Age (mean, range (years)) Sex (male: female)	60.4 (53-69) 3:2
Risk factors (n) Diabetes mellitus Hypertension ESRF Ceberal stroke Nil	3 3 1 1 1
Presentation (n, %) Neck swelling Odynophagia Dysphagia Fever	5 (100) 2 (40) 5 (100) 2 (40)
Source of infection (n) Odontogenic Quincy Neck skin necrotizing fasciitis	3 1 1
Mean time from admission to surgical drainage (hours, range)	10.3 (6-13.5)
Severity of DNM (Endo's classification, n) Type I Type IIa Type IIb	1 2 2
Tracheostomy (n, %)	3 (60)
Mean ICU stay (days, range)	7.8 (2-12)
Mean hospital stay (days)	38.6 (22-52)
Revision cervical drainage (n, %)	2 (40)
Inpatient intravenous antibiotic regime (n) Piperacillin–tazobactam Augmentin Ceftazidime Meropenem Clindamycin	4 3 1 1 3
Outpatient antibiotic regime (n) Cefuroxime Augmentin Clindamycin	2 3 3
Mean duration of inpatient antibiotics (days)	31.7
Mean duration of outpatient antibiotics (days)	14.8
Vacuum dressing therapy Number of subjects (n) Mean duration of usage (days) Complications (n)	3 11 (5-14) 1*

ESRF, end-stage renal failure; DNM, descending mediastinitis; ICU, intensive care unit.
*Bleeding from wound edges.

Discussion

Descending necrotizing mediastinitis is a rare subset but a severe form of mediastinitis, which has a rapid course and high lethality rate. The term "descending" implies the infection and inflammation that start from head and neck source, commonly odontogenic or pharyngeal foci.[1] Other direct or predisposing causes such as penetrating neck trauma, foreign body ingestion, and immunocompromised states secondary to uncontrolled diabetes, chemotherapy, or long-term systemic steroid are less common.[4,5] Recent review by Prado-Calleros et al[6] showed an increasing tendency of pharyngeal foci such as

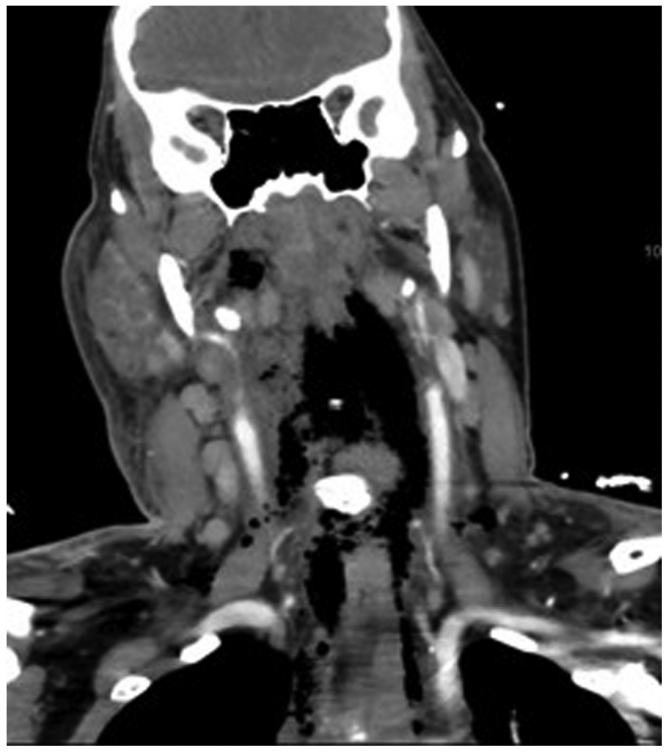

Figure 1. CT imaging of type I Endo's classification DNM (coronal). CT, computed tomography; DNM, descending necrotizing mediastinitis.

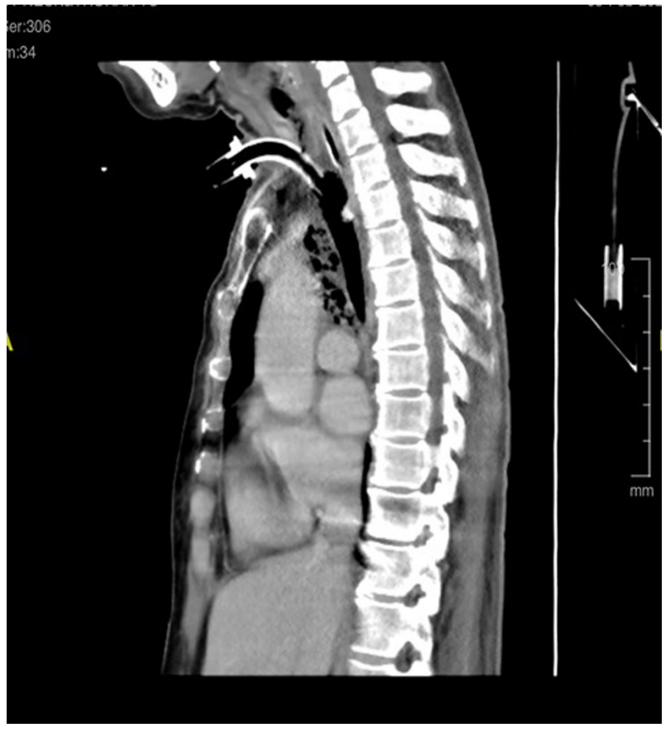

Figure 2. CT imaging of type IIa DNM (saggital). CT, computed tomography; DNM, descending necrotizing mediastinitis.

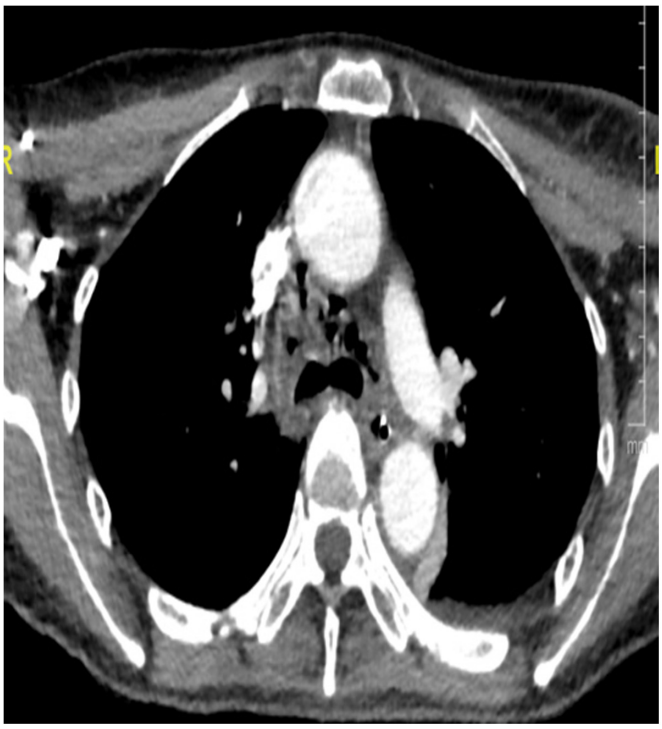

Figure 3. CT imaging of type IIb DNM, where the infection extended beyond tracheal bifurcation (axial). CT, computed tomography; DNM, descending necrotizing mediastinitis.

retropharyngeal, peritonsillar abscess which later led to DNM.[6] In our series, odontogenic infection constituted the primary source of infection.

The cervical involvement of DNM is relatively easy to be recognized from the noticeable clinical features such as edema, erythema, and tenderness around the neck region. Unfortunately, prompt recognition of the mediastinal involvement can be challenging due to vague clinical signs and symptoms. In many of these cases, infection is clinically silent, and symptoms may be masked by the use of analgesics and over-the-counter antibiotics, therefore leading to a diagnostic delay and management of DNM, causing the disease to progress into fulminant systemic sepsis rapidly, and this has been recognized as a poor prognostic factor.[2] None of our patients presented with classical clinical features of DNM that includes subcostal pain, pleuritic chest pain, features of pleural effusion or pericardial effusion.

Since the delay in diagnosis is a primary factor contributing to mortality, early cervicothoracic CT has become an integral part of DNM management. It has been proven to be a reliable diagnostic tool for the early detection of DNM (sensitivity, 100% and specificity, 90%) and established the diagnosis more consistently than the clinical suspicion and conventional radiographs.[7]

Brunelli et al[8] found cervicothoracic CT imaging to be diagnostic in all patients in whom it was used, while Yang et al[9] also

Table 2. The Characteristics, Treatment Course, and Outcome

	Case 1	Case 2	Case 3	Case 4	Case 5
Age/gender	**62/M**	**58/F**	**53/M**	**60/M**	**69/F**
Premorbidities	HTN, ESRF	None	HTN, DM, CVA	DM	DM, HTN
Presenting symptoms	Neck swelling, dysphagia, hoarseness	Neck swelling, dysphagia, hoarseness, trismus	Neck swelling, dysphagia, hoarseness, trismus	Neck swelling, fever, hoarseness, dysphagia	Neck swelling, fever, dysphagia
Origin of infection	Right peritonsillar abscess	Odontogenic	Odontogenic	Anterior neck skin necrotizing fasciitis	Odontogenic
Extension of infection (Endo's classification)	Type I	Type IIb	Type IIb	Type IIa	Type IIa
Drainage approach	Transcervical	Transcervical	Transcervical	Transcervical	Transcervical
Wound management, duration (days)	Daily washout, 22	Vac dressing, 14	Daily washout, 40	Vac dressing, 14	Vac dressing, 5
Duration of hospital stay (days)	22	36	52	45	38
ICU stay (days)	10	2	12	10	5
Tracheostomy	Not done	Done	Done	Not done	Done
Re-operation	No	No	Yes	No	Yes
Complications during hospital stay, after drainage	Pneumonia	Pericardial and pleural effusion, pneumonia	AKF	Mild pleural and pericardial effusion	AKF, pneumonia, hematoma from wound after vacuum started
Outcome	Alive, back to premorbid	Alive, back to premorbid, decannulated	Alive, on tracheostomy tube, back to premorbid	Alive, back to premorbid	Alive, back to premorbid, decannulated

AKF, acute kidney failure; Vac, vacuum; HTN, hypertension; ESRF, end-stage renal failure; DM, diabetes mellitus; CVA, cardiovascular accident.

Figure 4. Image shows a vacuum dressing applied through the tracheostomy tube.

found that contrast-enhanced cervicothoracic CT imaging delivered the most timely and accurate information on DNM.[8,9]

Hence, some authors recommended routine application of CT of the neck and thorax in deep neck space infection in order not to miss the diagnosis of DNM.[10,11] We routinely included the coverage of CT till thorax when the lower extent of the inflammatory process progressed beyond the suprasternal notch. Additionally, a CT scan is a useful tool in assessing the response of DNM from both medical and surgical treatment.

Treatment of DNM involves multidisciplinary teams of oto-rhinolaryngologists, cardiothoracic surgeons, infectious disease and medical physicians, anesthetists, and intensivists. Prolonged ICU stay and hospitalization are the rules for DNM, even with the advances of antibiotics and aggressive surgical drainage. Surgical intervention remains the mainstay of treatment in severe and complicated deep neck space infections. Although multiple surgical approaches had been described in managing DNM, the best approach used for most successful drainage is still controversial. Corsten et al[12] reported that the survival rate of patients who underwent combined transcervical and transthoracic drainage (47%) was significantly higher than those who underwent transcervical incision alone (19%).[12] In a recent review in 2016, Prado Calleros et al[6] pointed out that transcervical drainage may be sufficient for DNM limited to upper mediastinum (Endo type I). In cases of advanced disease (Endo type II), extended below the tracheal carina, a more aggressive surgical approach via thoracotomy combined with transcervical debridement allows to achieve low morbidity, a low mortality rate, and less reoperation rate.[6]

Comparatively, this method is more invasive and carries higher morbidity and mortality due to its risk of injury to thoracic organs.[14] Thus far, there are no guidelines with a high level of evidence (above level III) on the treatment of DNM, and the best was from systemic review dated more than 5 years ago.[4,15,16]

As a comparison to a recent study from our neighboring country, our result was superior in terms of the length of ICU and hospital stay, where we recorded as 7.8 days (vs. 26.4 days) and 38.6 days (46.7 days), respectively. All their subjects with DNM underwent combined surgical drainage. Their mortality was reported at 20%. Our superior results might be possibly explained by the relatively earlier presentation of our subjects to the hospital, which was at 4 days as compared to 9.4 days in their study.[17] We believed that the earlier the subjects present themselves to health care facilities, the better the chance for them to be treated in time, to avoid missing the golden hours of sepsis treatment. It is difficult to make the matched comparison since some of our patients had VAC dressing which could be a confounding factor.

Furthermore, the counterpart study did not classify the severity of DNM, according to Endo et al's[3] classification. Randomized control trials on this life-threatening illness are not feasible. Hence, because of individual practitioners' (where transcervical drainage was the routine first-line practice by our cardiothoracic counterpart) and patients' cultural background bias (patients' refusal for transthoracic drainage), our patients in this study were purely managed via transcervical drainage. Yet, all our subjects survived the fulminant illness.

In our report, we also described the adjunctive usage of a VAC dressing in the successful management of severe DNM with both involvements of the superior and inferior mediastinum. Vacuum-assisted closure dressing helps to remove inflammatory exudates by creating a negative pressure environment at the wound, where it promotes granulation.[18,19] This pressure is higher compared to a conventional drainage tube and hence counteracts the existing intrathoracic negative pressure. As a result, there have been many successful examples of wound management from the use of VAC dressing for post-sternotomy mediastinitis.[20]

Vacuum-assisted closure dressing has also been tested in pharyngocutaneous fistulas after total laryngectomy and in head and neck wounds with promising results by Dhir et al.[21] The negative pressure applied was between –110 and –175 mmHg based on literature review.[19,21]

We reported a successful VAC dressing for an Endo type IIa DNM in 2016, and this current study is a follow up with more successful examples of VAC dressing in severe DNM in our institution, without necessitating transthoracic drainage.[22] Based on our experience in VAC, we abandoned it in case 5 due to excessive bleeding from wound edges, and it was believed to be associated with antiplatelet she was on. The same reason precluded the use of VAC in case 1 as well. Underlying stroke without full consciousness, as in case 3, may not allow the subject to present himself on time when complications occurred. Therefore, VAC must be carefully used in selected patients to avoid devastating complications. The above points mentioned add to the existing contraindications of VAC included the application on ischemic tissues, exposed major vasculature, fragile skin, malignancy, and those with skin allergy to the adhesive.[23] We did not encounter any significant VAC-related complications thus far.

In addition to surgical drainage, broad-spectrum intravenous antibiotics must be installed as part of treatment, against aerobic and anaerobic organisms. Close monitoring of the function of vital organs in an intensive care setting is of extreme importance. In a recent review, a third-generation cephalosporin with metronidazole or a combination of piperacillin–tazobactam was suggested. A long course of treatment between 14 and 21 days was recommended.[24] This similarity was observed in our study, where piperacillin–tazobactam was used most frequently. Clindamycin was used instead of metronidazole to cover for anaerobic microorganisms. Our mean duration of both inpatient and outpatient antibiotic usage was 46.5 days, which was more than double the timeline suggested by the previous review. It could be explained by the fact that most of our subjects had a severe type of DNM involving both superior and inferior mediastinum, and they were addressed with only transcervical surgical drainage. The mixed aerobic and anaerobic microorganism was commonly isolated from DNM. The commonest are *Streptococci, Fusobacterium, Bacteroides, Staphylococci, Haemophilus, Pseudomonas* species.[25] Our result was consistent with the previous review with mostly polymicrobial colonization.

Sixty percent of our subjects had tracheostomy done in the same setting as transcervical drainage for airway compromise. Its routine use was controversial since cervical contamination may happen.[26] It happened in case 3, where the situation was resolved with VAC dressing. As compared to the last systemic review by Prado Calleros et al.[6] our re-operation rate and total hospital stay were 0%, 38.6 days and 26.6%, 25 days, respectively.[6] To date, this is the first series of DNM managed purely with transcervical drainage irrespective of the severity of DNM, with additional usage of VAC as an adjunct tool. However, VAC usage did not seem to shorten the duration of the hospital stay. Our findings could contribute to the currently existing literature for future references.

In summary, DNM is a dreaded life-threatening infection. An improved understanding of the natural history of this infectious process and the relevant anatomy continues to promote improvements in therapy for affected patients. We reviewed and described a series of severe DNM treated with the only transcervical approach with or without VAC dressing. Based on experience accrued, less invasive transcervical alone drainage may be adequate in treating severe DNM, as long as early treatment is recognized and initiated. We specifically emphasize early diagnosis and surveillance with CT imaging. The involvement of a multidisciplinary team of surgeons and physicians is of utmost importance in close monitoring of DNM, with a low threshold for early transthoracic drainage whenever indicated. Incorporating VAC in the treatment course may open the door for a new algorithm, with its value needed to be tested further in higher-level researches.

Ethics Committee Approval: This study was approved by Ethics committee of University Malaya (Approval No: 20201025-9165).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

Peer-review: Externally peer-reviewed.

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