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CLINICAL STUDY

Surgical treatment of descending necrotising mediastinitis caused by odontogenic infection: a retrospective analysis of 20 patients

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ABSTRACT

OBJECTIVES: Analysing the results of patients with odontogenic descending necrotising mediastinitis (DNM) treated predominantly by transcervical approach.

BACKGROUND: Odontogenic DNM is a rare but serious complication of dental disease and dental procedures.

METHODS: Retrospective evaluation of 20 patients who underwent surgery for odontogenic DNM.

RESULTS: The mean age was 33.95±12.24 years, and 18 patients (90 %) were men. Type I and diffuse form of DNM were identified in 8 (40 %) and 12 (60 %) patients, respectively. The mean time between the onset of symptoms and surgery was 7.16±4.23 days. The transcervical approach was used in 16 patients, combined cervicotomy and subxiphoid incision in three patients, and cervicotomy and posterolateral thoracotomy was used in one patient. Four patients were reoperated. The mean mediastinal drainage duration and postoperative length of stay (LOS) were 17.05±10.27 days and 20.70±10.87 days, respectively. Fourteen (70 %) patients received mechanical ventilation with a mean duration of 8.86±9.55 days. Comorbidities were present in five (26 %) patients; there were complications in 17 (85 %) patients. In-hospital mortality reached 5 % (1 patient). Thirty-five teeth were extracted. Lower mandibular molars represented 21 (62 %) of extracted teeth. Submandibular and submental spaces were the most affected by the presence of deep neck infection (five and four cases, respectively).

CONCLUSION: This study supports the role of transcervical mediastinal drainage as an alternative approach in the surgical treatment of odontogenic DNM *(Tab. 4, Fig. 2, Ref. 30)*. Text in PDF *www.elis.sk*

KEY WORDS: descending necrotising mediastinitis; odontogenic infection; surgical treatment; transcervical drainage.

Introduction

Descending necrotising mediastinitis (DNM) is a life-threatening inflammatory process that involves mediastinal connective tissues and is directly related to the downward spread of diverse head and neck infections (1–3).

DNM is diagnosed based on the criteria proposed by Estrera et al (Tab. 1) (4). Despite advances in treatment, DNM remains a rare surgical emergency associated with high morbidity and mortality, which is closely linked with delayed diagnosis or initiation of effective therapy (1, 3, 5, 6). Early clinical suspicion, subsequent confirmation by computed tomography (CT), aggressive surgical treatment, antibiotic therapy, and intensive care are currently the mainstay of therapy for a successful outcome in patients with DNM

Tab. 1. DNM criteria and classification.

DNM criteria (4)		
Clinical evidence of severe infection		
Characteristic radiological features		
Surgical or post-mortem verification of necrotising mediastinal infection		
Confirmation of the relationship between the source of infection and DNM		
DNM classification (8, 9)		
Type and form		Mediastinal involvement
Localised form	Type I	Infection localised above the carina
Diffuse form	Type IIA	Infection extended below the tracheal carina to the lower anterior mediastinum
	Type IIB	Infection extended below the tracheal carina to both the anterior and posterior mediastinum

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(1, 2, 7). Adequate mediastinal debridement with effective drainage and elimination of the primary focus of infection are goals widely accepted by thoracic surgeons (1, 2, 7). However, the most appropriate surgical approach in patients with this condition remains under debate. Endo et al. proposed a CT-based DNM classification to evaluate the distribution of DNM and tailor the surgical approach depending on the extent of the infection (Tab. 1) (8, 9).

Dental disease and invasive dental procedures can lead to local infectious complications (10). Odontogenic infection sporadically originates from the second and third mandibular molars and their supporting structures, but it can occasionally spread to adjacent fascial spaces and lead to deep neck infection (DNI) (10–12). DNM can evolve in 2.4–4.3 % of patients with untreated DNI or failed response to therapy (13, 14).

Most published papers report few patients with odontogenic DNM or patients predominantly representing a prognostically favourable subgroup with type I DNM (15).

This study aimed to analyse the results in patients with strictly odontogenic DNM who were treated predominantly with transcervical mediastinal drainage. The separation of this subgroup from patients with other infectious sources offers more precise data to specialists who treat dental pathologies.

Material and methods

Forty-five patients with DNM treated at our institution from September 2001 to May 2019 were analysed. Twenty patients (18 men, 2 women) fulfilled the criteria of odontogenic DNM and were included in this single-centre retrospective study. The mean age of the patients was 33.95 ± 12.24 (range, 15–62 years). All patients were transferred from other hospitals after DNM was confirmed on a CT scan. The patients underwent surgical exploration within the first 6 h of admission. The preferred approach was unilateral or bilateral longitudinal cervicotomy along the anterior border of the sternocleidomastoid in 16 patients, a combination of cervicotomy and subxiphoid incision in 3 patients, and transcervical approach and posterolateral thoracotomy in 1 patient. Mediastinal drains for continuous irrigation and suction designed by one of the authors (SH) were placed after radical debridement (Figs 1 and 2). Tooth extractions, debridement, and drainage of the infected neck spaces were an integral part of the surgical treatment. All patients were postoperatively admitted to the intensive care unit. Indication for reoperation was based on their clinical course and repeated CT evaluation. Four (25 %) patients with ongoing sepsis were reoperated after the CT scans were diagnostic for undrained collections. A combination of neck and mediastinal reexploration was indicated in two patients, and one patient underwent right-sided anterior mediastinotomy. Drains were placed in all three patients. The fourth patient required two reinterventions for undrained neck collections. A chest tube was inserted in nine patients for pleural effusion and in three patients for empyema. Gastrostomy with feeding jejunostomy was performed in one patient with persistent dysphagia. Patients' personal and clinical data were extracted from their medical records. In this study, the continuous variables are presented as mean ± standard deviation, and categorical variables

Fig. 1. Mediastinal drain for continuous irrigation and suction.

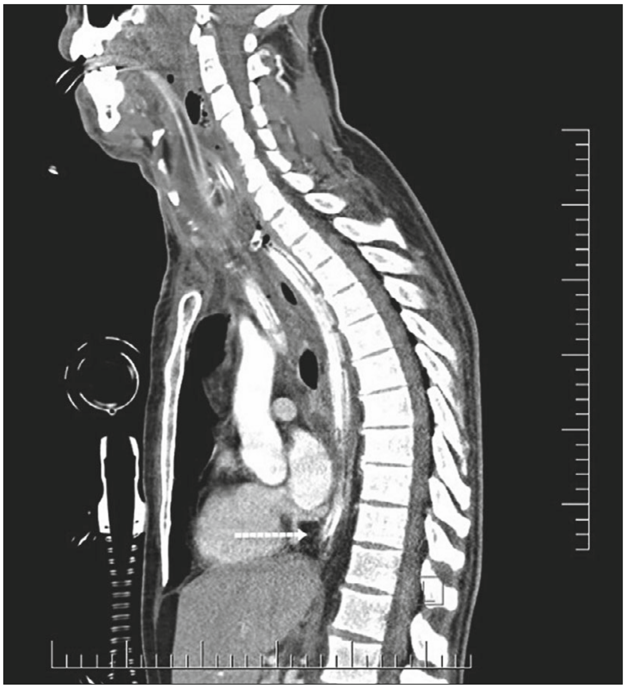

Fig. 2. Computed tomography scan of the patient with Endo type IIB descending necrotising mediastinitis after surgery. Tip of the mediastinal drain placed in the prevertebral space (white dotted arrow).

are expressed as counts and percentages. Statistical analysis was conducted using SPSS 22.0 for Windows (SPSS Inc. Chicago, Illinois, USA) software.

The study was approved by the institutional ethics committee. Informed consent was not required from study participants.

Results

Localised odontogenic DNM (Type I) and diffuse form DNM (Type IIA and IIB) were confirmed in 8 (40 %) and 12 (60 %) patients, respectively (Tab. 2).

Pain, neck swelling, fever, dysphagia, or odynophagia were initially present in 18 (90 %) patients and severe hypotension with impaired consciousness in 2 (10 %) patients with septic shock. The delay between symptoms and surgery ranged from 2 to 20 days (mean: 7.16±4.23) (Tabs 3 and 4).

Four (25 %) patients with ongoing sepsis were reoperated after the CT scans were diagnostic for undrained collections. A combination of neck and mediastinal reexploration was indicated in two patients. and one patient underwent a right-sided anterior mediastinotomy. Drains were placed in all three patients.

Tab. 2. Clinical characteristics of patients.

No	20
Age, years; Mean ± SD (Min–Max)	33.95±12.24 (15–62)
Male, No (%)	18 (90%)
Endo DNM classification, No (%)	
Endo type I	8 (40%)
Endo type IIA	6 (30%)
Endo type IIB	6 (30%)
Mechanical ventilation	14 (70%)
Tracheostomy (UAO) before the transfer, No (%)	2/20 (10%)
Tracheostomy (UAO) after DNM surgery, No (%)	1/10 (5%)
Tracheostomy (PMV), No (%)	3/20 (15%)
Comorbidities, No (%)	5/19 (26.3%)*
Pulmonary comorbidity	1 (5.26%)
Alcoholism	2 (10.53%)
Severe intellectual disability	1 (5.26%)
Diabetes mellitus	1 (5.26%)
Complications, No (%)	17 (85%)**
Sepsis	6 (30%)
Sepsis with MODS	4 (20%)
Bronchopneumonia	8 (40%)
Acute purulent bronchitis	1 (5%)
Upper airway obstruction	6 (30%)
Pleural effusion	8 (40%)
Empyema	3 (15%)
Pneumothorax	1 (5%)
Bradycardia with CPR	1 (5%)
Diabetic ketoacidosis	1 (5%)
Unilateral vocal cord paresis	1 (5%)
Persistent swallowing difficulty	1 (5%)
Horner´s syndrome	1(5%)
In-hospital mortality rate, No (%)	1 (5%)

* – 1 patient died after CPR and surgery with no medical history obtained, ** – More than one complication in 50 % of the patients, DNM – Descending Necrotising Mediastinitis, UAO – Upper Airway Obstruction, PMV – Prolonged Mechanical Ventilation, MODS – Multiorgan Dysfunction Syndrome, CPR – Cardiopulmonary Resuscitation

The fourth patient required two reinterventions for undrained neck collections. The mean length of the mediastinal drainage was 17.05±10.27 (range, 1–38) days and the mean postoperative length of stay (LOS) was 20.70±10.87 (range, 1–46) days (Tabs 3 and 4). Fourteen (70 %) patients were mechanically ventilated, with a mean duration of 8.86±9.55 (range, 1–34) days (Tabs 3 and 4).

Complications were present in 17 (85 %) patients. Sepsis, bronchopneumonia, and pleural effusion were the most frequent complications. We recorded more than one complication in 10 (50 %) patients (Tabs 2 and 3). The in-hospital mortality reached 5 %. One male patient with type IIB DNM was transferred after successful cardiopulmonary resuscitation and died of septic shock on postoperative day 1. Comorbidities were present in 26 % of the patients (5/19, data not available: 1 patient) (Tabs 2 and 3).

Five (25 %) patients experienced upper airway obstruction symptoms before transfer to our institution. Three (15 %) of them were intubated and two (10 %) underwent tracheostomy. One (5 %) patient with upper airway obstruction underwent tracheostomy after surgery, and three tracheostomies were performed in patients on prolonged mechanical ventilation (Tabs 2 and 3).

Of the dental extractions, 7 (35 %) were complicated by DNM, 10 (29 %) teeth were extracted by dentists, and 8 (80 %) were lower molars. An additional nine (45 %) patients with DNI were treated with dental extraction and concomitant neck revision before being transferred to our department. Eleven (31 %) teeth were removed in this subgroup; 10 (91 %) were lower molars. Submandibular and submental spaces were the most commonly affected spaces (five and four patients, respectively). Thirteen teeth were extracted in four (25 %) patients as a part of the definitive treatment at our institution; however, lower molars represented only three (23 %) of these extractions. One patient died prior to any dental manipulation. Of the 35 teeth extracted (data not available: one patient), lower molars represented 62 % (21/34) of the extracted teeth and the second and third lower molars represented 29.6 % and 20.6 %, respectively (Tab. 3).

Positive initial microbiological cultures were obtained in 13 patients (65 %) (Tab. 3). Polymicrobial growth was confirmed in 54 % of the patients with positive cultures. *Streptococcus constellatus* was the most common isolate. It was present in 23 % (3/13) of positive cultures.

Discussion

The transcervical approach was the preferred approach in the treatment of odontogenic DNM in our patients. This technique allowed proper insertion and placement of the mediastinal drains without any further reintervention in almost 85 % of patients regardless of the Endo type. The mortality rate of 5 % proved to be favourable and the mean LOS (20.70±10.87 days) was comparable with the results of the centres that offered VATS procedures in the DNM treatment.

The proper surgical management of DNM remains controversial, and the optimal approach is under investigation. Previous

Tab. 3. Selected clinical data in patients with odontogenic DNM.

Case	Age (years) /Sex	Symptoms present (days)	Endo Type	Drain-age (days)	Surgical approach	LOS (days)	MV (days)	Complications	Symptoms	Teeth extracted before DNM surgery (FDI-DNS)	Neck incisions and drainage before DNM surgery	Teeth extracted with DNM surgery (FDI-DNS)	Isolated bacterias	Airways	Other procedures
1	15/M	4	IIA	20	C	23	3	Pleural effusion	Pain Neck swelling Dysphagia	46	Submental sp. Submandibular sp. Vagina vasorum l.dx.		Negative cultures	Transferred intubated (upper airway obstruction)	Reoperation Chest tube insertion
2	18/M	9	IIA	19	C	27	7	Sepsis MODS Pleural effusion Deglutination problems Horner˘s syndrome	Fever An altered state of consciousness Hypotension	37	–	–	Peptostreptococcus sp, Bacteroides fragilis	Transferred intubated (upper airway obstruction)	Gastrostomy, Feeding jejunostomy Chest tube insertion
3	30/M	5	IIA	8	C + S	12	1	Pneumonia	Pain Neck swelling Dysphagia	38	Neck incision in the jugular fossa	–	Str. viridans	Tracheostomy (upper airway obstruction)	
4	21/F	6	I	14	C	15	–	Pneumonia	Pain Neck swelling Dyspnoea Odynophagia	35	Submandibular sp.	–	Peptostreptococcus sp	–	–
5	21/M	6	IIB	37	C	39	–	Sepsis	n/a	37	Submandibular sp. Submental sp. Parapharyngeal sp.	–	Negative cultures	Transferred with tracheostomy (upper airway obstruction)	Chest tube insertion
6	45/M	14	IIA	13	C + T	28	7	Pneumonia	Pain Neck swelling Odynophagia	44	–	–	Negative cultures	Tracheostomy (MV)	
7	39/M	20	I	10	C	11	–	Pleural effusion	Pain Neck swelling Dysphagia Fever	37,38	Submandibular sp.	–	Negative cultures		Chest tube insertion
8	21/M	7	I	7	C	8	–	–	Neck swelling	37	Submandibular sp.		Staphylococcus sp.	–	–
9	27/M	10	IIA	24	C	25	4	Sepsis MODS Pleural effusion Pneumonia	n/a	36	Submandibular sp. Submental sp. Parapharyngeal sp.		Peptococcus sp.		Chest tube insertion

Tab. 3.

Case	Age (years) /Sex	Symptoms present (days)	Endo Type	Drain-age (days)	Surgical approach	LOS (days)	MV (days)	Complications	Symptoms	Teeth extracted before DNM surgery (FDI-DNS)	Neck incisions and drainage before DNM surgery	Teeth extracted with DNM surgery (FDI-DNS)	Isolated bacterias	Airways	Other procedures
10	39/F	9	IIB	7	C	17	–	–	Pain Neck swelling Odynophagia Stridor	–	Submental sp. Retropharyngeal sp.	48	Str. anginosus Peptococcus sp.	Transferred intubated	–
11	35/M	8	I	23	C	26	1	Sepsis Empyema	Pain Neck swelling Fever	46,47,48	–		Negative cultures		Chest tube insertion
12	28/M	5	I	15	C	15	8	Sepsis Empyema, Pneumonia	Pain Neck swelling Dysphagia Fever Trismus An altered state of consciousness	48		Fractured root fragments retrieval	α–hemolytic streptococci	Transferred with tracheostomy (upper airway obstruction)	Chest tube insertion Residual radix extraction (48)
13	32/M	7	IIA	17	C	20	1	Pleural effusion Purulent bronchitis	Neck swelling Dysphagia Odynophagia Fever	46,47			Negative cultures		Chest tube
14	58/M	7	I	8	C	14	2	Sepsis	Neck swelling Dysphagia Dyspnoea Fever	38		–	Enterobacter cloacae St. aureus	Intubated (upper airway obstruction)	
15	41/M	6	IIB	25	C	30	17	Pneumonia Unilateral vocal paresis Pneumothorax	Neck swelling Dysphagia	37	Submandibular sp.	–	St.hominis Str. constellatus	Intubated (upper airway obstruction)	Submental abscess incision Mediastinal drain Chest tube
16	62/M	n/a	IIB	1	C + S	1	1	Septic shock MODS Exitus	Dyspnoea Acute respiratory insufficiency An altered state of consciousness Asystole Seizures	–	–	–	Str. constellatus St. warneri	Intubated for respiratory insufficiency	–
17	38/M	6	I	12	C	14	1	–	Pain Neck swelling Dysphagia Fever	46,47	Submandibular sp.	–	Negative cultures	–	–

Tab. 3.

Case	Age (years) /Sex	Symptoms present (days)	Endo Type	Drain-age (days)	Surgical approach	LOS (days)	MV (days)	Complications	Symptoms	Teeth extracted before DNM surgery (FDI-DNS)	Neck incisions and drainage before DNM surgery	Teeth extracted with DNM surgery (FDI-DNS)	Isolated bacterias	Airways	Other procedures
18	35/M	3	IIB	38	C + S	46	34	Sepsis Pneumonia Pleural effusion Empyema	Pain Neck swelling Dysphagia Fever	–	–	37, 38	Str. constellatus	Tracheostomy (MV)	Chest tube insertion Reoperation (Ant. mediastinotomy) Tracheostomy Pterygomandibular sp. incision
19	38/M	2	IIB	26	C	36	15	Sepsis MODS Ketoacidosis Pneumonia Pleural effusion	Dysphagia Odynophagia Dyspnoea	–	–	28, 32, 33,34,35 43	Slackia exigua Str. anginosus	Transferred intubated Tracheostomy (MV)	Chest tube PEG
20	36/M	2	I	15	C	31	18	Sepsis Pleural effusion Bradycardia with CPR	Dysphagia Dyspnoea	n/a	–	31, 32, 41, 42	Prevotella buccae, Solobacterium moorei	–	Bilateral chest tube insertion Neck revision for submandibular abscess

M – Male, F – Female, C – Transcervical approach (cervicotomy), C + T – Transcervical approach with posterolateral thoracotomy, C + S – Transcervical approach with a subxiphoid incision, LOS – Length of postoperative stay, MV – Mechanical ventilation, FDI-DNS – World Dental Federation- Dental Notation System, ALI – Acute Lung Injury, MODS – Multiple Organ Dysfunction Syndrome, CPR – Cardiopulmonary Resuscitation, n/a – not available, PEG – Percutaneous gastrostomy, DNM – descending necrotising mediastinitis

studies have described several techniques based on the Endo classification, and the transcervical approach is considered an acceptable procedure for type I DNM (1, 2, 5–7, 9, 12, 16–21). Cervicotomy combined with right-sided posterolateral thoracotomy, video-assisted thoracic surgery (VATS), sternotomy, or clamshell approach were recommended for diffuse DNM forms (1, 2, 5–7, 9, 12, 16–21). Transcervical drainage in patients with type II DNM is not recommended because almost 80% of patients initially treated with this technique require a subsequent thoracotomy (2). This results in a significant difference in mortality between patients receiving neck and thoracic drainage and neck drainage alone (3). Contrastingly, some authors have proposed a transcervical approach in patients with DNM below the tracheal carina, with the mortality being comparable to that of open surgical techniques (22).

We achieved adequate infection control with the transcervical approach in 70 % of patients with diffuse DNM and 60 % of patients with type IIB DNM. No patient required subsequent thoracotomy because the transcervical approach can be utilised safely and effectively even in patients indicated for reoperation.

The mean postoperative LOS in survivors treated by open surgical techniques varies significantly between different institutions (24–39.3 days) (1, 7, 16, 17, 21, 23). Some studies indicated that VATS could substitute open techniques as it decreases postoperative pain, reduces the surgery time and LOS (20.6–28.8 days), and leads to faster recovery (18, 20, 22). Hsu et al's study found a favourable mean LOS (28.1 days) in patients treated by transcervical mediastinal drainage (22). Therefore, we can assume that the transcervical approach offers a LOS comparable with that of VATS.

Prado-Calleros et al. accentuated timely diagnosis and surgical treatment within the first 15–72 h because treatment delay directly influences patients' survival (2). The mean duration between symptom onset and hospital admission in patients with odontogenic DNM is 7.2 days and 4.9–9.5 days in a group of patients, regardless of the DNM origin (1, 15, 23, 24). These numbers are comparable with our results.

The majority of our patients (90 %) were admitted to the hospital with local symptoms affecting the neck and underlying organ soft tissues. DNI advances rapidly along the cervical fascial planes and results in swelling of neck tissues, leading to acute upper airway obstruction (25). Routine tracheostomy has been considered a crucial part of airway control in patients with this complication (1, 24, 25). Utilisation of tracheostomy in patients with DNM ranges from 28.9 % to 85 % (1, 9, 24–26). The small number of patients (15 %) who underwent tracheostomy in our study is a result of our highly selective approach. We assume that the number of patients with critical upper airway obstruction is lower than anticipated, and the need for tracheostomy in patients with DNM should be assessed on an individual basis. This policy requires comprehensive monitoring of the patients and an active approach if upper airway obstruction symptoms become evident.

Odontogenic DNM is associated with worse outcome in some studies. Previous studies report mortality rates from odontogenic

DNM to be between 25 % and 43 % (2, 26, 27). The degree of DNM distribution also influences the prognosis (2). Qu et al. reported a mortality of 4.9 % in patients with predominantly odontogenic type I DNM (15). The mortality rate for odontogenic type II DNM has not been mentioned in the literature; however, mortality from type II DNM, irrespective of its origin, can be up to 31.5 % (2). Septic shock, comorbidity, and age >70 years are poor prognostic factors that directly influence the mortality in DNM patients (2, 16). Nearly 18 % of patients with odontogenic DNM die of septic shock with multiorgan dysfunction syndrome (MODS) (26). The mortality rate of 5 % in our group of patients was lower than anticipated. The incidence of lethal septic shock with MODS (5 %) was decreased in our patients with odontogenic DNM compared to the published results.

The presence of associated comorbidities influences up to 60 % of the patients with odontogenic DNM, with diabetes mellitus affecting the course of the disease most frequently (15, 28). Comorbidities were identified only in 26.3 % of our patients. It is possible that the low mean age of our patients resulted in fewer comorbidities and positively influenced the outcome of our study.

Odontogenic infection was considered the most frequent cause of DNM, but the latest review identified pharyngotonsillar foci as the leading source (1, 2, 12). The third lower molar is most frequently associated with odontogenic DNM in 36−68 % of cases, followed by other mandibular molars and premolars (15, 29). The second lower molar was identified as the most frequent origin of odontogenic infection in our group of patients, followed by the third lower molar. The presence of odontogenic infection influences the outcome in 8 % of dental procedures. Simple tooth removal is responsible for 60 % of odontogenic infections complicating invasive procedures; however, with only 2.5 % of reported cases, it is a rare origin of DNM (10, 15, 30). Odontogenic DNM complicating simple tooth removal occurred 35 % more frequently in our group of patients.

This study supports the dominant role of the odontogenic infection in the development of DNM in our group of patients. The exact dental pathology leading to odontogenic DNM was not specified in their medical files; however, poor oral health with multiple dental caries and periodontal disease was present in all patients.

The results of this retrospective analysis should be accepted cautiously. The rarity of odontogenic DNM did not allow us to collect a representative group of patients and also prevented us from designing a prospective randomised control trial with a control group treated with other surgical approaches.

Conclusion

Odontogenic infection remains a prevalent cause of DNM. The extent of the disease usually influences the type of surgical approach used for treatment. Many centres recommend transcervical mediastinal drainage as the approach of choice only in patients with localised odontogenic DNM. Contrary to prevailing opinion, this technique could be offered as a safe and effective alternative approach in patients with diffuse odontogenic DNM, with results comparable with other surgical techniques. The exact role of transcervical mediastinal drainage in the treatment of diffuse DNM should be re-evaluated in well-designed prospective studies in centres with extensive previous experience with the transcervical approach for the treatment of other mediastinal pathologies.

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