CLINICAL STUDY

Negative pressure catheter drainage and jejunal feeding for descending necrotizing mediastinitis by interventional techniques: a retrospective study

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ABSTRACT
Purpose: Descending necrotizing mediastinitis (DNM) is a lethal and acute suppurative disease. This report aimed to summarize our experience in the treatment of DNM with continuous negative pressure catheter drainage and transnasal jejunal feeding by interventional techniques.

Materials and Methods: We retrospectively analyzed relevant clinical data of patients with DNM who underwent continuous negative pressure catheter drainage and transnasal jejunal feeding. All drainage catheters and jejunal feeding tubes were inserted by interventional techniques.

Results: In total, 21 patients were diagnosed with DNM by esophagography and computed tomography (CT). Catheters for the drainage of mediastinal abscesses as well as transnasal jejunal feeding tubes were successfully placed in all patients, indicating a 100% success rate. Of all patients, 13 underwent insertion of abscess drainage catheters through percutaneous puncture under DynaCT guidance, while eight had drainage catheter insertion through fistula orifices in the posterior nasopharyngeal wall or esophagus under fluoroscopic guidance. In total, 26 drainage tubes were inserted. One patient with diabetes died of sepsis and diabetic ketoacidosis 5 days postoperatively, while the remaining 20 patients showed good recovery with successful removal of the drainage catheters. Durations of catheterization were 45.2±50.44 days. The overall clinical success rate was 95.2%.

Conclusion: The above described methods are non-surgical, minimally invasive and efficacious, and may be alternative therapeutic tools for patients who are not eligible for surgical operation, have a high postoperative risk, or are more likely to choose minimally invasive techniques.

Keywords: descending necrotizing mediastinitis; drainage; Interventional radiology; Intensive care

INTRODUCTION
Descending necrotizing mediastinitis (DNM) is a lethal and acute suppurative disease, which could be caused by odontogenic infection, infection of the mouth floor and the maxillofacial region, posterior pharyngeal wall infection, perforation of the upper esophagus, trauma, and a complication of central venous catheterization. Indeed, infection spreads to the deep cervical fascia and the mediastinum, and eventually progresses to DNM. DNM is an aggressive disease that spreads rapidly, with a high mortality rate of 7%–20%. Furthermore, it easily leads to severe complications such as sepsis, mediastinal abscesses, and intrapericardial infection (1-3).

Early diagnosis and treatment by alert clinicians can increase the curative effects of treatments, decreasing complication and mortality rates. The primary reasons for high mortality include misdiagnosis, mixed infections with various bacteria, improper surgical procedures, and postoperative complications. Many scholars suggest that surgical incision and drainage should be scheduled as early as possible after diagnosis. However, conventional incision and drainage procedures cause additional trauma to patients. Because of the anatomical complexity of the mediastinum, ordinary rubber drainage tubes cannot be accurately placed into mediastinal abscesses. Such drainage tubes are easy to
be blocked, and irrigation of abscess cavities challenging (4-6).

To overcome the shortcomings of traditional drainage techniques and reduce the trauma caused by surgical drainage, we have successfully used negative pressure catheter drainage and trans-jejunal feeding for spontaneous esophageal rupture and perforated esophageal carcinoma with mediastinal abscesses (7, 8). The aim of this study was to summarize our experience in the treatment of DNM with continuous negative pressure catheter drainage and transnasal jejunal feeding by interventional techniques.

**MATERIALS AND METHODS**

This study was approved by the Ethics Committee of our hospital. All patients provided written informed consent. This was a retrospective analysis of medical records of DNM patients who were treated with continuous negative pressure catheter drainage and transnasal jejunal feeding between September 2011 and September 2016 in the Interventional Radiology Department of our hospital. DNM diagnosis was based on clinical manifestations, esophagography, and chest CT. Patients with esophageal perforation related to carcinoma or intrathoracic anastomotic leakage after esophagectomy were excluded, as well as those with DNM treated by other methods, i.e., surgery or supportive care.

Technical success was defined by successful insertion of mediastinal abscess drainage catheters with effective abscess drainage. Technical failure was defined as failure to insert a mediastinal abscess drainage catheter or incomplete drainage. Clinical success was defined as a complete resolution of DNM by the sole use of mediastinal abscess drainage catheters inserted by the interventional techniques, without any need for surgical debridement, with the patient surviving without any signs of abscess relapse at 6 months after intervention (7, 8).

All interventional procedures were performed under conscious sedation. Topical tetracaine spray was used for the nasal and pharyngeal cavities. All abscess drainage catheters and jejunal feeding tubes were inserted by interventional techniques. For mediastinal abscesses connected to the pharyngeal cavity or esophagus, the drainage catheters were inserted through the nose and fistula orifices under fluoroscopic guidance; otherwise, the catheters were inserted by percutaneous puncture using the Seldinger technique under DynaCT guidance.

**Insertion of transnasal drainage catheters through fistula orifices in the posterior nasopharyngeal wall or esophagus**

Under fluoroscopic guidance, a 5F catheter was inserted over a wire into the pharyngeal cavity through one side of the nasal cavity. The catheter was inserted into the mediastinal abscess through the fistula orifices in the posterior nasopharyngeal wall or esophagus. Two milliliters of abscess fluid was acquired for bacterial culture and drug sensitivity tests. Radiography with injection of water-soluble contrast medium through the catheter showed the position and size of the mediastinal abscess. The catheter was replaced using a 5F straight catheter with multiple side holes (Cook Medical Inc., IN, USA) and/or a 5F pigtail catheter (Cook Medical Inc., IN, USA). The catheter tip was placed in the lowest part of the abscess. The abscess was repeatedly irrigated with 10–20 ml of normal saline until the flushed fluid was no longer turbid. Contrast medium was injected via the catheter and completely aspirated to confirm appropriate positioning of the drainage catheter. Finally, the drainage catheter was fixed for suction under negative pressure (Figure 1, 2).

**Insertion of mediastinal abscess drainage catheters through percutaneous puncture under DynaCT guidance**

First, neck and chest DynaCT was performed to determine the puncture points and pathways. Then, an 18G puncture needle was used to successfully puncture the mediastinal abscess, after which 2 ml of fluid was obtained for bacterial culture and drug sensitivity tests. DynaCT was performed again to ensure that the puncture pathways were not close to vital viscera and blood vessels. Subsequently, a wire was inserted into the puncture needle to replace the 5F single-curve catheter. Under fluoroscopic guidance, the 5F catheter over the wire was inserted into the lowest part of the mediastinal abscess. Next, the latter catheter was withdrawn, and an 8.5F external drainage catheter with multiple side holes (Cook Medical Inc., Bloomington, IN, USA) and/or a single-lumen central venous catheter was inserted over the wire. The tip of the mediastinal abscess drainage catheter was adjusted in the inferior region of the mediastinal abscess, which was repeatedly irrigated using 10–20 ml of normal saline until the flushed fluid was no longer turbid. Contrast medium was injected through the drainage tubes and aspirated again later. We ensured that the contrast medium was completely aspirated, because it helps determine the appropriate positioning of the drainage catheter. Finally, the drainage catheter was fixed for suction under negative pressure (Figure 3, 4).

**Tube placement for transnasal jejunal feeding**

After successful insertion of the drainage catheter, another catheter was transnasally inserted over a guidewire into the proximal jejunum under fluoroscopic guidance. The catheter was then withdrawn, and a 14F jejunal feeding tube was delivered into the jejunum over the guidewire. Jejunal feeding was thus provided postoperatively.

**Postoperative management**

Depending on the volume of the mediastinal abscess fluid collected, 10–20 ml of normal saline was used once/twice per day after irrigation of the abscess cavity until the flushed fluid was clear. Then, the drainage catheter was connected to a syringe by a multidirectional stopcock. Continuous negative pressure of 10–20 mmHg was applied by the syringe for mediastinal abscess drainage.
Fluid color, turbidity and amounts were recorded. Antibiotics and enteral nutrition were provided via a transnasal jejunal feeding tube after the procedure. Patients with mediastinal abscesses connected to the pharyngeal cavity or esophagus were prohibited water and food intake by mouth until the abscess healed; otherwise, the patients commenced oral intake 1 week postoperatively.

Shrinking of the abscess cavity was observed by radiography after contrast medium injection via the drainage tube every 5-7 days. Chest CT was performed if necessary. Once the lower part of the abscess cavity was completely closed, the drainage catheter was withdrawn to ensure that its tip remained in the open abscess cavity. The drainage catheter and jejunal feeding tube were withdrawn until complete absence of any drainage fluid and total resolution of the abscess.

**Figure 1.** A representative case of a 64-year-old woman with descending necrotizing mediastinitis and perforation of the posterior pharyngeal wall. Neck and chest CT shows a cervical and mediastinal abscess (arrow indicates the abscess).

**Figure 2.** a (Oblique esophagogram) and b (Posteroanterior esophagogram) show contrast medium infiltration into the mediastinal abscess (arrows show the mediastinal abscess). c. Chest CT image showing the inserted drainage catheter and transnasal jejunal feeding tube (single arrow indicates the 5F straight catheter with multiple side holes; two parallel arrows indicate the transnasal jejunal feeding tube).

**Figure 3.** A representative case of a 43-year-old man with descending necrotizing mediastinitis caused by posterior pharyngeal wall infection. Neck and chest computed tomography shows a cervical and mediastinal abscess (arrows).
RESULTS

A total of 21 patients, including 15 men and six women aged 48.86±14.97 years, were enrolled in this study. The time intervals between disease onset and the drainage were 5.24±1.81 days (median, 6 days; range, 1–8 days). Four (19.0%) patients were diagnosed with odontogenic infection, seven (33.3%) with infection of the mouth floor and the maxillofacial region, three (14.3%) with posterior pharyngeal wall infection, three (14.3%) with mediastinal abscess after removal of esophageal foreign bodies, two (9.5%) with infection after surgical debridement of a cervical incision wound, one (4.8%) with upper esophageal perforation during transesophageal echocardiography, and one (4.8%) with infection caused by posterior pharyngeal wall perforation during gastroscopy. All patients were febrile preoperatively. Overall, 95.2% (20/21), 14.3% (3/21) and 33.3% (7/21) of patients had leukocytosis, anemia and hypoproteinemia preoperatively, respectively. All patients were definitively diagnosed by esophagography with water-soluble contrast medium as well as neck and chest CT. Eight of the 21 patients exhibited mediastinal abscesses connected with the posterior nasopharyngeal wall or upper esophagus.

Mediastinal abscess drainage catheters and transnasal jejunal feeding tubes were successfully inserted in all 21 patients, indicating a technical success rate of 100%. No massive hemorrhage, wound caused by drainage catheter insertion, and vital organ damage were observed. Thirteen patients underwent drainage catheter insertion through percutaneous puncture under DynaCT guidance. Of these, four and nine received two and one abscess drainage catheters, respectively. The remaining eight subjects underwent drainage catheter insertion through fistula orifices in the posterior pharyngeal wall or esophagus. Of these eight patients, one received a 5F pigtail catheter, six were inserted one 5F straight catheter with multiple side holes, and one received both catheter types. In total, 26 drainage catheters were inserted, including twelve 8.5F external drainage catheters, two 5F pigtail catheters, seven 5F straight catheters with multiple side holes, and five single-lumen central venous catheters with multiple side holes. One patient with diabetes died of sepsis and diabetic ketoacidosis 5 days postoperatively.

Following drainage catheter and transnasal insertion of the jejunal feeding tube, irrigation and suction of mediastinal abscesses under negative pressure, antibiotic therapy, enteral and parenteral nutrition, and appropriate treatment based on symptoms, the remaining 20 patients recovered well, with body temperatures returning to normal within 1–3 days of the interventional procedure. Daily drainage volumes were 10–400 ml/day. The drainage liquid gradually turned to clear from turbid, while the drainage fluid volume decreased each day in all patients. Radiography with contrast medium injection via the abscess drainage catheter and CT confirmed abscess shrinkage within 1 week in 19 patients. In one patient, although the original abscess
showed obvious shrinkage, a new one appeared in a different location in the mediastinum. The latter abscess could not be drained by the original drainage tubes; therefore, a new drainage catheter was inserted by percutaneous puncture.

All 20 patients showed good recovery, with successful drainage catheter removal. Durations of catheterization were 45.2±50.44 days, and obstruction of the inserted drainage catheters never occurred. Therefore, the clinical success rate was 95.2%. No patient required surgical debridement or drainage because of drainage failure or incomplete drainage. All patients were followed up either through telephone calls or clinical visits once a month for 6 months. No recurrence was shown on chest CT at the first month after discharge.

DISCUSSION

In this study, DNM was treated with continuous negative pressure catheter drainage and transnasal jejunal feeding by interventional techniques. One (4.8%) patient with diabetes died of sepsis and diabetic ketoacidosis 5 days postoperatively; the remaining 20 (95.2%) recovered completely. No patient required surgical debridement and drainage. This study provided new treatment methods for DNM.

As shown above, drainage catheter insertion through Dyna CT-guided puncture or the nasal cavity was safe and minimally invasive. Furthermore, the use of interventional techniques was not limited by the patient’s physical condition. Endo et al. reported that surgical transcervical mediastinal drainage is suitable for patients with a type I DNM (localized to the upper mediastinal space above the carina), transcervicotomy and anterior mediastinal drainage through a subxiphoidal incision are suitable for type II A DNM (with infection involving the lower anterior region of the mediastinum), and posterior mediastinal drainage through right standard thoracotomy followed by left minimal thoracotomy is suitable for type II B DNM (infection involving the lower anterior and posterior regions of the mediastinum) (9). Suga reported the case of an 84-year-old patient with DNM who received treatment for septicemia, disseminated intravascular coagulation, and heart failure. The patient underwent tracheotomy 2 weeks after endotracheal intubation in the intensive care unit and recovered 120 days after the surgical operation (1). Surgical drainage of the mediastinal abscess could only be performed under general anesthesia and with endotracheal intubation. Meanwhile, patients with poor general health can barely tolerate general anesthesia and surgical trauma. Mediastinal abscess drainage catheters and transnasal jejunal feeding tubes were inserted under local anesthesia and conscious sedation in the present study; these procedures were independent of the patient’s general health and caused less trauma and pain.

Compared with surgical drainage tube insertion, insertion using an interventional technique was easier, and provided adequate drainage without complications such as thoracic cavity infection (10). Freeman reported that surgical drainage in 10 DNM patients required a multidisciplinary team comprising a head and neck surgeon, a thoracic surgeon, and an oral and maxillofacial surgeon. The average number of operative procedures per patient in this series was 6±2 (range, 4-8), including 4±1 (range, 2-5) transcervical and 2±1 (range, 2-4) transthoracic procedures (11). In the present study, drainage tubes were successfully inserted on the first attempt in all patients, precluding the need for a second trial. After successful tube insertion, regular abscess irrigation and negative pressure suction prevented inadequate drainage and tube blockage, which also explained why no second tube insertion was necessary. Moreover, interventional procedures avoided thoracic cavity contamination.

DynaCT-guided catheter insertion is likely more precise than the CT-guided procedure. Ronalds reported a success rate for CT-guided mediastinal abscess drainage tube insertion of 95.6% (22/23) (12). Only in one patient, the drainage tube erroneously punctured the pulmonary vein. DynaCT help precisely determine puncture points, puncture depth, and insertion length. The Seldinger puncture technology does not allow direct puncture and scan review to confirm the right puncture points and pathways, and prevent the puncture of other vital organs. In this technique, the drainage catheter was inserted over a guidewire, which improved the safety of the procedure.

Irrigation via mediastinal abscess drainage catheters and continuous negative pressure suction are important factors for a good prognosis. Irrigation enables dilution of the drainage fluid and maintains catheter patency, while continuous negative pressure suction prevents drainage fluid accumulation and further spread of inflammation (13). In the present study, several types of abscess drainage catheters were used, including 8.5F external drainage catheters with multiple side holes, 5F straight catheters with multiple side holes, 5F pigtail catheters, and single-lumen central venous catheters. They all provided adequate abscess drainage. The external and internal diameters of these drainage catheters are considerably smaller than those used in surgical drainage tubes. This also resulted in better portability and reduced pain. Furthermore, these drainage catheters carrying a hydrophilic coating are easier to be inserted in mediastinal abscesses, which can be clearly visualized on CT and fluoroscopy, thus enabling position adjustments and precise placement. Fracture resistance is an added advantage, and the assessed catheters maintained good patency and allowed convenient irrigation.

Patients with posterior pharyngeal wall or esophageal perforation by the mediastinal abscess cannot intake food and liquids orally. Moreover, patients with intraoral infections and infections in the maxillofacial region exhibit local swelling, soreness, and restrictions in mouth opening and eating. Transnasal jejunal feeding tubes inserted through...
the nasal cavity by an interventional technique provided enteral nutrition, helped alleviate anemia and hypoproteinemia, improved the patient’s nutritional status, and promoted abscess healing.

This study was a retrospective analysis with a small sample size. There remain some unresolved issues with the technology presented here. Although mediastinal abscess drainage catheters adequately drained the abscesses and rapidly alleviated clinical symptoms, the wound healing process was slow. Further studies should discuss measures to promote abscess healing and decrease catheterization duration. We will assess the effects of different drainage tubes, and design an optimal drainage tube for DNM in an upcoming study.

In conclusion, continuous negative pressure catheter drainage and transnasal jejunal feeding are minimally invasive and efficacious for the treatment of DNM. They could be used as an alternative approach for patients who are not eligible for surgical operation, have a high postoperative risk, or are more likely to choose minimally invasive options.

REFERENCES
1. Suga A, Inoue Y, Takeichi H, et al. A case of an elderly patient treated for descending necrotizing mediastinitis. Gen Thorac Cardiovasc Surg 2011; 59: 623-626.
2. Sarna T, Sengupta T, Miloro M, et al. Cervical necrotizing fasciitis with descending mediastinitis: literature review and case report. J Oral Maxillofac Surg 2012; 70: 1342-1350.
3. Caputo FJ, Magnotti LJ, Hauser CJ, et al. Descending necrotizing mediastinitis: unique complication of central venous catheterization. Surg Infect (Larchmt) 2007; 8: 611-614.
4. Cruz Toro P, Callejo Castillo A, Tornero Salto J, et al. Cervical necrotizing fasciitis: report of 6 cases and review of literature. Eur Ann Otorhinolaryngol Head Neck Dis 2014; 131: 357-359.
5. McDermott S, Levis DA, Arellano RS. Chest drainage. Semin Intervent Radiol 2012; 29: 247-255.
6. Kocher GJ, Hoksch B, Caversaccio M, et al. Diffuse descending necrotizing mediastinitis: surgical therapy and outcome in a single-centre series. Eur J Cardiothorac Surg 2012; 42: e66-72.
7. Han X, Zhao YS, Fang Y, et al. Placement of transnasal drainage catheter and covered esophageal stent for the treatment of perforated esophageal carcinoma with mediastinal abscess. J Surg Oncol 2016; 114: 725-730.
8. Wu G, Zhao YS, Fang Y, et al. Treatment of spontaneous esophageal rupture with transnasal thoracic drainage and temporary esophageal stent and jejunal feeding tube placement. J Trauma Acute Care Surg 2017; 82: 141-149.
9. Nougue H, Le Maho AL, Boudiaf M, et al. Clinical and imaging factors associated with severe complications of cervical necrotizing fasciitis. Intensive Care Med 2015; 41: 1256-1263.
10. Collin Y, Sirios M, Carignan A, et al. Group A Streptococcus causing descending necrotizing mediastinitis: report of a case and literature review. Surg Infect (Larchmt) 2012; 13: 57-59.
11. Freeman RK, Vallieres E, Verrier ED, et al. Descending necrotizing mediastinitis: An analysis of the effects of serial surgical debridement on patient mortality. J Thorac Cardiovasc Surg 2000; 119: 260-267.
12. Arellano RS, Gervais DA, Mueller PR. Computed tomography-guided drainage of mediastinal abscesses: clinical experience with 23 patients. J Vasc Interv Radiol 2011; 22: 673-677.
13. Chen SJ, Han XX. Transoral negative-pressure catheter drainage of a retropharyngeal and mediastinal abscess. Am J Otolaryngol 2014; 35: 313-317.