Nonoperative Catheter Management for Cervical Necrotizing Fasciitis With and Without Descending Necrotizing Mediastinitis

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Objective: To evaluate the clinical utility of catheter drainage for cervical necrotizing fasciitis (CNF) with and without descending necrotizing mediastinitis (DNM).

Design: Retrospective analysis.

Setting: Department of Traumatology and Acute Critical Medicine, Osaka University Graduate School of Medicine.

Patients: Thirty-two patients with clinically and radiographically diagnosed CNF with and without DNM were included.

Interventions: Catheters were introduced into the infected space through the patients’ necks under sonographic and x-ray fluoroscopic guidance.

Main Outcome Measures: Treatments, clinical course, complications, and mortality were evaluated.

Results: Catheter drainage was successfully performed in all patients. The CNF was due to pharyngeal infection in 14 patients (44%) and dental infection in 14 other patients (44%). Mediastinal extension occurred in 14 patients (44%). Overall mortality was 3.1%; only 1 patient with DNM died due to Clostridium sepsis. Both pharyngeal origin and diabetes mellitus were significantly associated with the development of DNM. More intensive treatment is necessary for patients with CNF with DNM than for patients with CNF without DNM.

Conclusion: Percutaneous catheter drainage may be used as an effective treatment for CNF with and without DNM.


Cervical necrotizing fasciitis (CNF) and descending necrotizing mediastinitis (DNM) are progressive polymicrobial infections associated with high mortality rates (25%-40%). They most commonly originate from dental or pharyngeal infection. Because of the rapid and fulminant course of necrotizing fasciitis, prompt recognition, adequate antimicrobial therapy, and early radical surgical debridement are the keys to a successful outcome. On the basis of computed tomography (CT) findings, many authors have recommended transcervical or transthoracic surgical mediastinal drainage, others have reported a thoracoscopic approach. The optimal surgical drainage method is controversial. Since October 1998, we have performed percutaneous catheter drainage instead of conventional surgical drainage for the treatment of CNF and DNM. Our research group recently reported that percutaneous catheter drainage as a novel treatment for CNF and DNM is less invasive than conventional surgical drainage, and it controlled infection effectively. We found several advantages of percutaneous catheter drainage compared with open surgical drainage. Percutaneous catheter drainage areas are less likely to become secondarily infected by antibiotic-resistant bacteria, and percutaneous catheter drainage seems superior to surgical drainage in terms of pain control and prevention of protein leakage from the wound. In the present study, we evaluated the clinical utility of our method for treatment of CNF with and without DNM.

METHODS

PATIENTS

Thirty-two patients who were hospitalized in our critical care center between October 1998 and July 2005 with clinically and radiographically diagnosed CNF with or without DNM.
were included in this study. Radiographic diagnosis drew on CT (Asteion TSX-021A; Toshiba Medical Systems Corporation, Otawara, Tochigi, Japan) in all cases showing diffuse thickening of cervical fascial planes and fat with gas tracking along fascial planes. Multidetector CT was carried out with a field of view of 240 mm, a collimation of $4 \times 1$ mm, effective section thickness of 2 mm, increment of 1 mm, scan time of 0.75 seconds per 360° rotation, and tube voltage of 120 kV, 230 mA per section. The images were transferred to a workstation (Terarecon Aquarius Workstation, version 3.1; San Mateo, California), running a software package for generating multiplanar reconstructions and maximum intensity projections. All patients were treated with percutaneous catheter drainage. Patients who had undergone aggressive surgical treatment before admission to our center were excluded from the study.

We evaluated clinical features of all patients with CNF and compared those with DNM (DNM group, n=14) and without DNM (non-DNM group, n=18). The following patient characteristics were evaluated: sex, age, primary site of infection, findings of initial microbiologic culture, underlying condition, time from appearance of symptoms to admission at our center, initial C-reactive protein level, and total leukocyte count (immature to total neutrophil ratio). The following aspects of medical treatment were evaluated: number of catheters, duration of mechanical ventilation, duration of antibiotic therapy, and length of the intensive care unit (ICU) stay. Clinical outcomes were evaluated according to length of the ICU stay, complications, and mortality rate.

**CATHETER DRAINAGE**

Intravenous contrast-enhanced CT with iodine-based contrast agents was performed in all patients, and CT was used to confirm the extent of infection and to identify the space requiring drainage (Figure 2 and Figure 3). After nasotra-

![Figure 1](https://archotol.jamanetwork.com/)

**Figure 1.** The changes in treatment for cervical necrotizing fasciitis (CNF) and descending necrotizing mediastinitis. A, Neck swelling with redness in patient with CNF. B, Neck after surgical drainage. C, Neck after percutaneous catheter drainage.

![Figure 2](https://archotol.jamanetwork.com/)

**Figure 2.** Contrast-enhanced computed tomographic scan shows cervical necrotizing fasciitis without descending necrotizing mediastinitis. Marked edema of the subcutaneous fat is present with gas in the left masticator space to buccal space (arrow).
thyroid into the infected space targeting any low-echoic lesion with fluid collection or hyperechoic folliculi showing scattered collections of gas (Figure 4).

For catheter drainage, a No. 7 French catheter kit for percutaneous transhepatic bile duct drainage (PTCD Kit; Create Medic, Yokohama, Japan) was used. We were able to guide the catheter using an angiography guidewire with contrast medium into all infected spaces, retropharyngeal, parapharyngeal, anterior mediastinum, and posterior mediastinum. Fluid extracted from each catheter was sent to the laboratory for bacterial culture analysis. To examine the efficacy of catheter drainage, we injected contrast medium from each catheter and performed CT scanning (Figure 5). If the scan revealed any infected space without contrast medium, drainage was considered insufficient and another catheter was added. Multidetector CT with thin slice increments allowed high resolution coronal and sagittal reformations, which facilitated depicting catheter placement and course (Figure 6). Catheters were removed when we confirmed radiographic improvement and decrease and sterility of the drainage fluid.

ANTIBIOTIC THERAPY

Treatment with benzylpenicillin potassium (20 million U/d) for 2 days and imipenem cilastatin (1 g/d) for 7 days was initially administered to all patients. In all cases, the initial regimen was subsequently modified according to bacteriologic findings and antibiotic sensitivity testing. Termination of antibiotic therapy was dependent on improved CT findings and a decreased C-reactive protein level. Amphotericin B (900 mg/d) was also administered to each patient via nasogastric tube for decontamination of the gastric tract.

STATISTICAL ANALYSIS

Data are presented as mean (SD). The unpaired t test was used for analysis of differences between CNF with and without DNM. The $\chi^2$ test was used to analyze differences in the origin of infection. Statistical significance was accepted at $P < .05$.

RESULTS

OVERALL PATIENT CHARACTERISTICS

Over a 7-year period, 32 patients with CNF with or without DNM were referred to our ICU. The patients included 26 men (81%) and 6 women (19%) ranging in age from 19 to 81 years (mean [SD] age, 58.7 [16.7] years). Mean time from the onset of symptoms until hospita-
In 11 of the 32 cases (34%), an underlying condition that may have favored development of the infection was found: diabetes mellitus in 8 cases, renal failure in 2, and alcoholism in 1. In the remaining 21 cases, CNF developed in otherwise healthy patients. Cervical necrotizing fasciitis was due to pharyngeal infection in 14 patients (44%), dental infection in 14 other patients (44%), parotitis in 1 patient, and an unknown cause in 3 patients. Mediastinal extension occurred in 14 patients (44%).

Figure 5. Computed tomography (CT) images taken before (A) and after (B) catheter drainage. A, The CT image shows infection present in the sublingual space. B, The CT image acquired after catheter drainage shows contrast medium present in the infected spaces.

Figure 6. Computed tomography scans after catheter drainage. The large image on the left represents a maximum intensity projection image with numbered lines indicating planes of further evaluation: (1) at the neck level, there is a catheter in the retropharyngeal space (arrow); (2) at the upper thorax level, there is a catheter in the anterior mediastinum and another 2 in the posterior mediastinum (arrows); and (3) at the middle thorax level, there is a catheter in the anterior mediastinum and another in the posterior mediastinum (arrows) (same catheters as seen in subpanel 2).
Table 1. Microbiologic Findings of Primary Cultures

<table>
<thead>
<tr>
<th>Bacterial Finding</th>
<th>Cultures, No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streptococcus</td>
<td>27</td>
</tr>
<tr>
<td>Prevotella or Bacteroides</td>
<td>22</td>
</tr>
<tr>
<td>Propionibacterium</td>
<td>5</td>
</tr>
<tr>
<td>Peptostreptococcus</td>
<td>2</td>
</tr>
<tr>
<td>Other (Fusobacterium, Staphylococcus, Bilophila, Lactobacillus, Neisseria, Clostridium, Klebsiella, Porphyromonas)</td>
<td>8</td>
</tr>
</tbody>
</table>

Abbreviations: CRP, C-reactive protein; DNM, descending necrotizing mediastinitis; HbA1c, hemoglobin A1c; ICU, intensive care unit; NR, not reported.

Table 2. Clinical Characteristics of Patients With Cervical Necrotizing Fasciitis

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Non-DNM Group</th>
<th>DNM Group</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality, No.</td>
<td>0 of 18</td>
<td>1 of 14</td>
<td>NR</td>
</tr>
<tr>
<td>Origin, pharyngeal No./dental</td>
<td>4/14</td>
<td>10/4</td>
<td>.005</td>
</tr>
<tr>
<td>and others, No.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HbA1c, %</td>
<td>5.1 (0.6)</td>
<td>7.4 (2.6)</td>
<td>.004</td>
</tr>
<tr>
<td>WBC, ×10^3/µL</td>
<td>16.6 (5.6)</td>
<td>12.8 (6.0)</td>
<td>.07</td>
</tr>
<tr>
<td>Immature cells, %</td>
<td>11.0 (7.7)</td>
<td>21.1 (24.1)</td>
<td>.17</td>
</tr>
<tr>
<td>CRP, mg/L</td>
<td>282 (83)</td>
<td>285 (123)</td>
<td>.09</td>
</tr>
<tr>
<td>Catheters, No.</td>
<td>2.4 (1.2)</td>
<td>6.9 (4.1)</td>
<td>.002</td>
</tr>
<tr>
<td>Duration of mechanical</td>
<td>7.2 (4.6)</td>
<td>13.8 (11.7)</td>
<td>.04</td>
</tr>
<tr>
<td>ventilation, d</td>
<td>10.4 (4.7)</td>
<td>16.1 (16.2)</td>
<td>.16</td>
</tr>
<tr>
<td>Duration of antibiotic therapy, d</td>
<td>17.4 (9.4)</td>
<td>29.1 (25.0)</td>
<td>.07</td>
</tr>
<tr>
<td>ICU stay, d</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: CRP, C-reactive protein; DNM, descending necrotizing mediastinitis; HbA1c, hemoglobin A1c; ICU, intensive care unit; NR, not reported; WBC, white blood cell count.

SI conversion factors: To convert HbA1c to a proportion of total hemoglobin, multiply by 0.01; to convert CRP to nanomoles per liter, multiply by 0.001; to convert WBC to ×10^3/µL, multiply by 0.001.

MICROBIOLOGIC FINDINGS OF PRIMARY CULTURES

Numerous bacteriologic cultures were performed in each case (Table 1). Specimens obtained by puncture aspiration of the site of infection showed the presence of mixed flora of anaerobic and aerobic bacteria. Streptococcus species and Prevotella or Bacteroides were most commonly isolated. Clostridium species was found in only 1 instance.

CLINICAL OUTCOMES

Overall mortality was 3.1%; only 1 patient died. This was a patient with DNM who died from Clostridium sepsis. The mean (SD) duration of antibiotic therapy was 12.9 (11.4) days. The mean duration of mechanical ventilation was 9.9 (8.8) days, and mean length of the ICU stay was 22.5 (19) days. Complications included jugular vein thrombosis in 8 patients, septic shock in 4, compromised airway in 2, empyema in 2, and bronchocavitary fistula in 1.

Two patients with DNM experienced complications during the catheter insertion procedure. One had mediastinal hemorrhage due to minor arterial injury, but the hemorrhage stopped spontaneously. The other had esophageal puncture when the catheter was introduced from the neck into the posterior mediastinum. The puncture wound was treated conservatively without further complication.

DIFFERENCES IN CLINICAL FEATURES OF CNF WITH AND WITHOUT DNM

No statistically significant difference was found between the DNM and non-DNM groups in mortality or complications. No statistically significant difference was found between the 2 groups in sex ratio (male to female ratio in the non-DNM group, 14:4 vs 12:2 in the DNM group), age (55.7 [19.4] years in the non-DNM group vs 62.6 [12.0] years in the DNM group), results of initial microbiologic culture, time from the appearance of symptoms to admission to our center (5.3 [2.5] days in the non-DNM group vs 5.2 [2.5] days in the DNM group), C-reactive protein level, or total leukocyte count (Table 2).

The presence of diabetes (n=1 in the non-DNM group vs n=7 in the DNM group) and primary site of infection differed significantly between the 2 groups. The CNF was of pharyngeal origin in 22% of patients without DNM (n=4) and in 71% of patients with DNM (n=10). The mean (SD) hemoglobin A1c level was 5.1% (0.6%) in the non-DNM group and 7.4% (2.6%) in DNM group (P=.004). To convert hemoglobin A1c to a proportion of total hemoglobin, multiply by 0.01. Both pharyngeal origin and diabetes mellitus were significantly associated with the development of DNM (Figure 7).

With respect to treatment, more catheters were used for patients in the DNM group than for patients in the non-DNM group (6.9 [4.1] for the DNM group vs 2.4 [1.2] for the non-DNM group) (P=.002), and the mean duration of mechanical ventilation was significantly longer for patients with DNM than for patients without DNM (13.8 [11.7] days for the DNM group vs 7.2 [4.8] days for the non-DNM group) (P=.04). No statistically significant difference was found between the 2 groups in the duration of antibiotic therapy or ICU stay. More intensive treatment was required by patients with DNM than by patients without DNM (Figure 8).

COMMENT

Necrotizing fasciitis is a fast-spreading soft tissue infection of polymicrobial origin characterized by necrosis of the subcutaneous tissue and superficial fascia. The invasiveness is often influenced by synergistic interactions among multiple species. A predominance of male patients is commonly reported in the literature. Despite the introduction of antimicrobial therapy and CT imaging, CNF with DNM has continued to produce mortality rates between 25% and 40%. Spread of infection from the cervical region to the thorax is considered an ominous sign; the associated mortality is high. This poor prognosis could be in part due to the difficulty of establishing and maintaining adequate surgical drainage as DNM spreads among the fascial compartments of the neck and chest.

Because of the anatomic relations in the cervicothoracic region and the progressive nature of DNM, contro-
versy exists as to the optimal surgical approach. Our group recently reported that percutaneous catheter drainage as a novel treatment for CNF and DNM controlled infection effectively and was superior to surgical drainage in terms of pain control and prevention of protein leakage from the wound.10 In the present study, we evaluated the clinical course of 32 patients with CNF treated with percutaneous catheter drainage and compared clinical outcomes between those with and those without DNM. All patients except 1 survived without serious complication. The mortality rate of 3.1% in our study was lower than that previously reported in the literature.11-13 Although some authors believe that early radical surgical drainage is the most important factor affecting outcome,12,13 we effectively controlled CNF even with DNM by percutaneous catheter drainage. Streptococcus was found in 84% of our cases (n=27), and Bacteroides or Prevotella was found in 69% (n=22). We used benzylpenicillin potassium to target Gram-positive cocci and imipenem cilastatin to target Gram-negative bacteria, particularly anaerobes, and these antibiotics were effective. Percutaneous catheter drainage is a closed drainage system that decreases secondary infection by antibiotic-resistant bacteria. Only 1 patient died, and this was due to Clostridium sepsis. Nakamura et al14 reported that most gas-producing infections in the head and neck region are nonclostridial and proceed along fascia, whereas clostridial infections progress in muscular layers and are often lethal.

We evaluated the clinical features of CNF with and without DNM. In this series, 14 patients with thoracic extension of infection experienced mediastinitis. Both pharyngeal origin and diabetes mellitus were significantly

![Figure 7](https://archotol.jamanetwork.com/)

**Figure 7.** Risk factors for mediastinal invasion in cervical necrotizing fasciitis (CNF). A, In patients with descending necrotizing mediastinitis (DNM), 71% of infections were of pharyngeal origin (P=.005). B, Patients with DNM had higher hemoglobin A1c (HbA1c) levels than patients without DNM. To convert HbA1c to a proportion of total hemoglobin, multiply by 0.01 (error bars indicate SD).

![Figure 8](https://archotol.jamanetwork.com/)

**Figure 8.** Cervical necrotizing fasciitis (CNF) treatment in patients with and without descending necrotizing mediastinitis (DNM). Error bars indicate SD. A, More catheters were needed to treat patients with DNM than to treat those without DNM. B, The mean duration of mechanical ventilation was significantly longer in patients with DNM than in those without DNM.
associated with the development of DNM. Anatomic spread of infection from the craniocervical region to the thorax is well recognized. Potential spaces in the neck (pretracheal, retrovisceral, and prevertebral) contain loose tissue and, by virtue of their communication with the pericardium, parietal pleura, and mediastinum, readily serve as portals of entry for oropharyngeal or cervical infection into the chest.1,15 Easy spread from the pharyngeal source to the parapharyngeal or retropharyngeal space allows for downward spread into the mediastinum.16 This anatomic feature accounts for pharyngeal origin as a factor associated with DNM. In other recent studies of DNM, the infection was more frequently of pharyngeal origin than of dental origin.1,17-19

Several factors, including obesity, diabetes mellitus, severe liver disease, immunosuppression, and renal failure, have been implicated in the occurrence of necrotizing fasciitis.4 Patients with diabetes mellitus, which impairs leukocyte function and contributes to suppression of the host’s immune system, have been considered at an unusually high risk of developing the infection. Our study showed that diabetes mellitus is a factor significantly associated with DNM.

In patients with CNF without DNM, fewer catheters were needed to achieve drainage (non-DNM group, 2.4 [1.2] vs DNM group, 6.9 [4.1]), and the duration of mechanical ventilation was shorter (non-DNM group, 7.2 [4.8] days vs DNM group, 13.8 [11.7] days). More intensive treatment was needed for our patients with DNM than for those without DNM. However, even in patients with DNM, we were able to effectively control infection. Under real-time sonographic guidance and fluoroscopy, catheters could be inserted and added into the targeted infected space including mediastinum in all cases. The low mortality and complication rates in our study support the notion that percutaneous catheter drainage may be a safe and effective treatment for CNF in patients with or without DNM. Furthermore, percutaneous catheter drainage is less invasive than surgical drainage.10 Thus, catheter drainage can serve as an alternative approach for management of CNF with and without DNM.

In 32 patients with CNF treated with percutaneous catheter drainage, both pharyngeal origin and diabetes mellitus were significantly associated with the development of DNM. More intensive treatment (greater number of catheters, longer duration of mechanical ventilation) was necessary for patients with DNM than for patients without DNM. The low mortality rate in our study showed that percutaneous catheter drainage may be used as an effective treatment for CNF with and without DNM.

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Author Contributions: Dr Sumi had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Sumi, Ogura, Nakamori, Kuwagata, Tanaka, and Sugimoto. Acquisition of data: Sumi, Ukai, Tasaki, Shimazu, and Sugimoto. Analysis and interpretation of data: Sumi, Ogura, Kuwagata, Shimazu, and Sugimoto. Drafting of the manuscript: Sumi, Ogura, Nakamori, Ukai, Tasaki, Kuwagata, Shimazu, Tanaka, and Sugimoto. Critical revision of the manuscript for important intellectual content: Ogura, Shimazu, and Sugimoto. Statistical analysis: Sumi and Tasaki. Administrative, technical, and material support: Ogura, Ukai, Tasaki, Kuwagata, Shimazu, and Sugimoto. Study supervision: Ogura, Nakamori, Kuwagata, Shimazu, Tanaka, and Sugimoto. Financial Disclosure: None reported.

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