Odontogenic Versus Nonodontogenic Deep Neck Space Infections: CT Manifestations

Hyung-Jin Kim, M.D., Eui Dong Park, M.D., Jung Hee Kim, M.D., Jae Hyoung Kim, M.D., Eui Gee Hwang, M.D., Sung Hoon Chung, M.D.

Purpose: The purpose of this study was to evaluate computed tomographic (CT) findings of deep neck space infection (DNSI) with particular attention to the differences in the spaces involved and in complications between odontogenic and nonodontogenic groups.

Materials and Methods: Forty-four patients (21 odontogenic and 23 nonodontogenic) were included in this study. Among odontogenic DNSIs, 15 had the dental infection in the second or third mandibular molar. We compared the CT features between odontogenic and nonodontogenic DNSIs with special emphasis on the differences in the spaces involved and in the rate and type of complications.

Results: In all patients, CT clearly differentiated abscess from cellulitis. The most common spaces involved in 21 patients with odontogenic DNSI were the parapharyngeal (n=18), the submandibular (n=18), the anterior visceral (n=13), the masticator (n=9), and the sublingual (n=7) spaces. In contrast, in 23 patients with nonodontogenic DNSI, the anterior visceral space (n=14) was most frequently involved. The parapharyngeal, the submandibular, and the masticator spaces were statistically more frequently involved in odontogenic than in nonodontogenic DNSI (p<.05). Twenty-two patients had one or more complications shown by CT, of which airway compromise was more frequent and severe in odontogenic than in nonodontogenic DNSI.

Conclusion: We conclude that the parapharyngeal, the submandibular, and the masticator spaces are more significantly vulnerable in odontogenic DNSI than in nonodontogenic DNSI. The predilection for certain spaces of the neck in odontogenic DNSI seems to originate from the intimate relationship of the mandibular molars to the adjacent deep neck spaces.

Index Words: Neck, infections
Neck, CT
Teeth

A thorough knowledge of the anatomy of the deep fascial layers and spaces of the neck is essential to understand the passageway of deep neck space infection (DNSI), because serious life-threatening complications such as airway compromise, jugular vein thrombosis, mediastinal involvement, pericarditis, pneumonia, empyema, arterial erosion, or intracranial extension may ensue if the diagnosis and the treatment are delayed. Recently, dental infection has become one of the most important sources of DNSI (1, 2). It often has been described that the particular spaces of the neck tend to be involved in odontogenic DNSI. This mainly results from the close relationship between the position of the dental roots and the origin or insertion of the adjacent muscles of the jaw and the mouth floor (2, 3). Although there have been many descriptions concerning the usefulness of computed tomography (CT) in the evaluation of DNSI (4–14), less attention has been paid on the different modes of spread between odontogenic and nonodontogenic DNSIs in the radiologic literature (7, 10, 14). However, because of the reported
predilection of the certain spaces involvement in odontogenic DNSI, its early detection by CT may lead one to search for an odontogenic source and help one direct to the appropriate management without delay. Accordingly, the purpose of this study was to evaluate the usefulness of CT in patients with DNSI with special emphasis on the differences in the spaces involved and in complications between odontogenic and nonodontogenic DNSIs.

**MATERIALS and METHODS**

We reviewed the CT scans of 60 patients with DNSI examined between March 1989 and May 1993 in our institution. Of the 60 patients, the cause of DNSI could be identified by the medical history or physical examination in 44 patients who formed the basis of this study. There were 28 men and 16 women with their ages ranging from 3 to 78 years (mean, 42 years). The diagnosis was established by surgery in 31 patients and by the clinical signs and symptoms in 13 patients. The specific microorganisms were isolated from the culture in 26 patients, among whom Streptococcus species was the most common aerobe demonstrated in 17 patients.

Among the causes of DNSI identified, dental infection was the most frequent etiology (n=21), followed by trauma including surgery and foreign body injury (n=10), upper respiratory tract or tonsillar infection (n=8), septicemia (n=2), skin furuncle (n=1), erysipelas (n=1), and spread of infection by the infected second branchial cleft cyst (n=1). Among the 10 patients with trauma, there were three patients with fishbone injury, two in the cervical esophagus and one in the mouth floor, and one patient with antrum in the posterior neck, hematoma in the posterior neck following blunt injury, mandibular fracture, and hypopharyngeal perforation by blunt trauma each. In the remaining three patients, DNSI developed after surgery, two in the anterior neck and one in the posterior neck.

We classified the cause into odontogenic only if all of the following three criteria were met: (1) the presence of the dental infection should be documented by a dentist; (2) there should be an appropriate cause and effect chronological sequence between the dental problem and the clinical manifestations; and (3) other causes could be excluded clinically. Of the 21 patients with the dental infection, the specific teeth infected were the second or third mandibular molar in 15 patients, the first mandibular molar with or without the teeth anterior to it in four patients, and the second maxillary molar in one patient. In the remaining one patient, there were widespread caries in the mandibular teeth.

CT was performed with a GE 9800 scanner (GE Medical System, Milwaukee, Wis) after the IV administration of the contrast material. Axial scans were obtained in all patients with a 5–10 mm slice thickness and table incrementation through the region of interest. The additional coronal scans were obtained in some patients. If necessary, the gantry angle was modified to minimize artifacts from metallic dental reconstructions.

We reviewed CT scans, paying particular attention to the location and extent of the infectious process, the presence of an abscess to be drained, and the complication(s) associated with DNSI. Two radiologists interpreted the CT scans and reached a consensus. Involvement of each space by the infectious process was documented only on a present or absent basis. Abscess was considered to be present if there was discrete low density area with peripheral rim enhancement at CT. If there was only soft tissue swelling or infiltration which obliterated the fascial plane(s) at CT, cellulitis was considered. When abscess in one space was accompanied by the infiltration in the contiguous space(s) at CT, we considered the patient to have both abscess and cellulitis. We then compared the CT features between odontogenic and nonodontogenic DNSIs with special emphasis on the differences in the spaces involved and in the rate and type of complications.

According to the various authors, different terms have been applied to describe the fasciae and spaces of the deep neck. Among those, we largely adopted the terminology described by Harnsberger (15) in this paper.

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**Fig. 1.** A 74-year-old woman with the right third mandibular molar infection. CT scans at the level of the ramus (a) and the body (b) of the mandible show multiple abscesses in the right mastilicatior (arrow in a), submandibular (arrows in b), and sublingual (arrowheads in b) spaces. Note the higher attenuation (open arrow in a) in the right parapharyngeal space fat in comparison with the contralateral normal side.
RESULTS

Abscess versus Cellulitis

Of the 44 patients, seven patients were judged to have cellulitis alone and 37 patients to have both cellulitis and abscess based on CT. Incision and drainage procedure was performed in 31 out of 37 patients with abscess(es) and confirmed the CT findings. Six patients in whom CT showed a minimal amount of fluid collection without significant complication were treated with trial of needle aspiration followed by medication without single case of failure. All of seven patients whose CT showed cellulitis alone improved with medication only. Of the 37 patients who had abscess, gas bubbles within abscess were noted in 18 patients.

Differences in the Spaces Involved between Odontogenic and Nonodontogenic DNSIs

In general, in the patients with a more obvious clini-

Table 1. Differences in the Spaces Involved between Odontogenic and Nonodontogenic Deep Neck Space Infections (DNSIs)

<table>
<thead>
<tr>
<th>Anatomic Spaces Involved</th>
<th>Odontogenic DNI (n=21)</th>
<th>Nonodontogenic DNI (n=23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parapharyngeal space</td>
<td>18&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5</td>
</tr>
<tr>
<td>Submandibular space</td>
<td>18&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9</td>
</tr>
<tr>
<td>Anterior visceral space</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>Masticator space</td>
<td>9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2</td>
</tr>
<tr>
<td>Sublingual space</td>
<td>7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3</td>
</tr>
<tr>
<td>Carotid space</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Retropharyngeal space</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Posterior cervical space</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Parotid space</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Paraspinal space</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Space of Burns</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Superficial space</td>
<td>17</td>
<td>18</td>
</tr>
</tbody>
</table>

<sup>a</sup>Significant at p < .05 by X<sup>2</sup> analysis.

Fig. 2. A 79-year-old woman with the right second maxillary molar infection. CT scans at the level of the ramus (a) and the angle (b) of the mandible show multiple abscesses with air-fluid level in the right superficial (arrows) and deep (arrowheads in a) masticator, and parapharyngeal (open arrows) spaces.

Fig. 3. Nonodontogenic deep neck space infection. a. CT scan of a 68-year-old woman with the upper respiratory tract infection shows an abscess in the right anterior visceral space. b. CT scan of a 60-year-old woman with the upper respiratory tract infection shows an abscess in the retropharyngeal space.
cal history such as trauma, tonsillitis, skin furuncle, or the underlying neck cyst, it was easy to interpret CT findings concerning the primary site of infection. However, the massive involvement of the contiguous neck spaces seen in many patients in our study prevented us from telling the exact pathways of the spread of infection or the initial site of infection by CT with confidence. In many patients, infection seemed to violate the adjacent neck spaces without respecting the fascial barrier. Nevertheless, certain spaces of the neck were more frequently involved in odontogenic DNSI than in nonodontogenic DNSI. The differences in the spaces involved between odontogenic and nonodontogenic DNSIs are summarized in Table 1. Of the 21 patients with odontogenic DNSI, the parapharyngeal and the submandibular spaces were the two most common spaces involved seen in 18 patients each, followed by the anterior visceral, the masticator, and the sublingual spaces (Fig. 1 and 2). In contrast, of the 23 patients with nonodontogenic DNSI, the anterior visceral space (Fig.

### Table 2. Differences in Complications between Odontogenic and Nonodontogenic Deep Neck Space Infections (DNSIs)

<table>
<thead>
<tr>
<th>Complications</th>
<th>Odontogenic DNSI (n=21)</th>
<th>Nonodontogenic DNSI (n=23)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airway compromise</td>
<td>12&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Mediastinitis/medialstinal abscess</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Jugular vein thrombosis</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Empyema</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Pericarditis</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Aortic pseudoaneurysm</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

<sup>a</sup>Significant at p<.05 by χ² analysis.

**Fig. 4.** Complications of deep neck space infection.

a. Mediastinal abscess: CT scan of a 39-year-old man with a traumatic injury to the hypopharynx shows a gas-containing abscess involving the mediastinum.

b. Jugular vein thrombosis: CT scan of a 44-year-old man with the left second mandibular molar infection shows an abscess containing gas bubbles within the left carotid sheath. The laterally displaced internal jugular vein is severely compressed and appears in crescentic shape (arrows). Surgery confirmed the partially eroded and thrombosed jugular vein.

c. Pseudoaneurysm formation: CT scan of a 52-year-old woman with the fishbone injury to the hypopharynx shows a large abnormal vascular structure (arrow) beneath the aortic arch, accompanied by the mediastinal infection. At surgery, inadvertent dissection of the mediastinum caused massive uncontrolled hemorrhage.
3a) was most frequently involved seen in 14 patients, followed by the submandibular, the retropharyngeal (Fig. 3b), the posterior cervical, and the parapharyngeal spaces. The parapharyngeal, the submandibular, and the masticator spaces were statistically more frequently involved in odontogenic than in nonodontogenic DNSI(p< .05). According to the specific teeth infected, there was no significant difference in the spaces involvement among the patients with odontogenic DNSI.

Complications of DNSI
Twenty-two patients had one or more complications shown by CT(Table 2). These were airway compromise, mediastinal involvement(Fig. 4a), jugular vein thrombosis(Fig. 4b), empyema, pericarditis, and pseudoaneurysm of the aortic arch(Fig. 4c). Among the various complications, airway compromise was statistically more frequent in odontogenic than in nonodontogenic DNSI((p < .05).

DISCUSSION
Deep neck space infection involves the spaces of the head and neck which are surrounded and compartmentalized by the three layers of the deep cervical fascia. It can spread via lymphatic vessels, blood vessels, or direct extension, leading to multiple contiguous spaces involvement, and thus be categorized into transpatial disease(16). Since the advent of antibiotics, the incidence of DNSI has continuously declined, but it still occasionally causes serious life-threatening complications. For the early diagnosis and the appropriate treatment to reduce a morbidity and mortality, a comprehensive understanding of the pertinent cervical anatomy is crucial, described elsewhere(1,13,17-19).

Etiology of DNSI
In the preantibiotic era, pharyngeal infection was the most common cause of DNSI. However, with the introduction of antibiotics, various other portals of entry have been recognized more importantly than before(1, 11-13,20); these are intravenous drug abuse, odontogenic infection, skin infection, ear infection, cervical adenitis, trauma, and so forth. It has also been reported that the cause of DNSI could not be found up to 50% of the cases(20). Concerning odontogenic infection, the prevalence has been reported in 9—34%(1, 12, 20). If we include the 16 patients with unknown etiology in our study, odontogenic infection comprises 35%(21/60) of the etiology of DNSI.

Abscess versus Cellulitis
There are different opinions about the optimal timing of surgical therapy for DNSI. While recent investigators advocate early incision and drainage during the cellulitis stage(20), the more or less prevailing traditional thought is that no drainage should be attempted during the stage of cellulitis(5, 9). It is often difficult to determine clinically whether a patient with a painful tender and swollen neck has an abscess or has cellulitis alone, because the characteristic fluctuation of an abscess frequently cannot be felt in the region of the deep neck(12, 13). In the study of 51 patients with neck abscess, Tom and Rice(12) reported that fluctuation was noted only in 27%. One of the most important values of CT in the evaluation of DNSI is its high reliability on the

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Fig. 5. Diagram demonstrating the different pathways of the dental infection according to the relationship between the buccinator muscle attachment to the alveolar process and the position of the root apices of the molar teeth. If a maxillary molar with a long root extending beyond the buccinator attachment is infected, infection can reach the buccal space with ease, from which it can spread into the masticator or submandibular space. On the contrary, if a mandibular molar with a short root above the buccinator attachment is infected, infection is preponderantly directed to the oral vestibule.

Fig. 6. Diagram demonstrating the different pathways of the dental infection according to the relationship between the mylohyoid muscle attachment to the mandible and the position of the root apices of the mandibular teeth. If a mandibular teeth with a long root extending beyond the mylohyoid ridge is infected as shown on the right side of the diagram, infection can directly spread to the submandibular space. In contrast, if a mandibular teeth with a short root above the mylohyoid ridge is infected as shown on the left side of the diagram, infection tends to involve the sublingual space initially.
differentiation between abscess and cellulitis, thus it is useful for treatment planning and management of the patients. The distinguishing feature of abscess vs cellulitis on CT scan is the enhancing rim that represents the wall of abscess. In our study, surgery confirmed the CT findings in all of 31 patients whose CT showed a considerable amount of abscess fluid. In six patients in whom CT showed a minimal amount of abscess fluid, we simply aspirated the fluid followed by medication instead of incision and drainage. With this method, we could achieve the favorable clinical outcome in most of the cases.

**Differences in the Spaces Involved between Odontogenic and Nonodontogenic DNSIs**

Although the massive involvement of the contiguous neck spaces often made it difficult to make sure about the exact pathways of the spread of infection in this study, our results showed that there is a different tendency of the space involvement between odontogenic and nonodontogenic DNSIs. This knowledge of the predilection sites involved in odontogenic DNSI is important because it may lead a radiologist to warn the clinician to search for an underlying or hidden odontogenic source and help guide to remove it without delay. In our study, the parapharyngeal, the submandibular, and the masticator spaces were statistically more frequently involved in odontogenic than in nonodontogenic DNSI. Although the sublingual space was also more frequently involved in odontogenic(7/21) than in nonodontogenic(3/23) DNSI, it was not statistically significant.

More than one anatomical relationships between the mandibular or maxillary molars and the adjacent deep neck spaces may result in the different spaces involvement between the two groups. Several important anatomic details are described below. First, in the region of the mandibular and maxillary molars, it is the attachment of the buccinator muscle to the base of the alveolar process that directs the path of the dental infection(3). If there is an infection of the mandibular or maxillary molars which have long roots extending beyond the buccinator attachment, as in the second or third mandibular and maxillary molars, it can reach the buccal space with ease, from which it can spread into the masticator or submandibular space(3, 19) (Fig. 5). Second, infection from a mandibular molar that directly perforates the buccal or lingual plate of the mandible can invade the superficial or deep masticator space, respectively(3). Third, the relation of the apices of the mandibular teeth to the mandibular attachment of the mylohyoid muscle may be subject to the individual variation. In cases where it extends below the mylohyoid ridge, the submandibular space can be directly involved; on the other hand, in cases where it lies above the mylohyoid ridge, the sublingual space is involved first(Fig. 6).

**Complications of DNSI**

The most important role of CT in the evaluation of DNSI is probably the identification of serious complications. A variety of complications associated with DNSI have been reported; airway compromise, jugular vein thrombosis, mediastinal involvement, pericarditis, pneumonia, empyema, arterial erosion, intracranial extension, or necrotizing fasciitis(5, 8, 9, 23—25). Recognition of these potentially life-threatening complications as soon as possible should lessen morbidity and mortality by the prompt surgical procedures. In our study, airway compromise and mediastinal involvement were the two most frequent complications of DNSI. Although the reason is not clear, the airway com-
promise was more frequent and severe in odontogenic than in nonodontogenic DNSI, similar to the results of Tom and Rice(12). Mediastinal involvement was less prevalent in odontogenic DNSI in our study. The spread of DNSI into the mediastinum can occur via the anterior visceral space or the retropharyngeal space, either of which has components that cross the thoracic inlet(13). In addition, mediastinitis can also result from suppuration in the parapharyngeal space spreading down through the carotid sheath(11). A single mortality case occurred in a patient with fishbone injury to the cervical esophagus. In this patient, the mediastinal extension of DNSI caused the erosion of the aortic arch resulting in the formation of a pseudoaneurysm (Fig. 4c).

We conclude that somewhat different modes of spread of infection exist between odontogenic and nonodontogenic DNSIs and this difference originates from the intimate relationship of the mandibular molars to the adjacent deep neck spaces. CT should be used as the principal diagnostic tool in the evaluation and management of DNSI.

REFERENCES

CT를 이용한 치성과 비치성 심부 경부 감염의 비교: 파급된 경부 공간을 중심으로

1 경상대학교 의과대학 진단방사선과학교실
2 경상대학교 의과대학 이비인후과학교실

김형진 · 박의동 · 김정희 · 김재형 · 황의기 · 정성훈

목 적: 본 논문의 목적은 CT를 이용하여 치성과 비치성 심부 경부 감염에 있어서 침범된 경부 공간과 합병증의 차이를 알 아보기 위함이다.

대상 및 방법: 심부 경부 감염으로 확진되고 임상적으로 그 원인을 파악할 수 있었던 44명의 환자를 대상으로 하였으며 이 중 치성 감염자가 21명, 비치성 감염자가 23명이었다. 21명의 치성 감염자 중 15명에서 단형이 된 치아 병변은 제 2 또는 제 3 하악 대구치에 있었다. 저자들은 치성과 비치성 심부 경부 감염의 두 군에서 침범된 심부 경부 공간과 합병증의 양상에 상이 한 점이 있는지에 주안점을 두고 CT 소견을 분석하였다.

결 과: 전예에서 CT로 농양과 봉괴의 구분이 가능하였다. 21명의 치성 감염자군에서 가장 흔히 침범되는 심부 경부 공간은 각각 18명에서 관찰된 부인두강과 하악하강이었고 내장강이 13명, 저작강이 9명, 설하강이 7명에서 침범되었다. 반면 23명의 비치성 감염자군에서는 내장강이 14명으로 가장 흔히 침범되었다. 부인두강, 하악하강과 저작근강은 치성 감염자군 에서 비치성 감염자군보다 통계학적으로 유의하게 더 흔히 침범되었다. 전체 환자 중 22명에서 하나 또는 그 이상의 합병증 이 CT에서 관찰되었는데 이중 기도 압박의 소견은 치성 감염자군에서 통계학적으로 유의하게 더 흔하였다.

결 론: 치성 감염시 심부 경부 공간들 중 부인두강, 하악하강과 저작근강은 비치성 감염꺼보다 쉽게 침범되며 치성 감염에 의한 이러한 특정 공간의 침범은 하악 대구치와 그에 인접한 경부 공간들간의 긴밀한 해부학적 관계에 기인한 것으로 사료 된다.