Deep facial infections of odontogenic origin: CT assessment of pathways of space involvement.

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Deep Facial Infections of Odontogenic Origin: CT Assessment of Pathways of Space Involvement

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PURPOSE: **We investigated the pathways of spread of odontogenic infection in the facial and neck spaces.**

METHODS: **CT scans of 45 patients with extensive spread of odontogenic infection into the facial and neck spaces were analyzed to document pathways of spread.**

RESULTS: **Odontogenic infections arising in the mandible first spread upward, into the masseter and/or medial pterygoid muscles in the masticator space, and downward, into the sublingual and/or submandibular spaces, and then spread into the spaces or muscles adjacent to one or more of these locations. Infections from the masseter muscle spread into the parotid space to involve the temporalis and lateral pterygoid muscles. Infections from the medial pterygoid muscle spread into the parapharyngeal space to involve the lateral pterygoid muscle. Infections in the maxilla did not spread downward; instead, they tended to spread upward and superficially into the temporal and/or masseter spaces and deeply involve the lateral and/or medial pterygoid muscles in the medial masticator space.**

CONCLUSION: **CT may be useful to depict the extent of infection and to plan treatment of extensive odontogenic infection, which can be life threatening when therapy is ineffective.**

Odontogenic infections rarely extend beyond the jaw bone barriers into the deep spaces of the face and neck (1). But once they occur, they are often difficult to assess accurately by clinical and conventional radiologic techniques, and the outcome may be serious and potentially life threatening (2). Because of its ability to locate diseases in clinically inaccessible portions of the body, computed tomography (CT) has been used to evaluate deep facial and neck infections (2–4). However, CT studies in large populations of patients with widespread deep infections of the neck originating from odontogenic infections have been scarce, and pathways through which the inflammatory processes extend have not been studied intensively. We assessed profiles of involvement of the deep facial and upper neck spaces by infections of odontogenic origin.

Methods

Patients

The study population included 45 patients (30 male and 15 female, 6 to 80 years old) with extended odontogenic infection in the facial and neck spaces. Of these, 38 were extensions from mandibular infections and seven were from maxillary infections. Odontogenic origins of infection were confirmed by plain radiography of the jaw bones and by the patients' clinical course. In some patients, varying degrees of osteitis or osteomyelitis were evident around the roots of the infected tooth on CT scans. Typically, patients presented with a recent onset of tender swelling of the face and neck. Some infections were associated with fever and leukocytosis at the time of the CT examination, but the clinical features depended on the treatment that had been given before CT was performed. We excluded from the study patients who had primary maxillary sinusitis. In most of the patients, we confirmed the presence of infection in the spaces by surgical drainage (28 patients) or by needle biopsy aspiration (10 patients) during the patients' hospital stay. In the remaining seven patients, infection was confirmed by regression after antibiotic treatment.

CT

CT was performed with patients in the supine position. After intravenous injection, via rapid drip, of 100 mL of contrast medium (iopamidol, Iopamiron 300, Schering, Germany), axial scans were obtained contiguously, with a section thickness of 4 mm and with the scan plane parallel to the inferior margin of the mandible and to the Frankfurt horizontal plane for the maxilla. Involvement of facial and neck spaces by extending infection was determined on CT scans by the following criteria: 1) enlargement of involved muscle(s) and/or obliteration by soft-tissue densities of the interfacial fat spaces (the parotid and submandibular glands may be enlarged and/or show increased CT values when the parotid and submandibular spaces are involved, respectively); and 2) the appearance of low-attenuation areas surrounded by varying degrees of rim enhancement after intravenous injection of contrast medium.

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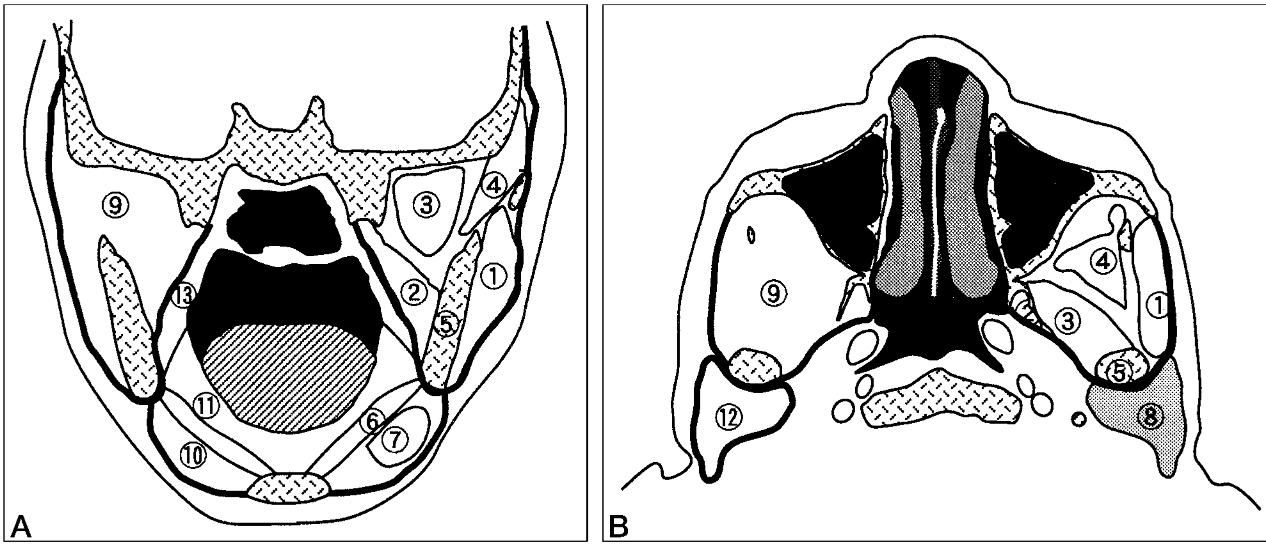

FIG 1. Anatomic schemata of the normal masticator, sublingual, submandibular, parapharyngeal, and parotid spaces in coronal (*A*) and axial (*B*) projections. *1* indicates masseter muscle; *2*, medial pterygoid muscle; *3*, lateral pterygoid muscle; *4*, temporalis muscle; *5*, mandible; *6*, mylohyoid muscle; *7*, submandibular gland; *8*, parotid gland; *9*, masticator space; *10*, submandibular space; *11*, sublingual space; *12*, parotid space; and *13*, parapharyngeal space.

Facial and Neck Space Anatomy

We assessed the CT appearance of the facial and neck spaces (including the masticator, parotid, parapharyngeal, retropharyngeal, buccal, submandibular, and sublingual spaces) according to descriptions published previously (5, 6). The masticator space was further assessed as to which of the masticator muscles (masseter, medial pterygoid, lateral pterygoid, and temporalis) were involved (Fig 1). We also assessed involvement by infections in deeper spaces, such as the prevertebral and vascular spaces.

Results

CT Features

Typical CT features of facial and neck space involvement are shown in Figure 2. These included a low-attenuation area of water–to–soft tissue density surrounded by varying degrees of rim enhancement after contrast administration. The low-attenuation area was either lobulated (Fig 2A) or multifocal (Fig 2B). The spread of infection could be observed as a massive swelling of the involved muscle (Fig 2C), and was often associated with obliteration of the fat spaces between the neighboring muscles. Enlarged muscles were often homogeneous, but areas of lower attenuation were also observed, especially when contrast material was used. This appearance is suggestive of abscess formation (Fig 2D).

Fascial Infections Derived from Mandibular Odontogenic Origins

Tables 1 and 2 summarize the CT profiles of the spread of odontogenic infection into the facial and neck spaces. The masticator space—which encompasses the posterior body of the mandible, ramus, and condyle, and a part of the alveolar ridge of the mandible as well as associated masticatory muscles (Fig 1A and B)—was found to be most frequently involved in the spread of mandibular infection (in 33 [87%] of 38, Table 2). Of the masticator muscles involved in these patients, the masseter (29 [76%] of 38) and medial pterygoid (24 [63%] of 38) muscles were most often involved. The temporalis (10 [26%] of 38) and lateral pterygoid (8 [21%] of 38) muscles were less frequently involved (Table 2). In no case was infection of the anterior teeth found to be associated with infection of the masticator space.

Spaces other than the masticator space were involved much less frequently. The parapharyngeal space, which is adjacent medially to the medial pterygoid muscle in the masticator space (Fig 1A), was frequently involved (19 [79%] of 24) when the medial pterygoid muscle was involved, and the medial pterygoid muscle was always involved when the parapharyngeal space was involved (Table 2). The parotid space, which is adjacent posteriorly to the masticator space and is located in the vicinity of the masseter muscle (Fig 1B), was involved in 17 (59%) of the 29 patients who had masseter muscle involvement, and the masseter muscle was always involved when the parotid space was involved (Table 2). The retropharyngeal space, which is posteromedially adjacent to the parapharyngeal space, was not involved as far as we could judge on the CT scans (Table 2). These results suggest that the parapharyngeal and parotid spaces are the secondary sites of spread of infection from the masticator space.

The sublingual and submandibular spaces are located at the floor of the mouth, separated partially by the mylohyoid muscle (Fig 1A). The sublingual space borders the lower part of the mandibular body. Seventeen (45%) of the 38 patients had involvement of this space (Table 2). The submandibular space was involved in 23 (61%) of the 38 patients with odonto-

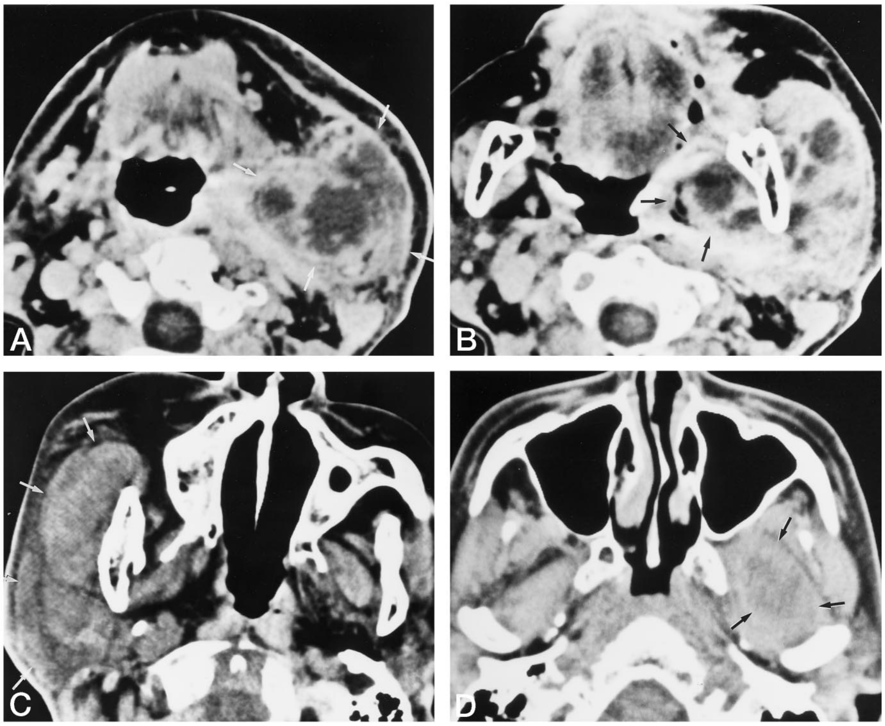

FIG 2. Typical CT scans of facial and neck infection of odontogenic origin (*arrows* indicate abscess and/or cellulitis).

A, Axial CT scan shows spread of infection downward to involve the submandibular space. Multifocal attenuated abscesses are present (case 1).

B, A more cephalad axial CT scan shows masticator space abscess with displacement of the oropharyngeal air column (case 1).

C, Axial CT scan shows massive swelling of the masseter muscle and the parotid gland. The medial pterygoid muscle and the parapharyngeal space are normal in appearance (case 16).

D, Axial CT scan through the level of the coronoid process of the mandible shows lateral pterygoid muscle swelling associated with a region of slightly lower attenuation in the muscle (case 40).

genic infection arising in the mandible (Table 1). The results also showed that five of 38 patients had only submandibular and/or sublingual space involvement (Table 1), supporting the possibility of direct spread of mandibular infection into these spaces. Two patients had isolated involvement of the sublingual space (Table 1).

The buccal space was involved in 11 (29%) of 38 patients with mandibular infection. Buccal space involvement was always associated with masseter muscle involvement (Table 2). Other muscles in the masticator space were less frequently involved in buccal space infection.

Fascial Infections Derived from Maxillary Odontogenic Origins

The spread pattern of maxillary infection differed from that of mandibular infection. First, involvement of the temporalis muscle occurred in seven (100%) of seven patients; involvement from mandibular infection occurred in only 10 (26%) of 38 patients (Table 2). Second, downward spread (spreading into the sublingual and submandibular spaces) never occurred in patients with maxillary infection (Table 2). The lateral pterygoid and masseter muscles were frequently involved (six [86%] of seven), as in the case of mandibular infection. The other spaces (parapharyngeal and parotid) were also involved, but much less frequently. The buccal space was involved in four (57%) of seven patients with maxillary infection.

Discussion

We have described the spread profile of odontogenic infection into the facial and neck spaces. Although the pattern of spread varied among patients, a relatively constant trend in the distribution of infection into the spaces seemed to be evident. The results clearly showed that the masticator space is the most prevalent site of spread from odontogenic infection. Taken together with the finding that the masticator space encompasses the posterior mandibular body, ramus, and a part of the alveolar bones of the maxilla, this suggests that the masticator space may be the initial site of spread of odontogenic infection. This contention was further supported by the finding that mandibular infection more frequently involved the masseter and medial pterygoid muscles, located in the lower compartment of the masticator space where the mandible is included, than the temporalis and lateral pterygoid muscles in the upper compartment of the space where part of the maxilla is included (Fig 1A, Table 2).

Our findings seem to differ from the results obtained by Bridgeman et al (7), who, in their review of 107 cases, reported that 53% of their patients had single-space infections, whereas in our study, 93% of the infections involved multiple spaces (Table 1). In addition, 82% of their 50 patients who had infection in multiple spaces had submandibular space involvement, whereas in our study, 61% of the multiple-space infections were associated with submandibular space involvement. The most likely explanation for these discrepancies may be that 24% of their study population consisted of nonodontogenic patients and 19% consisted of postoperative patients.

The spaces adjacent to the masticator space are the parotid space posteriorly, the parapharyngeal space medially, and the submandibular and sublingual

TABLE 1: Deep face and upper neck space involvement in patients with odontogenic infection

Case	Age, y/Sex	Masticator Space				Pa	PP	BS	SM	SL
		Superficial		Deep						
		MM	TM	MPM	LPM					
1	80/F	+	+	+	+	+	+		+	+
2	25/M	+		+		+	+		+	+
3	12/M	+		+			+	+	+	+
4	48/M	+			+			+	+	+
5	38/F	+		+		+	+		+	
6	67/F	+		+			+		+	+
7	38/M	+								
8	72/M	+	+		+	+				
9	30/F			+			+			+
10	54/F	+		+		+	+		+	+
11	6/F	+							+	
12	61/M	+	+	+	+	+	+		+	+
13	42/M			+					+	+
14	55/M								+	+
15	29/M								+	+
16	68/F	+				+				
17	18/M			+			+		+	+
18	35/F								+	+
19	13/M	+		+			+	+		
20	32/F	+		+		+	+		+	
21	60/F	+	+	+	+	+	+	+	+	
22	65/M	+	+		+			+		
23	74/M	+	+			+		+		
24	69/M	+	+	+	+	+		+		
25	61/F									+
26	53/M	+								+
27	65/F	+		+					+	
28	50/M	+	+	+	+	+		+		
29	44/M	+						+		
30	31/F	+		+			+			
31	56/M	+		+		+	+		+	
32	12/M	+		+		+	+		+	
33	68/M	+							+	
34	51/M	+		+		+	+			
35	38/M									+
36	65/F	+	+	+	+	+	+	+	+	+
37	66/M	+	+	+		+	+	+	+	+
38	47/M			+					+	
39	64/M	+	+	+	+		+	+		
40	44/M		+	+	+		+			
41	59/F	+	+		+	+				
42	58/M	+	+		+			+		
43	51/M	+	+	+	+	+				
44	13/M	+	+			+		+		
45	73/M	+	+		+			+		

Note.—MM indicates masseter muscle; TM, temporalis muscle; MPM, medial pterygoid muscle; LPM, lateral pterygoid muscle; Pa, parotid space; PP, parapharyngeal space; BS, buccal space; SM, submandibular space; and SL, sublingual space. Cases 1–38 are odontogenic infection of mandibular origin; cases 39–45 are odontogenic infection of maxillary origin.

spaces inferiorly (8) (Fig 1A and B). The parapharyngeal space occupies the central position among the masticator, parotid, and carotid vascular spaces. Therefore, infections in the parapharyngeal space may originate from any adjacent space. A fascia extends from the posterior superior margin of the medial pterygoid muscle to the base of the skull to separate the masticator space from the parapharyngeal space (5). This may lead us to believe that infection spreading from the masticator space into the parapharyngeal space may pass via the medial pterygoid muscle. Indeed, 100% (19 of 19) of patients with parapharyngeal space involvement also had medial pterygoid muscle involvement, and 79% (19 of 24) of patients with medial pterygoid muscle involvement had concomitant involvement of the parapharyngeal space (Table 2). On the other hand, in none of our cases did infection spread from the submandibular

TABLE 2: Profiles of space involvement by odontogenic infection

Space and Muscles	Origin of Infection		Space and Muscle Involvement by Mandibular Infection									
	Mandible (%) n = 38	Maxilla (%) n = 7	Ma	Ma				Pa	PP	BS	SM	SL
				MM	TM	MPM	LPM					
Ma	33 (87)	7 (100)	· · ·	· · ·	· · ·	· · ·	· · ·	17/33	19/33	11/33	20/33	11/33
MM	29 (76)	6 (86)	· · ·	· · ·	10/29	20/29	8/29	17/29	17/29	11/29	17/29	9/29
TM	10 (26)	7 (100)	· · ·	10/10	· · ·	7/10	8/10	9/10	5/10	7/10	5/10	4/10
MPM	24 (63)	3 (43)	· · ·	20/24	7/24	· · ·	6/24	14/24	19/24	8/24	18/24	11/24
LPM	8 (21)	6 (86)	· · ·	8/8	8/8	6/8	· · ·	7/8	4/8	5/8	4/8	3/8
Pa	17 (45)	3 (43)	17/17	17/17	9/17	14/17	7/17	· · ·	12/17	6/17	11/17	6/17
PP	19 (50)	2 (29)	19/19	17/19	5/19	19/19	4/19	12/19	· · ·	6/19	15/19	10/19
BS	11 (29)	4 (57)	11/11	11/11	7/11	8/11	5/11	6/11	6/11	· · ·	5/11	3/11
SM	23 (61)	0 (0)	19/23	17/23	5/23	18/23	4/23	11/23	15/23	5/23	· · ·	13/23
SL	17 (45)	0 (0)	12/17	9/17	4/17	11/17	3/17	6/17	10/17	3/17	13/17	· · ·
Re	0 (0)	0 (0)	· · ·	· · ·	· · ·	· · ·	· · ·	· · ·	· · ·	· · ·	· · ·	· · ·

Note.—Ma indicates masticator space; MM, Masseter muscle; TM, temporalis muscle; LPM, lateral pterygoid muscle; MPM, medial pterygoid muscle; Pa, parotid space; PP, parapharyngeal space; BS, buccal space; SM, submandibular space; SL, sublingual space; and Re, retropharyngeal space.

into the pharyngeal spaces, although previous studies have suggested this route of spread (9, 10).

The parotid space abuts the posterior masticator space and is enveloped by a layer of the deep cervical fascia (6). Infections in the parotid space have been thought to result mainly from parotitis (2, 11). However, the present study showed that odontogenic infection may occasionally extend into the parotid space, probably via the masticator space; 17 of 38 mandibular infections and three of seven maxillary infections were associated with parotid space involvement (Tables 1 and 2).

The retropharyngeal space connects the skull base to the upper mediastinum and, in its infrahyoid portion, contains only loose fatty tissue. Thus, the retropharyngeal space is considered to be important because of its proximity to the airway and because infection in this space may cause mediastinitis, bronchial erosion, and even septicemia (2, 6). Fortunately, we did not encounter any involvement of this space. Davis et al (3) reported nine patients with a mass of the retropharyngeal space resulting from infection. The original sites of infection in these patients included the faucial tonsils of the oropharyngeal mucosal space and the adenoids of the nasopharyngeal mucosal space. Another study also showed that no retropharyngeal space was involved in 107 maxillofacial infections (1). These studies, as well as the present findings, suggest that primary pharyngeal infection may be the main cause of retropharyngeal space involvement. The vertebral and vascular spaces are thought to be rarely involved by head and neck infection (2). In fact, we found no instance of infection spreading into these spaces.

Accumulated pus perforates bone at the weakest and thinnest part of the bone. In the mandible, this is in the lingual aspect of the molar region (1, 12). If odontogenic infection perforates this portion of bone, it will spread into the sublingual or submandibular space. As these spaces are partially separated by a sheet of mylohyoid muscle, infection in either space easily spreads into the other. Consistent with this, we observed simultaneous involvement of these spaces in our study. It is generally believed that the midline enables free communication from either the sublingual or submandibular space (6). However, we encountered only one patient who had bilateral involvement of the sublingual space originating from mandibular molar infection (case 35, Table 1).

Since limited data were available regarding maxillary infection, we cannot conclusively delineate its spread pattern. However, it is plausible to consider that the observed difference in the spread profile between maxillary and mandibular infections may be due to differences in the distance between the original focal area in the jaw bones and each of the spaces. For instance, maxillary infection was associated with temporalis muscle involvement more often than was mandibular infection. Furthermore, in no case was maxillary infection associated with involvement of the sublingual or submandibular space. Nyberg et al (2) reported a case of maxillary infection spreading into the submandibular space associated with vascular space involvement. Since no other space was reported to be involved, the most likely possibility is that the infection spread along the vascular space into the submandibular space.

Taken together, these findings indicated that odontogenic infection arising in the mandible spreads first to the masticator space. The masseter and medial pterygoid muscles in the masticator space are most frequently involved. Thereafter, the infection spreads medially into the parapharyngeal space and posteriorly into the parotid space. Involvement of the sublingual and submandibular spaces seems to occur directly from the primary site of mandibular infection. The maxillary infection also spreads first to the masticator space, but the temporalis and lateral pterygoid muscles are predominant targets for the spread of infection. Involvement of the sublingual and submandibular spaces is rare in maxillary infection. However, it is conceivable that pathways other than those identified in the present study may facilitate the spread of odontogenic infection. The candidates include a route through the cervical lymph node chains (2). Furthermore, spread such as from submandibular to parapharyngeal spaces, which was not seen in this study, may be present. These routes, which might complicate the spread pattern of odontogenic infection, remain to be elucidated in future studies.

Conclusion

CT is useful in the identification and evaluation of facial and neck space inflammation processes originating from odontogenic infection, since infection of the deep spaces is difficult to assess clinically. The results indicate that 1) the masticator space is the primary site of spread from mandibular infection, 2) the parotid and pharyngeal spaces are the secondary sites of spread from the masticator space, 3) mandibular infection spreads directly to the sublingual and submandibular spaces, and 4) maxillary infection spreads to the deep facial and neck spaces in a different way from that of mandibular infection.

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