Computed Tomographic Assessment in Deep Space Infections of Odontogenic Origin

Sankalp Verma, Ravi Prakash Sasankoti Mohan, Anchal Singh, Udita Singh, Neha Agarwal
Department of Oral Medicine, Diagnosis and Radiology, Kothiwal Dental College and Research Centre, Moradabad, Uttar Pradesh, India

Correspondence: Dr. Sankalp Verma, Department of Oral Medicine, Diagnosis and Radiology, Kothiwal Dental College and Research Centre, Moradabad, Utter Pradesh, India. E-mail: sankalpdentist2004@yahoo.co.in

ABSTRACT

Background/Aim: The objective of the article is to investigate the pathways of spread of odontogenic infection in the facial and neck spaces and to determine the accuracy of contrast enhanced computed tomography (CT) in diagnosing deep neck space infections. **Study Design/Materials and Methods:** Contrast enhanced CT scans of 27 patients with extensive spread of odontogenic infection into the facial and neck spaces were analyzed to document the pathways of spread. **Results:** The results of the study indicated that the masseter space was the most commonly involved space followed by the pterygoids (both lateral and medial) and a different spread (other than medial pterygoids) to the parapharyngeal space has been proposed. Odontogenic infections from the mandible spread in two different ways. It first spreads upward, into the masseter and/or medial pterygoid muscles in the masticator space, and downward, into the sublingual and/or submandibular spaces, and then spreads into the spaces or muscles adjacent to one or more of these locations. Infections from the masseter muscle spreads 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 do not spread downward; instead, they tend to spread upward and superficially into the buccal space. **Conclusion:** CT is useful in depicting the exact site and extent of infection and in planning the treatment of extensive odontogenic infection, which can be life threatening when therapy is ineffective.

Key words: Contrast enhanced computed tomography; muscles; odontogenic; spaces

Introduction

Infection can be defined as "invasion and colonization by pathogenic microorganism of body tissues, which results in local cellular injury due to competitive metabolism, release of toxins, intracellular replication and antigen-antibody response." Depending on the virulence of the organism and host resistance, these bacterial infections have a potential to spread beyond the bony confines of the tooth and jawbones into the surrounding soft tissues. When dental infection spreads deeply into soft tissue rather than exiting superficially through oral and cutaneous routes, fascial spaces may be affected. With the spread of infection following the path of least resistance, it flows by hydrostatic pressure into loose areolar connective tissue of the fascia that surrounds the muscles. This type of tissue is destroyed easily by the hyaluronidases and collagenases produced by the bacteria, thus opening potential spaces surrounding the muscles. Odontogenic infections rarely extend beyond the jaw bone barriers into the deep spaces of the face and neck. But once it occurs, it is often difficult to assess accurately by clinical and plain conventional radiologic techniques.[1] Occasionally, infection spreads into critical spaces, such as the parapharyngeal, retropharyngeal, or carotid spaces, resulting in potentially life-threatening conditions. It is thus important to understand the pathways on the basis of anatomical relationships. In this regard, many imaging studies have been conducted with computed tomography (CT) and/or magnetic resonance imaging (MRI). 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 extensively.[2] We have investigated the pathway of infection originating from mandibular and maxillary teeth and related CT anatomies.

Access this article online	
Quick Response Code:	Website: www.wajradiology.org
	DOI: 10.4103/1115-1474.134607

Materials and Methods

It was a prospective study where study group comprised 27 patients (17 males and 10 females) in the age group of 11–58 years, provisionally diagnosed with deep space infections of odontogenic origin based on clinical signs and symptoms supported by orthomopantogram finding. An oral radiologist and a radiologist for CT interpretation were recruited to be the observers. An informed consent from all the 27 patients was taken before undergoing the CT examination. Ethical clearance was obtained from the Institutional Ethical Committee. After a thorough clinical examination, the patients underwent blood investigations in the form of differential leukocyte count and total leukocyte count, which confirmed the presence of infection. Orthomopantogram was also done to confirm the odontogenic origin. CT examination was performed with a GE high speed spiral CT Lxi model and 3-5 mm contiguous axial sections were taken of the region of interest both before and after the contrast agent infusion. All patients underwent intravenous contrast enhancement (rapid drip of 100 mL omnipaque) (Iohexol GE healthcare, Osaka, Japan). CT images were evaluated independently by a radiologist. The involvement of soft tissue was evaluated by definitive changes in the shape and density caused by edematous change, abscess and gas formations and tissue enhancement after contrast medium administration. Thickening of the muscles and disappearance of the fat layer between the muscles were the main CT findings indicating inflammatory changes. The soft tissue adjacent to the alveolar cortical plates, the muscles of facial expression, and the fascial spaces were evaluated. As for the soft tissue adjacent to the cortices, a positive evaluation was determined based on the existence of thickened soft-tissue-density structure extending beyond the outer line of the cortices. Patients with definitive changes of adjacent muscles were classified as positive.

Results

The results of the study showed that the masticator was the most common clinical space (92.6%) followed by submandibular (44.4%), buccal (25.9%), and parotid (22.2%). None of the patients had involvement of sublingual space. CT findings revealed masseter muscle to be the most commonly involved locations, whereas temporalis muscle and retropharyngeal space were the least involved locations [Figure 1]. Apart from parotid, for all the other findings, clinical findings correlated perfectly with CT findings. When correlating with parotid there was a matching of 96.3%. When correlating the masticator space with CT examination, CT is 100% accurate in differentiating the individual muscles of the masticator space. Infection arising from maxillary teeth only spread to the buccal space while from mandibular teeth can spread to any space including the buccal space. In all the cases of masseter muscle involvement, maximum involvement of lateral pterygoid muscle was seen in 56%, while least number (4%) of cases demonstrated involvement in temporalis muscle and retropharyngeal space. In temporalis muscle involvement, there is 100% involvement of masseter, pterygoids, parotid space, and submandibular space. In medial pterygoid involvement masseter muscle is involved in 100% cases and minimum involvement is in temporalis muscle. In all cases of lateral pterygoid muscle involvement, masseter muscle is involved in 100% cases and minimum involvement is in temporalis muscle. In cases of parotid space involvement, masseter muscle is involved in 100% cases and minimum involvement is in temporalis muscle. In cases of parapharyngeal space, masseter muscle is involved in 100% cases and minimum involvement is in submandibular space and retropharyngeal spaces. In cases of buccal space involvement, masseter muscle is involved in 100% cases and minimum involvement is in submandibular space. In cases of submandibular space involvement, masseter muscle is involved in 100% cases and minimum involvement is in parotid and parapharyngeal spaces. In cases of retropharyngeal space involvement, masseter muscle is involved in 100% cases [Table 1].

Contrast enhanced CT interpretation of spaces

Typical CT features of facial and neck space involvement are shown in Figures 2 and 3. 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 or multifocal. The spread of infection could be observed as a massive

Table 1: Relationship of individual space with the other spaces on CT

Space involved *N* (%)	M.M. *N* (%)	T.M. *N* (%)	MPM *N* (%)	LPM *N* (%)	PS *N* (%)	PA SP *N* (%)	BS *N* (%)	SM *N* (%)	SL *N* (%)	RP SP *N* (%)
M.M. (*n*=25)	25 (100)	1 (4)	13 (52)	14 (56)	7 (28)	3 (12)	5 (20)	12 (48)	0 (0)	1 (4)
T.M. (*n*=1)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)
MPM (*n*=13)	13 (100)	1 (7.7)	13 (100)	12 (92.3)	4 (30.8)	2 (15.4)	2 (15.4)	6 (46.2)	0 (0)	0 (0)
LPM (*n*=14)	14 (100)	1 (7.1)	12 (85.7)	14 (100)	5 (35.7)	2 (14.3)	2 (14.3)	6 (42.9)	0 (0)	0 (0)
PS (*n*=7)	7 (100)	1 (14.3)	4 (57.1)	5 (71.4)	7 (100)	0 (0)	0 (0)	3 (42.9)	0 (0)	0 (0)
PA SP (*n*=3)	3 (100)	0 (0)	2 (66.7)	2 (66.7)	0 (0)	3 (100)	0 (0)	1 (33.3)	0 (0)	1 (33.3)
BS (*n*=7)	5 (71.4)	0 (0)	2 (28.6)	2 (28.6)	0 (0)	0 (0)	7 (100)	1 (14.3)	0 (0)	0 (0)
SM (*n*=12)	12 (100)	6 (50)	6 (50)	6 (50)	3 (25)	1 (8.3)	1 (8.3)	12 (100)	0 (0)	0 (0)
SL (*n*=0)	-	-	-	-	-	-	-	-	-	-
RP SP (*n*=1)	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (100)	0 (0)	0 (0)	1 (100)

M.M. – Masseter muscle; T.M. – Temporalis muscle; MPM – Medial pterygoid muscle; LPM – Lateral pterygoid muscle; PS – Parotid space; PA SP – Parapharyngeal space; BS – Buccal space; SM – Submandibular spac; SL – Sublingual space; RP SP – Retropharyngeal space; CT – Computer tomography

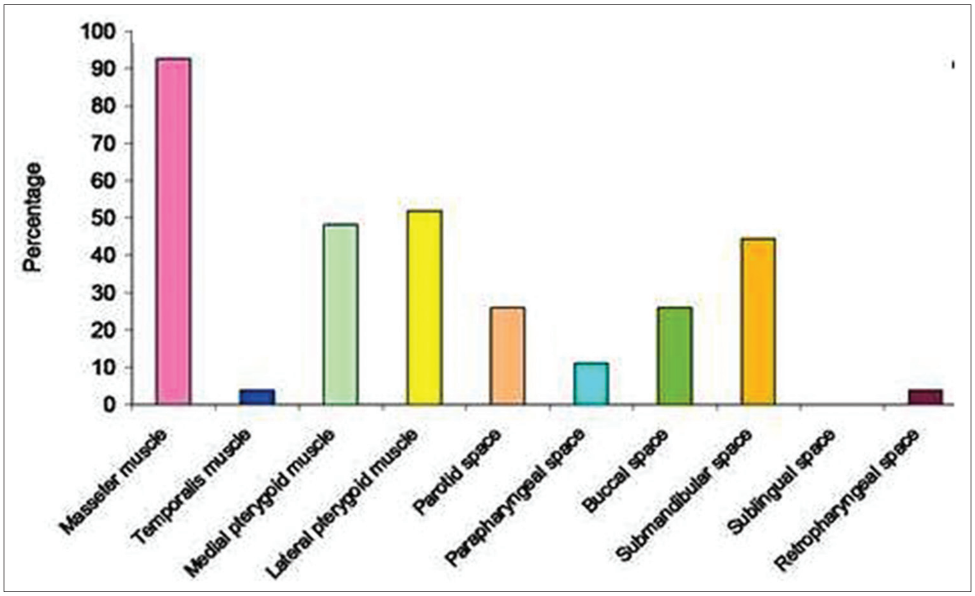

Figure 1: Distribution of subjects according to computed tomography diagnosis on graph

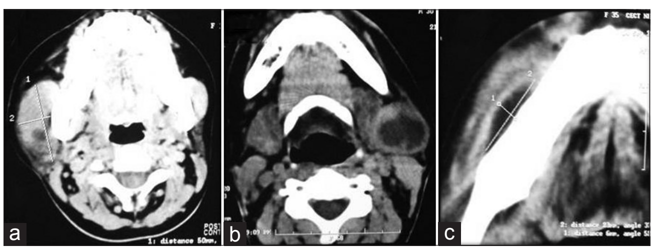

Figure 2: (a) Axial computed tomography (CT) scan shows massive swelling of the masseter muscle and the parotid gland associated with a region of slightly lower attenuation in the muscle. (b) Axial CT scan shows areas of lower attenuation within the region of parotid gland highly suggestive of abscess. (c) Axial CT scan shows a low attenuation area beneath the body of mandible in submandibular region

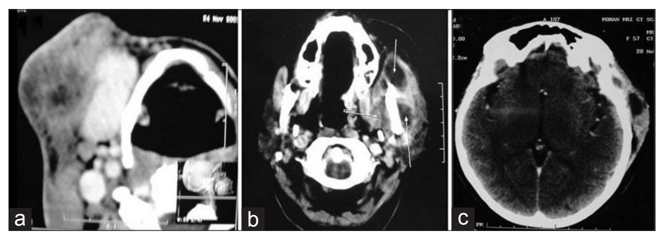

Figure 3: (a) Axial computed tomography (CT) scan shows area of lower attenuation in the region of buccal space suggestive of buccal space abscess. (b) Axial CT scan shows multiple areas of lower attenuation in the region of masseter muscle, parotid space and parapharyngeal space. (c) Axial CT scan shows low attenuation area in the region of superficial temporal space

swelling of the involved muscle and was often associated with obliteration of the fat spaces between the neighboring muscles.

Discussion

We have described the spread profile of odontogenic infection into the fascial 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.

Clinically, masticator space is most commonly involved space with a prevalence of 92.6%, followed by submandibular in 44.4%, buccal in 25.9%, parotid in 22.2% cases, and sublingual in 0% cases. Cmejrek *et al.*[3] found submandibular space to be the most commonly affected space in 8% cases while parotid is involved in 4% cases; Ohshima *et al.*[2] found buccal space to be the most commonly involved space in 52.14% cases followed by masticator space in 41.18% cases, submandibular space in 23.53% cases, and sublingual space in 11.76% cases. The possible reason for the difference in our study was due to the smaller sample size. The results of our study was in accordance with the studies of Flynn *et al.*,[4] who demonstrated that masticator was the most commonly involved space in 78%, followed by submandibular in 54%, buccal in 41%, sublingual in 16%, and parotid in 3% cases and Jankouske *et al.*[5] who found submandibular space to be involved in 67% cases. On contrast enhanced CT (CECT) masseter muscle was found to be the most commonly involved space in 92.6% cases followed by lateral pterygoid muscle in 51.9%, medial pterygoid in 48.1%, submandibular space in 44.4%, buccal space and parotid space in 25.9% cases, parapharyngeal space in 11.1%, temporalis muscle and retropharyngeal space in 3.7%, and sublingual space in 0% cases. Ohshima *et al.*[2] reported the incidence of buccal space in 52.94%, followed by submandibular space and medial pterygoid muscle in 23.52%, parapharyngeal and masseter muscle in 17.64%, and sublingual space in 11.76% cases. Bridgeman *et al.*[6] found submandibular space to be involved in 82% cases. Chang *et al.*[7] found retropharyngeal space to be involved in 18% and parapharyngeal space in 16% cases. Obayashi *et al*.[8] found buccal space to be involved in 15.56%, masticator space in 8.89%, and parapharyngeal space in 2.22% cases. The difference is due to the variable number of cases in all studies. When comparing clinical diagnosis with CT diagnosis it was found in our study that clinical diagnosis is accurate in 96.3% while CT diagnosis was 100% accurate. Our study was of the same agreement as that of Miller *et al*.,[9] who found that clinical accuracy was 63%, CECT accuracy was 77% while in combination it was 89% and Nagy *et al*.,[10] who found the clinical accuracy to be 83% and CT accuracy to be 100%. To the best of our knowledge only one study has shown the prevalence of individual space and their relationship with other spaces on CT. Yonetsu *et al*.[1] demonstrated that masseter muscle was the most commonly involved followed by medial pterygoid and lateral pterygoid muscle and lastly the temporalis muscle. Rest of the spaces were less commonly involved. When it comes to the secondary spaces involvement, he showed that parapharyngeal always spread from medial pterygoid muscle and parotid always spread from masseter. He also showed that retropharyngeal, which is situated posteromedially to parapharyngeal space, was not involved. So, parapharyngeal and parotid are the secondary sites of spread of infection from the masticator space. In contrast, our study demonstrated that parapharyngeal was involved in 66.7% cases of medial pterygoid involvement showing a probability of spread from some other space. In all cases of parotid space, masseter muscle was involved showing a definite spread from masseter muscle to parotid space.

Conclusions

Based on the results of the present study, the following conclusions were drawn:

- Masseter muscle followed by pterygoids are most commonly involved in the masticator space
- Parotid, parapharyngeal and retropharyngeal spaces are the secondary sites of spread from the masticator space
- Spread to the parapharyngeal space is not always from medial pterygoid but instead there might be some other pathway too, which further needs documentation
- Mandibular infection spreads directly to the submandibular spaces
- CECT is 100% accurate in diagnosing deep space infections as it can differentiate the individual muscle involved.

References

1. Yonetsu K, Izumi M, Nakamura T. Deep Facial Infections of Odontogenic Origin: CT Assessment of Pathways of Space Involvement. AJNR Am J Neuroradiol 1998;19:123-8.
2. Ohshima A, Ariji Y, Goto M, Izumi M, Naitoh M, Kurita K, *et al*. Anatomical considerations for the spread of odontogenic infection originating from the pericoronitis of impacted mandibular third molar: Computed tomographic analyses. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;98:589-97.
3. Cmejrek RC, Coticchia JM, Arnold JE. Presentation, diagnosis, and management of deep-neck abscesses in Infants. Arch Otolaryngol Head Neck Surg 2002;128:1361-4.
4. Flynn TR, Shanti RM, Levi MH, Adamo AK, Kraut RA, Trieger N. Severe Odontogenic Infections Part 1: Prospective Report. J Oral Maxillofac Surg 2006;64:1093-103.
5. Jankowska B, SalamiA, Cordone G, Ottoboni S, Mora R. Deep neck space infections. Int Congr Ser 2003;1240:1497-500.
6. Bridgeman A, Wiesenfeld D, Hellyar A, Sheldon W. Major maxillofacial infections: An evaluation of 107 cases. Aust Dent J 1995;40:281-8.
7. Chang L, Chi H, Chiu NC, Huang FY, Lee KS. Deep Neck Infections in Different Age Groups of Children. J Microbiol Immunol Infect 2010;43:47-52.
8. Obayashi N, Ariji Y, Goto M, Izumi M, Naitoh M, Kurita K, *et al*. Spread of odontogenic infection originating in the maxillary teeth: Computerized tomographic assessment. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;98:223-31.
9. Miller WD, Furst IM, Sàndor GK, Keller MA. A prospective, blinded comparison of clinical examination and computed tomography in deep neck infections. Laryngoscope 1999;109:1873-9.
10. Nagy M, Backstrom J. Comparison of the sensitivity of lateral neck radiographs and computed tomography scanning in pediatric deep-neck infections. Laryngoscope 1999;109:775-9.

How to cite this article: Verma S, Mohan RS, Singh A, Singh U, Agarwal N. Computed tomographic assessment in deep space infections of odontogenic origin. West Afr J Radiol 2014;21:64-7.

Source of Support: Nil, **Conflict of Interest:** None declared.