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Odontogenic Inflammatory Processes of Head and Neck in Computed Tomography Examinations

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Summary

Background: Infections of odontogenic origin are the most common cause of inflammatory disease of head and neck region. Computed tomography allows for defining localization and extent of inflammatory lesions, visualizes soft tissue involvement, presence of an abscess or an osteolytic lesion around causative tooth.

The aim of this study was to assess pathways, by which odontogenic infections spread into respective deep head and neck structures in computed tomography examination, taking into account the following criteria: frequency of involvement of respective deep cervical spaces, possibility to determine a probable causative tooth and concordance with the results of clinical examination.

Material/Methods: Thirty-eight patients cervicofacial inflammatory disease had undergone CT examination of head and neck region with a 64-slice CT scanner after intravenous contrast administration.

Results: Abscess was reported in 30 (79%) cases, while inflammatory infiltration was diagnosed in remaining 8 (21%) patients. There was full concordance between radiological report and intraoperative report In 33 cases (87%). The most commonly involved cervical space was masticator space – 31 patients (82%), followed by submandibular space – 27 patients (71%). Dental examination was impossible in 29 patient because of trismus. During analysis of CT studies we evaluated maxillary and mandibular alveolar processes for presence of osteolytic bone lesions around causative teeth roots and we found them in 30 cases (79%). In 32 cases (84%) cervicofacial infection were of mandibular odontogenic origin.

Conclusions: In most cases CT study in patients suspected of odontogenic craniofacial infection revealed presence of an abscess, needing urgent surgery. Inflammatory infiltration of dental origin most frequently involves masticator space, followed by submandibular space. In most cases CT scanning allows for identification of causative teeth, especially when trismus makes detailed clinical examination impossible.

MeSH Keywords: Inflammation • Multidetector Computed Tomography • Tooth

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Background

Odontogenic infections are the most frequent cause of inflammatory conditions in the cervicofacial region [1].

Odontogenic infections originate in periapical and marginal periodontum [2,3]. Infection may also occur as an iatrogenic complication of tooth extraction or local anesthesia. Treatment encompasses systemic administration of antibiotics, removal of infection source and abscess drainage.

Inflammatory infiltrate may rapidly extend from periodontum to particular head and neck compartments and spread further along, crossing fascial membranes that separate them. Massive inflammatory infiltration of both submaxillary and sublingual spaces (Ludwig's angina) is one of more dangerous complications that may lead to acute airway obstruction requiring urgent tracheostomy [3]. Mediastinitis is another dangerous complication important in terms of CT evaluation of head and neck region, requiring careful examination [4–6].

Since infiltration of deep compartments of extracranial head and neck area may be a life-threatening condition, patients with suspicion of such diagnosis are urgently admitted to the hospital. Deeper craniofacial spaces may be inaccessible on physical examination, while determination of type, localization and extent of inflammation is crucial for further management. Computed tomography (CT) is the examination of choice in such cases, allowing for detection and assessment of the extent of inflammatory lesions and enabling differentiation between cellulitis and an abscess [7,8]. It also visualizes changes to maxillary and mandibular structures, including osteolytic changes around the teeth (causative teeth), as inflammatory process taking place around them leads to development of inflammation in head and neck area [2].

Goals

The goal of this work is to assess effectiveness of computed tomography examination in the diagnostics of odontogenic inflammation spreading to specific cervical fascial spaces and viscerocranium structures , taking into consideration the following:

1. frequency and severity of involvement of particular craniofacial fascial spaces,
2. ability to establish the source of infiltration (causative tooth) in CT,
3. concurrence between results of CT examination, clinical examination and intraoperative findings.

Material and Methods

Material

In 2010–2013 we diagnosed inflammatory processes of unknown or odontogenic origin in 56 patients patients examined in Computed Tomography Facility of the Department of General Radiology, Interventional Radiology and Neuroradiology at the University Clinical Hospital in Wroclaw. Eighteen patients were excluded from the initial study group, as odontogenic etiology of this process could not be documented.

Thus, study material consisted of 38 patients with confirmed odontogenic inflammatory process in cervicofacial area, who had undergone CT examination of extracranial head or neck regions. There were 20 men and 18 women aged 9 to 73 years (mean age: 39 years) included in the study group.

Methods

CT examinations of extracranial head and neck areas were performed following administration of iodinated contrast using 64-slice LightSpeed VCT (GE) and Discovery HD (GE) devices. Patient was placed in supine position with upper limbs placed along the body. Examination encompassed viscerocranium from frontal sinus to clavicles or, in case of neck examination, from hard palate to clavicles.

Vascular access was secured with intravenous cannula introduced into cubital vein or veins of the forearm. Volume of administered highly-iodinated (over 350 mg of iodine/ml) contrast medium ranged between 60 ml and 120 ml depending on patient body mass (1 mg/kg). Contrast bolus was administered with automatic syringe. Contrast was given at a rate of 1.0 mL/s followed by 40 mL of physiological saline "wash-out bolus." Scanning of the region of interest was commenced with a 100-second delay.

In all cases, slice thickness was 0.67 mm with 1.3 pitch. Obtained cross-sections were subjected to secondary processing. Multidimensional reconstructions were performed and assessed in soft-tissue and bone windows using Advantage Workstation 4.4. Volume reconstructions were also performed for better visualization of bone structures.

Presence and severity of inflammatory infiltrates in individual craniofacial spaces were also assessed. Results are presented in Figures 1–5.

Medical histories of patients hospitalized in the Department of Craniofacial Surgery of University Clinical Hospital in Wroclaw were analyzed retrospectively. Causative teeth identified during dental examination were compared with signs of dental disease process (alveolar process osteolysis) visible in CT examination. Clinical signs and symptoms observed in patients referred for CT were also analyzed.

Results

Majority (80%) of patients with odontogenic inflammatory process present in cervicofacial region had computed tomography examination performed on the day of admission to the hospital and the majority of referrals came from the Emergency Department. In 13% of patients cervicofacial CT was performed on the second day of hospitalization. Average duration of symptoms before reporting to the hospital was 6 days (between 3 and 24 days). Symptoms presented by patients before computed tomography examination are shown in Figure 1.

Authors also took note of comorbidities that might facilitate inflammatory processes. The most frequent comorbidities in our study group were arterial hypertension and diabetes (Figure 2).

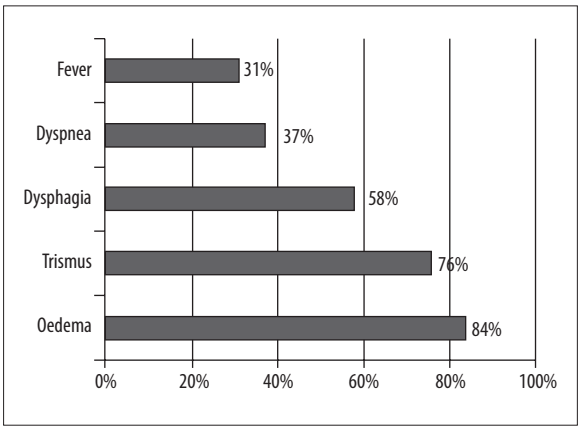

Figure 1. Clinical symptoms presented by patients.

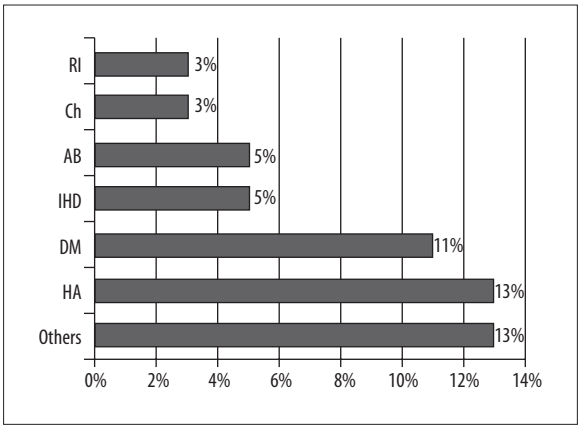

Figure 2. comorbidities accompanying maxillofacial infections of odontogenic origin: RI – renal insufficiency, Ch – cancer chemiotherapy , AB – bronchial asthma , IHD – ischemic heart disease, DM – diabetes mellitus, HA – arterial hypertension.

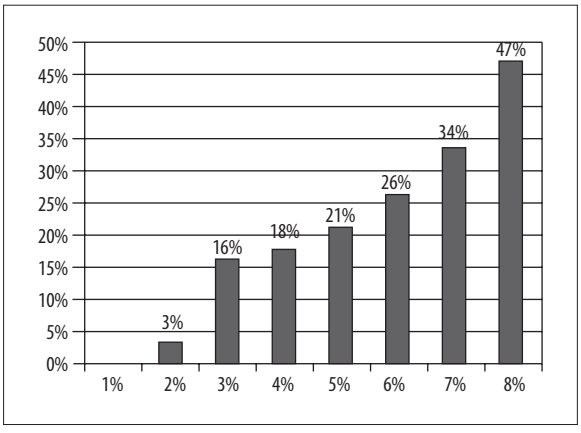

Figure 3. Frequency of occurrence a particular causal tooth in a mandible.

Dental records were also subjected to analysis. In 32 patients (84%) inflammation originated in mandibular teeth, while in 4 subjects (11%) dental examination demonstrated presence of causative teeth both within mandible as well as maxilla. Only in 2 cases (5%) causative teeth were located within maxilla.

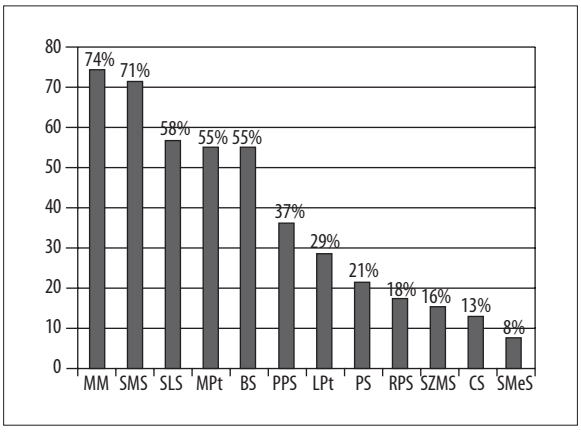

Figure 4. Frequency of occupation head and neck spaces and muscles. MM – masseter muscle, SMS – submandibular space, SLS – sublingual space; MPt – medial pterygoid muscle, BS – buccal space, PPS – peripharyngeal space, LPt – lateral pterygoid muscle, PS – parotid space, RPS – retropharyngeal space, SZMS – suprazygomatic masticator space, CS – carotid space, SMeS – submental space.

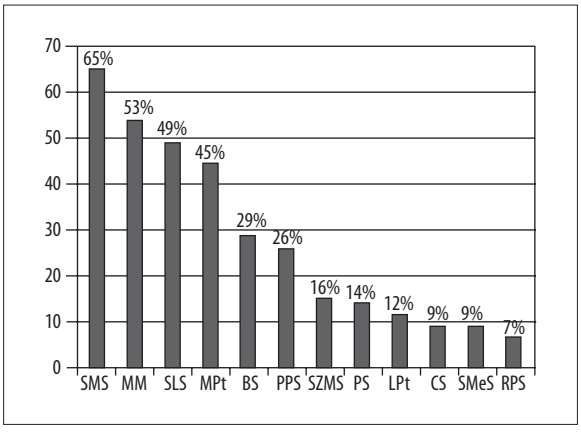

Figure 5. Intensity of occupation head and neck spaces. SMS – submandibular space, MM – masseter muscle, SLS – sublingual space, MPt – medial pterygoid muscle, BS – buccal space, PPS – peripharyngeal space, SZMS – suprazygomatic masticator space, PS – parotid space, LPt – lateral pterygoid muscle, CS – carotid space, SMeS – submental space, RPS – retropharyngeal space.

Among mandibular teeth the third molar tooth was the most common cause of inflammation (18 cases – 47%), followed by second molar (13 cases – 34%) and first molar tooth (10 cases – 26%). Frequency of development of inflammation in individual teeth is presented in Figure 3. It should be noted that in some cases dental examination indicated several causative teeth in one patient.

In as much as 12 (32%) patients medical history revealed tooth extraction before development of clinical symptoms. Among these patients, in one case of complicated extraction CT examination demonstrated a foreign body left in the dental alveolus (Figure 6). In another case, complication involved a tongue injury during the procedure. Inflammation of the tongue root in this patient caused significant airway obstruction requiring urgent tracheostomy.

Figure 6. CT examination of head and neck, coronal scan, bone window. A foreign body left in the alveolus after tooth extraction from the mandible on the right side (arrow).

Figure 7. CT examination of head and neck, coronal scan, bone window. Periapical osteolysis of a molar root with loss of cortical layer on the inner side of mandible's body (arrow).

During analysis of CT images we searched for foci of alveolar osteolysis around roots of causative teeth within maxilla and mandible. They were visualized in 30 (79%) of cases (Figure 7).

Presence of an abscess was demonstrated in 30 (79%) cases, while the remaining 8 (21%) patients had only signs of inflammatory infiltration visible as thickening and blurring of muscle and adipose tissue outlines. Gas bubbles consistent with presence of an abscess were seen in 10 (26%) CT examinations (Figure 8). In remaining studies an abscess was visualized as fluid-filled space surrounded by contrast-enhanced capsule. Abscess incision or drainage was performed in 87% of cases.

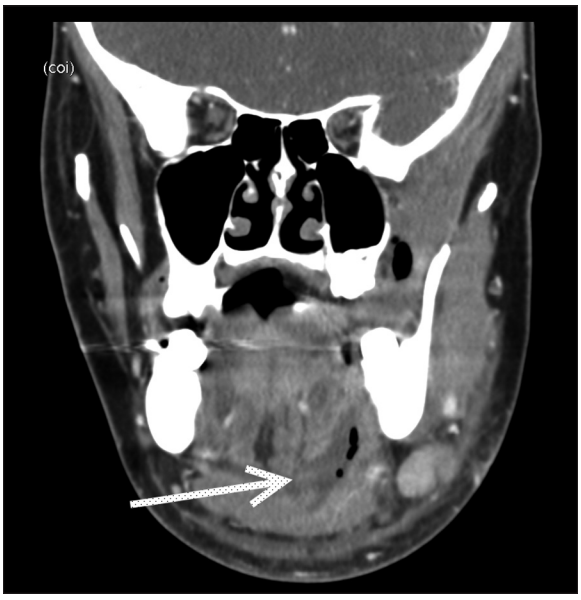

Figure 8. CT examination of head and neck, coronal scan, soft tissue window. Cellulitis of sublingual space with abscess formation (aarrow). Air bubbles are visible inside an abscess. Plegmonous thickening of left masseter muscle.

Figure 9. CT examination of head and neck, axial scan, soft tissue window reveals cellulitis of masseter and medial pterygoid muscles on the right side with abscess formation in the masseter muscle (arrow).

Within the whole group of studied patients, in 33 (87%) cases the type of inflammatory infiltration corresponded to intraoperative assessment and clinical condition. In the remaining 5 (13%) patients CT images were not confirmed during surgery.

Abscess and inflammatory infiltrate most often encompassed multiple spaces (82%), while being limited to a single space in a small number of cases (18%).

The most frequently involved fascial space of the neck in our study group was the masticator space – 82%. We divided masticator space for greater precision of assessment,

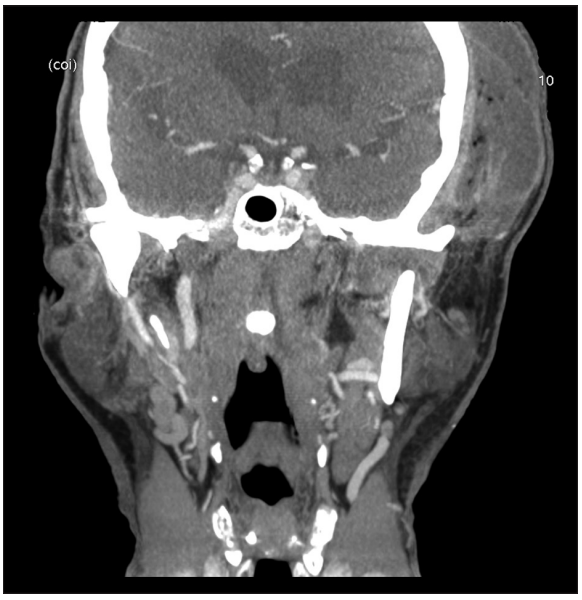

Figure 10. CT examination of head and neck, coronal scan, soft tissue window. Hypodense abscess with rim enhancing capsule and air bubbles inside is visible in the left temporal space .

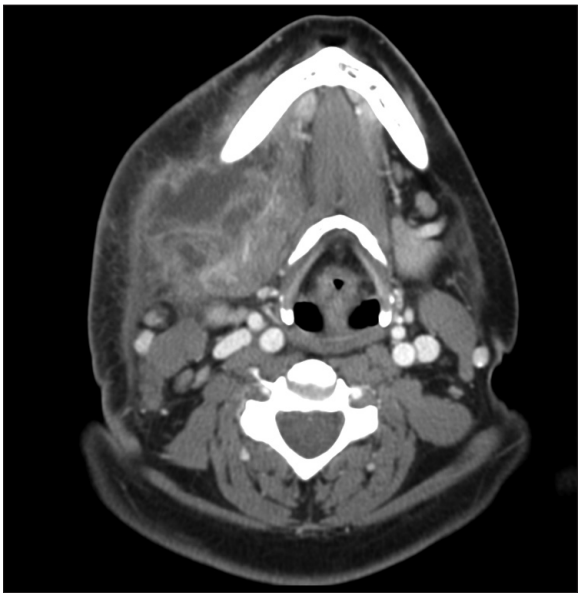

Figure 11. CT examination of head and neck, axial scan, soft tissue window. Phlegmonous thickening of mylohyoid and hyoglossal muscle and irregular abscess with septations localized within right submandibular space.

thus frequency of involvement of individual compartments of this space was as follows: masseter muscle (74%), medial pterygoid muscle (55%) (Figure 9), lateral pterygoid muscle (29%), and temporal space (16%) (Figure 10).

Submandibular space (71%) was another space evaluated with regard to the frequency of occurrence of inflammatory lesions (Figure 11). Sublingual space was involved in 58% (Figure 8), buccal space in 52%, most often when masseter muscle space was also affected (Figure 9). Parapharyngeal space was affected in 37% of cases (Figure 12).

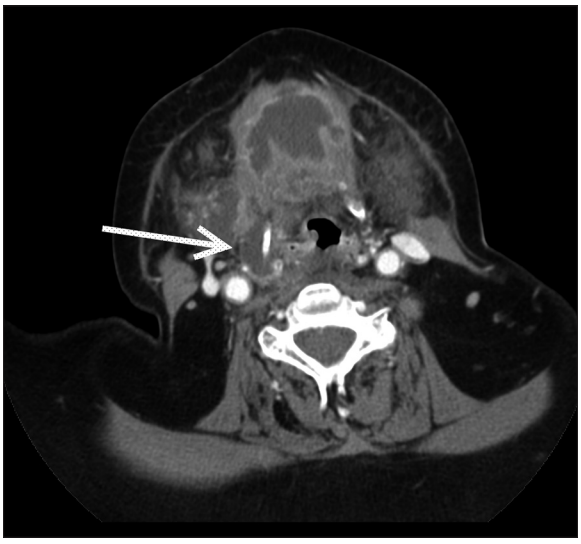

Figure 12. CT examination of head and neck, axial scan, soft tissue window. Abscess in the right parapharyngeal space, right greater horn of hyoid bone is visible within . Other abscesses are noticeable in sublingual space and right submandibular space.

Figure 13. CT examination of head and neck, sagittal scan, soft tissue window. Inflammatory process in retropharyngeal space – contrast enhancement and thickening of prevertebral soft tissues – at the level of C2 vertebrae it is over 12-mm.

Frequency of involvement of individual spaces of the neck is presented in Figure 4.

We also attempted to assess the severity of inflammatory changes in CT imaging in individual cervical spaces (Figure 5). For that purpose we introduced the following scoring: abscess – 3 pts, irregular fluid-filled spaces – 2 pts, increased density and blurring of soft tissue structures – 1 pt.

Changes of greatest severity were observed in submandibular space followed by masseter muscle. It should be

Figure 14. CT examination of head and neck – lower border, axial scan, soft tissue window. Inflammatory process extending to mediastinum – obliteration and hyperdensity of madiastinal adipose tissue.

emphasized that large abscesses were sometimes located in the temporal region (Figure 10). Changes of retropharyngeal space were characterized by lowest degree of severity (Figure 13).

Mediastinitis as a complication of odontogenic inflammatory process within cervicofacial region was diagnosed in 2 cases (5% of study group) (Figure 14).

CT demonstrated osteitis of the mandible (Figure 15) in 2 (5%) patients with long-lasting inflammation and CT examination was not performed on emergency basis.

In 5 patients (13%) CT study was performed twice. Two patients had a non-contrast CT performed as a first examination due to elevated creatinine levels, preventing visualization of an abscess. In the remaining patients control CT study was aimed at identification of drain locations.

Discussion

Inflammatory infiltrate of deep extracranial head and neck spaces spreads very rapidly. It may lead to airway obstruction or spread to mediastinum or intracranially. Therefore, patients require fast therapeutic decisions and urgent CT scanning [8]. Management consists of removal of infection source as well as antibiotic therapy in order to control spread of inflammatory infiltrate.

In our work, clinical data evoked suspicion that a tooth might be the source of infection in extracranial head and neck area only in some patients. In a large proportion of cases the cause of inflammatory process was unknown at the time of admission to the hospital. It was established in the course of diagnostics, during management, following orthopantomogram and intraoral examination, which was often only possible after resolution of trismus.

In a work by Bakir et al., which analyzed 173 craniofacial CT examinations containing inflammatory infiltrates teeth constituted a source of infection in 48% [84 patients] of cases. In our material patients with

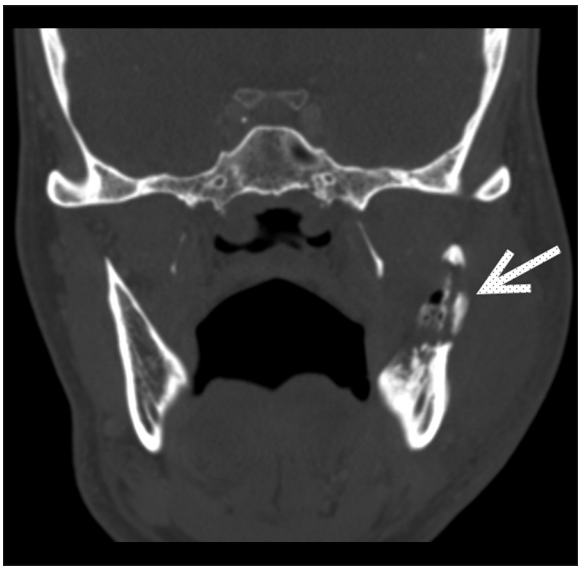

Figure 15. CT examination of head and neck, coronal scan, bone window. Osteomyelitis of the left mandibular ramus with osteonecrosis.

odontogenic inflammation constituted as much as 68%. However, results of our work cannot imply high general prevalence of odontogenic inflammatory process in relation to cervicofacial inflammation of other etiologies, as many head and neck CT examinations with known non-odontogenic infections were rejected by the authors and not included into the initial group.

As in other publications [9], aside from edema of the head and neck region, trismus constituted one of most frequent clinical symptoms our work, preventing intraoral physical examination. For that reason, authors attempted to establish whether computed tomography might be helpful in finding the source of infection, showing periapical osteolysis around causative teeth (positive in 79% of cases).

In a work by Abrahams et al. [10] analyzing CT scans of 400 patients in search of periodontitis, it was demonstrated and precisely classified into specific types. According to the authors of this work, radiologists who do not evaluate periapical lesions on regular basis should undergo training in this regard.

Cone Beam Computed Tomography aids in search for periodontal abscesses of maxilla and mandible. Advantages of this technique include excellent resolution, reduced artifacts from tooth fillings, software enabling special reconstructions, greater accuracy of cross-sections and reduced radiation dose compared to CT [11,12].

Orthopantomograms are also characterized by high spatial resolution allowing for assessment of minute periodontal lesions [10].

However, both CBCT and orthopantomograms are of limited value in assessment of soft tissues.

In our Center periodontal inflammatory foci are mainly diagnosed with orthopantomograms. Patients suspected

of an abscess in deep head and neck compartments have urgent CT examination performed due to the possibility of simultaneous soft tissue assessment. Therefore, we may attempt to find features of periodontal osteolysis in a bone window while analyzing viscerocranium CT images. Artifacts from tooth fillings may pose a problem, making soft tissue assessment more difficult. However, searching for foci of osteolysis around the teeth requires the radiologist to inspect roots of individual teeth in various planes devoting more time to the study, which is not always possible under on-call conditions. However, more in-depth assessment of those examinations is possible at later time.

Results of our work largely correspond to the results acquired by Yonetsu et al. [7], where mandibular teeth constituted a source of inflammation in 84% of cases and the most frequently affected space was the masticator space (87% exactly), followed by submandibular space in 61% of cases (71% in our work). A profile of involvement of individual muscles within masticator space was also similar: in the work by Yonetsu et al. masseter muscle was involved in 76% of cases, medial pterygoid muscle in 63%, temporal muscle and lateral pterygoid muscles were involved somewhat more often than in our study (26% and 21%, respectively). Submandibular space involvement was not demonstrated in a group of patients with inflammatory process starting in mandibular teeth, although this group of patients was small in our study as well.

Our results differ from those published by Marioni et al. [9], which demonstrated frequency of masticator space involvement in the second place (32.9%) after submandibular space (85.9%).

None of the previous works attempted to assess severity of changes, while our study shows that the greatest severity of inflammatory infiltration is observed in submandibular space. Frequency of infiltration of individual spaces in our study group may depend on evaluation of neck space in CT examination. Submandibular and buccal spaces, which are more accessible to clinical examination, do not require performing a CT examination as opposed to masticator space [13]. CT imaging enables broader assessment of pathological changes. Mediastinal involvement should be always assessed (Figure 14) as a cervicofacial inflammatory infiltration together with retropharyngeal space, which is a pathway by which inflammation spreads to mediastinum [4–6] (Figure 13) and so-called danger space.

In a work by Nyberg et al. description of CT examination corresponded to the result of intraoperative examination with regard to the presence or absence of an abscess in 23 of 25 cases (92%). In our work, we found concordance between inflammatory infiltrate visible in CT and intraoperative assessment in 33 (87%) cases. In some cases, the difference between intraoperative assessment of an abscess and result of CT imaging observed in our work resulted from a discrepancy between times of CT examination and surgery. An abscess (invisible in CT) was formed during that time. Moreover, other patients demonstrated pronounced improvement following administration of intravenous antibiotics, which in case of small, poorly differentiated abscess did not constitute an indication for urgent surgical treatment. Similar reasons for these discrepancies in results were mentioned by Nyberg.

While analyzing causative teeth, one should remember that in dental practice a significant proportion of periodontal abscesses are localized in oral antrum, where they form fistulas, in buccal space, or maxillary sinuses [3]. In such cases clinical management does not require performing computed tomography examination. Maxillary sinuses may be assessed in focused CT of the sinuses, which delivers a smaller dose of ionizing radiation. Therefore, the frequency of reporting individual teeth as infection source in our study refers only to the teeth, which produce inflammatory infiltrate in deeper craniofacial and neck spaces. According to our work mandibular molar teeth, particularly the third tooth, are most often causative. In a study by Marioni et al. first molar tooth was the most frequent cause of infection.

Marioni's work also took comorbidities into consideration – most common included hypertension, heart disease and diabetes. Reduced immunity augments the severity of inflammatory process, which is particularly visible in diabetes [14]. In our group of patients comorbidities also included hypertension and diabetes, less often ischemic heart disease.

Moreover, while assessing head and neck CT examination one should take note of orbital soft tissue inflammation as an important complication of odontogenic inflammatory processes [15]. In our work there were several cases of palpebral, but not orbital inflammation.

Conclusions

1. Odontogenic inflammatory infiltrate visible in CT imaging most frequently affects masticator space, including masseter muscle, followed by submandibular space.
2. CT examination enables identification of causative teeth in a large proportion of cases, particularly when trismus precludes accurate clinical examination.
3. In most cases suspect of odontogenic inflammatory process, head and neck CT examination reveals an abscess requiring urgent treatment.

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