

Incidental findings in the maxillofacial region detected by cone beam CT

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PURPOSE

The purpose of this study was to determine the location, nature, and occurrence of incidental maxillofacial findings on cone beam computed tomography (CBCT) scans performed for maxillofacial diagnostic purposes.

MATERIALS AND METHODS

CBCT images of 207 consecutive patients (129 females and 78 males) were examined. The sample consisted of 85 temporomandibular joint (TMJ) disorder patients, 45 paranasal sinusitis patients, 30 obstructive sleep apnea syndrome patients, 15 implant patients, and 32 others.

RESULTS

The overall rate of incidental findings was 92.8%. The highest rate of incidental findings was in the airway area (51.8%), followed by impacted teeth (21.7%), TMJ findings (11.1%), endodontic lesions (4.3%), condensing osteitis (1%), and others (2.9%). The airway incidental findings included mucosal thickening (21.3%), deviation of the nasal septum (12.6%), conchal hypertrophy (11.1%), bullous concha (3.9%), and retention cysts (2.9%). The impacted teeth consisted of third molars (18.8%) and canines (2.9%). The incidental findings for the TMJ patients were erosion of the condyle (4.8%), osteophytes (3.4%), and bifid condyle (2.9%).

CONCLUSION

Oral radiologists should be aware of possible incidental findings and should be vigilant about comprehensively evaluating possible underlying diseases.

Key words: • maxilla • cone beam computed tomography • diagnosis

During the past four decades, dentistry has seen a dramatic expansion and refinement of the technology used to identify dental and intraosseous disorders. Intra-oral radiographs, including periapical, bitewing and occlusal projections, are the basic (and often the only) imaging technique required for most dental pathologies. Plain film and panoramic radiography supply information about the teeth, upper and lower jawbone, sinuses, and other hard tissues of the head and neck. However, these techniques suffer from superimposition of all of the structures that lie in the path between the X-ray source and the film or detector.

Three-dimensional diagnostic imaging is certain to be the preferred imaging method in future dentistry. Computed tomography (CT), originally designed for cranial imaging, has been used for evaluating orofacial structures since its development. However, CT machines have limitations for dentistry, including their high cost, large footprint and high radiation exposure. Cone beam CT (CBCT) addresses these issues and provides many dental advantages (1). Over the last decade, CBCT has become available for maxillofacial radiographic imaging, and numerous systems are now in use (2).

CBCT radiation doses vary substantially depending on the device, field of view (FOV) and selected technique. The effective radiation dose is many times higher than that of conventional panoramic radiography, although it is less than the reported doses for conventional CT. In a large-FOV CBCT scan, for example, patients are exposed to a radiation dose equivalent to that of up to seven panoramic radiography images, and they are exposed to the equivalent of up to 336 panoramic radiography images in a conventional maxillomandibular CT scan (3).

CBCT technology allows a dental practitioner to evaluate patients for a wide variety of maladies, including dental and jaw trauma and infections, edentulism (quantitative and qualitative osseous evaluation for dental implants), temporomandibular joint (TMJ) osseous pathology, impacted and supernumerary teeth, developmental and congenital jaw deformities, dental endodontic lesions, and oral and maxillofacial pathology (4). The main limitations of CBCT compared to conventional CT are the lack of a soft tissue window, the lack of precise Hounsfield units, and higher image noise (1). The flat panel detectors used in the present study offered high spatial resolution and higher signal-to-noise ratios than the image intensifiers in cone beam machines (5).

An incidental finding is one that is unrelated to the present illness and is discovered unintentionally. The purpose of the present study was to retrospectively determine the location, nature, and occurrence of incidental findings in maxillofacial CBCT scans performed for maxillofacial diagnostic purposes.

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Materials and methods

The cone beam images were acquired using a Newtom 3G (Quantitative Radiology, Verona, Italy) Flat Panel-based CBCT machine. To establish a consistent orientation in the images, the patient was placed in a horizontal position such that the Frankfort horizontal plane (the plane between the highest point of the opening of the external auditory canal and the lowest point of the orbit) was perpendicular to the table, with the head within the circular gantry housing the X-ray tube. The X-ray tube detector system performed a 360° rotation around the head of the patient, with a scanning time of 36 s. The scanner operated with a maximum output of 110 KV and 15 mAs, a 0.16-mm voxel size and a typical exposure time of 5.4 s. The QR-NNT software version 2.21 (Quantitative Radiology) was used to analyze the images. After the raw data was acquired, the patient left the examination room, and the clinician performed the primary reconstruction to obtain axial slices with a 0.5 mm thickness. A secondary reconstruction was subsequently performed, and panoramic, sagittal, coronal, and cross-sectional slices with the required thickness and width were obtained.

The CBCT images for 207 consecutive patients (129 females and 78 males) were retrospectively examined. The sample consisted of 85 TMJ disorder patients, 45 paranasal sinusitis patients, 30 obstructive sleep apnea syndrome patients, 15 implant patients, and 32 others. The incidental findings were classified as airway findings, impacted teeth, TMJ findings, endodontic lesions, condensing osteitis, and idiopathic osteosclerosis. All of the incidental findings were noted on forms originally designed for this study. All of the scans were independently reviewed by two oral and maxillofacial radiologists with experience analyzing >1000 CBCT scans. Any conflicts in the reviews were resolved by consensus.

Results

A description of the subjects and their indications for CBCT are reported in Table 1, and the percentages of incidental findings are shown in Table 2. The overall rate of incidental findings was 92.8%. The highest rate of incidental findings was in the airway area (51.8%) (Fig. 1), followed by impacted teeth

Table 1. Description of the subjects and their indications for cone beam CT (CBCT) referral

| Age (years) | 30.29±13.80 (range, 9–74) |
|-----------------------------------|------------------------------|
| Gender (n) | |
| Male | 78 |
| Female | 129 |
| Indication for CBCT (n) | |
| Temporomandibular joint disorders | 85 |
| Paranasal sinusitis | 45 |
| Obstructive sleep apnea syndrome | 30 |
| Implant | 15 |
| Others | 32 |
| Total | 207 |

Table 3. The incidental findings in the 85 temporomandibular joint patients

| | n (%) |
|-------------------------------|-----------|
| Airway area | |
| Mucosal thickness | 22 (25.9) |
| Deviation of the nasal septum | 12 (14.1) |
| Conchal hypertrophy | 9 (10.6) |
| Bullous concha | 7 (8.2) |
| Retention cyst | 5 (5.9) |
| Impacted teeth | |
| Third molars | 27 (31.8) |
| Canines | 2 (2.3) |
| Endodontic lesions | 5 (5.9) |
| Condensing osteitis | 0 (0) |

(21.7%) (Fig. 2), TMJ findings (11.1%) (Fig. 3), endodontic lesions (4.3%) (Fig. 4), condensing osteitis and idiopathic osteosclerosis (1%), and others (2.9%). The incidental findings in the airway area included mucosal thickness (21.3%), deviation of the nasal septum (12.6%), conchal hypertrophy (11.1%), bullous concha (3.9%), and retention cysts (2.9%). The impacted teeth consisted of third molars (18.8%) and canines (2.9%). The incidental TMJ findings consisted of erosion of the condyle (4.8%), osteophytes (3.4%), and bifid condyle (2.9%).

Table 2. The incidental findings in the study population

| | % |
|-------------------------------|------|
| Airway area | 51.8 |
| Mucosal thickness | 31.3 |
| Deviation of the nasal septum | 12.6 |
| Conchal hypertrophy | 11.1 |
| Bullous concha | 3.9 |
| Retention cysts | 2.9 |
| Impacted teeth | 21.7 |
| Third molars | 18.8 |
| Canines | 2.9 |
| Temporomandibular joint | 11.1 |
| Erosion of the condyle | 4.8 |
| Osteophytes | 3.4 |
| Bifid condyle | 2.9 |
| Endodontic lesions | 4.3 |
| Condensing osteitis | 1 |
| Other | 2.9 |
| Total | 92.8 |

Table 4. The incidental findings in the 45 paranasal sinusitis patients

| | n (%) |
|-------------------------|----------|
| Temporomandibular joint | |
| Erosion of the condyle | 8 (17.8) |
| Osteophytes | 4 (8.8) |
| Bifid condyle | 2 (4.4) |
| Impacted teeth | |
| Third molars | 4 (8.8) |
| Canines | 0 (0) |
| Endodontic lesions | 1 (2.2) |
| Condensing osteitis | 0 (0) |

The most frequent incidental finding in the TMJ patients was impacted third molars (31.8% of the TMJ patients) (Table 3). In the paranasal sinusitis patients, the most frequent incidental finding was erosion of the condyles (17.8% of sinusitis patients) (Table 4).



Figure 1. a–c. The airway findings in CBCT. Deviation of the nasal septum and conchal hypertrophy are seen on the coronal view (a, arrow). Mucosal thickness and bullous concha (b, arrow) are seen on the coronal view. A retention cyst is seen on the axial view (c, arrow).

Discussion

In this study, 192 patients (92%) had incidental findings. The incidental findings were most frequently seen in the airway area, with mucosal thickening being the most common (31.3%). The high frequency of airway findings demonstrates that CBCT can be an efficient tool for detecting airway changes, such as mucosal thickness, deviation of the nasal septum, conchal hypertrophy, bullous concha and retention cysts.

Many of the incidental findings in the airway area have been previously studied using three-dimensional (3D) images (6–8). It has been reported that the joint incidence of nasal septal deviation and bullous concha is high (44.6%) (8). In a recent volumetric CT study, Smith et al. (7) found that 19.4% of their patients had a deviated septum, and 50.0% and 67.5% had mucosal thickening and bullous concha, respectively, which was consistent with maxillary sinusitis. They also noted that 49.3% of the patients with bullous

concha also displayed evidence of maxillary sinusitis. Our mucosal thickness, deviated septum, and bullous concha findings were relatively lower than those in the above-mentioned studies. However, we only considered the incidental findings. For example, we did not classify an airway finding as an

incidental finding in a CBCT scan of a paranasal sinusitis patient.

In another CBCT study, Cha et al. (6) found an 18.8% incidence of airway findings. They found the following distribution of airway findings in orthodontic patients: sinusitis (7.5%), retention cysts (3.5%), polyps (2.3%),

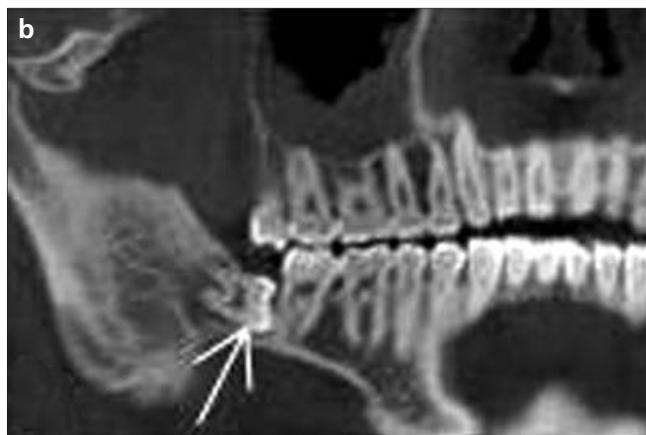


Figure 2. a, b. Impacted teeth from panoramic views in CBCT. The arrows show an impacted canine (a) and a third molar (b).



Figure 3. a–c. The temporomandibular joint findings in CBCT. The *arrows* show erosion (a), osteophytes (b), and bifid condyle (c).



Figure 4. a, b. The *arrows* show endodontic lesions on panoramic (a) and cross-sectional (b) views.

deviation of the nasal septum (0.4%), and conchal hypertrophy (0.4%). Their results are different from those of our study, and this difference may have resulted from differences in the study populations. A mucous retention cyst is a type of secretory cyst that it is rarely seen in radiographs (9). The frequency of mucosal thickening and retention cysts can vary with odontogenic factors (for the maxillary sinus), age, gender, and allergies. In our study, we found the frequency of incidental mucous retention cysts to be 2.9%.

The presence of mucosal thickening in the maxillary sinus always presupposes an irritation (9). Such irritation can result from odontogenic factors, trauma to the maxilla or the oral cavity that penetrates the antrum and infections of the nasal conchae (10). Vallo et al. (9) found the prevalence of mucosal

thickness in the maxillary sinuses to be 12% in panoramic radiography. In our study, however, the incidental frequency of mucosal thickness in CBCT was 31.3%. Thus, panoramic radiography may not be as reliable a method for diagnosing pathological dental or sinus findings as 3D imaging techniques (11). CBCT and CT provide 3D visualization and prevent the superimposition of anatomic structures and pathological changes. Further, the quality of flat-panel CBCT images of the paranasal sinuses is related to the radiation dose and scanning time (12).

Incidental findings in the TMJ region were equally prevalent and included erosion of the condyles (4.8%), osteophytes (3.4%), and bifid condyle (2.9%). Crow et al. (13) found that in panoramic radiography, there are no differences in condylar morphology

between patients with and without TMJ disorders. The prevalence of condylar bone changes in orthognathic surgery patients has been reported to be 55% by transpharyngeal radiographs (14) and 35.7% by CT (15). Our results were comparatively lower, but our study had a broader population and only included incidental findings. Miloglu et al. (16) found the frequency of bifid mandibular condyle in a Turkish patient population to be 0.3% by panoramic radiography. By contrast, we found the frequency of bifid mandibular condyle to be higher (2.9%). This difference may have been due to the superiority of CBCT for analyzing the TMJ region because of the absence of superimposition of anatomical structures. In particular, panoramic imaging and conventional tomography may yield disappointing results.

Failure of the eruption of permanent teeth is a common dental anomaly. CBCT allows a practitioner to view teeth in three spatial planes (17). Impacted teeth and their relationships with other anatomical structures can also be satisfactorily examined in three dimensions by CBCT. Jena et al. (18) investigated the distribution of individual tooth impaction in Northern India general dental patients by conventional radiography. They noted that the frequency of at least one impacted tooth (excluding third molars) was 0.49% and that the most frequently impacted teeth were the maxillary canines (52.27%). Fardi et al. (19) reported the incidence of impacted teeth by panoramic radiography to be 13.7%, with impacted maxillary canines being the most common, similar to Jena et al. (18). In our study, we found a higher frequency of impacted teeth than was found in the above-mentioned studies. We included third molars, however, and the frequency of impacted third molars was quite high.

Imaging is an important clinical aid for diagnosing endodontic bone lesions. Cotti (20) has reported that among the newest imaging modalities, digital cone beam volumetric tomography is becoming the new standard and that real-time echo tomography is attracting interest in diagnostic endodontics. We found incidental endodontic lesions by CBCT in 4.3% of the subjects in our study, as compared to 1.8% in another study (6).

Condensing osteitis lesions (also known as focal sclerosing osteomyelitis) are radio-opaque formations that are related to teeth with severe caries, restoration or pulpitis. We found the incidental frequency of condensing osteitis to be 1%. The frequency of condensing osteitis lesions in a Turkish patient population was previously found to be 0.81% by panoramic radiography (21), which is a similar result.

There have been only sporadic case reports of lesions discovered incidentally in adults or children. Asaumi et al. (22) found incidental lesions by panoramic radiography in 6.05% of pediatric patients. In a 2007 study of 500 people who underwent a CBCT examination, the authors noted unexpected incidental findings in 25%

of the sample (6). Our incidental findings were considerably higher because we included all of the different types of incidental maxillofacial findings (e.g., airway findings, TMJ findings, impacted teeth, endodontic lesions, condensing osteitis and other findings).

It should be noted that a dentist or oral radiologist is not expected to treat conditions outside of his or her professional expertise. However, he or she is not absolved of the moral responsibility of identifying deviations in the complete image. If an oral radiologist has concerns, then he or she should refer the patient to the relevant specialist.

In conclusion, oral radiologists should be aware of these incidental findings and comprehensively evaluate the possibility of underlying diseases.

Conflict of interest disclosure

The authors declared no conflict of interest.

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