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Original Article

Incidental cone beam computed tomographic findings among Taibah University patients, KSA: A retrospective study

Ebtihal H. Zain-Alabdeen, MDS * and Sara M. El Khateeb, D.D.Sc

Department of Oral and Basic Clinical Sciences, College of Dentistry, Taibah University, Almadinah Almunawwarah, KSA

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الملخص

أهداف البحث: تهدف هذه الدراسة إلى التقييم بأثر رجعي لمدى انتشار، ونوع، ومكان التشخيصات العرضية المكتشفة باستخدام التصوير المقطعي مخروطي الأشعة. أُجريت هذه الدراسة لتشخيص المشكلات المتعلقة بالأسنان في القسم النسائي من عيادات الأسنان بجامعة طيبة في المملكة العربية السعودية.

طرق البحث: أُجري ما مجموعه ١٥٠ أشعة تصوير مقطعي مخروطي خلال الفترة ما بين يناير ٢٠١٤ وفبراير ٢٠١٦. وتم الحصول على السجلات من خلال قاعدة بيانات برنامج "كيرستريم آر ٤" للتعامل مع المعلومات السريرية والعملية التابع لعيادات أسنان بجامعة طيبة. قمنا بتقييمها بأثر رجعي لاكتشاف التشخيصات العرضية ومن ثم اختصارها وتصنيفها إلى خمس مناطق تشريحية: مجرى الهواء البلعومي الأنفي, المفصل الصدغي الفكي, الجيوب الأنفية, منطقة الأسنان, منطقة العظم السنخي. بعد ذلك قمنا بتحليل عدد ونسبة الملاحظات في كل فئة.

النتائج: تم تسجيل ما مجموعه ٢٤٨ تشخيصا عرضيا في ٨٣ من ٩٠ صورة إشعاعية (٢,٧٦ تشخيصا لكل صورة). كانت النسبة الكلية لوجود التشخيصات العرضية ٩٢,٢%. وكانت منطقة الجيوب الأنفية ومنطقة العظم السنخي أكثر المناطق التي وُجد بها تشخيصات عرضية بنسبة ٢٧,٤% لكل منهما من بين المجموع. وكانت بقية النسب: المفصل الصدغي الفكي بنسبة ٢٢,٩%, يتبعها مجرى الهواء البلعومي الأنفي بنسبة ١٠,٩%, ثم منطقة الأسنان بنسبة ١٠,٥% والباقي ٠,٨%.

الاستنتاجات: تؤكد هذه الدراسة النسبة العالية لوجود التشخيصات العرضية الظاهرة في صور الأشعة المقطعية المخروطية في منطقة الوجه والفكين بين عينة من المرضى النساء في عيادات أسنان جامعة طيبة. وهذا يؤكد الحاجة إلى فحص دقيق لصور الأشعة المقطعية المخروطية لاكتشاف نتائج هامة سريريا داخل وخارج منطقة الاهتمام الأساسية, وذلك لصالح المرضى ولحماية الممارسين الصحيين.

الكلمات المفتاحية: الأشعة المقطعية المخروطية؛ التشخيصات العرضية؛ الوجه والفكين؛ نسبة انتشار؛ المفصل الصدغي الفكي

Abstract

Objectives: The aim of this study was to retrospectively evaluate the prevalence, type, and location of incidental findings by cone beam computed tomography (CBCT) scans. This study was performed to diagnose dental problems in the female population at Taibah University Dental Clinics (TUDC), KSA.

Methods: A series of 150 consecutive CBCT scans were identified between January 2014 and February 2016. The record was retrieved from the Carestream (CS) R4 Clinical and Practice Management Software database of TUDC. We retrospectively assessed them for incidental findings and then summarized and categorized them into five anatomical regions: nasopharyngeal airway, temporomandibular joint (TMJ), paranasal sinuses, dental findings, and alveolar bone region. We then analysed the frequency and percentage of findings in each category.

Results: A total of 248 incidental findings were reported in 83 of 90 scans (2.76 findings/scan). The prevalence of all incidental findings was 92.2%. The most common incidental findings were located in the paranasal sinuses and alveolar area, each representing about a quarter (27.4%) of all of the findings. Other common findings were in the TMJ (22.9%), followed by those in the nasopharyngeal airway (10.9%), dental area (10.5%), and others (0.8%).

Conclusion: This study confirms the high prevalence of incidental maxillofacial findings as shown by CBCT scans in a sample of female patients at TUDC. This emphasizes the need to thoroughly examine CBCT volumes for clinically significant findings inside and beyond the region of interest for the benefit of patients and the protection of practitioners.

* Corresponding address: Department of Oral and Basic Clinical Sciences, College of Dentistry, Taibah University, Almadinah Almunawwarah, KSA.

E-mail: ebtihalh@gmail.com (E.H. Zain-Alabdeen)

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Keywords: CBCT; Incidental findings; Maxillofacial; Prevalence; Temporomandibular joint

Introduction

Over the last decade, cone beam computed tomography (CBCT) has been quickly incorporated into the field of dentistry and become the method of choice for maxillofacial radiographic imaging.[1] A CBCT scan offers advantages over conventional imaging, as it eradicates geometric distortion and the superimposition of neighbouring anatomical structures. Moreover, the patient's exposure to radiation is much lower with CBCT than with conventional computed tomography (CT) imaging.[2,3]

Using CBCT equipment, the dentist is able to evaluate the patient for a broad variety of diseases and conditions, including trauma and infections, bone density, temporomandibular joint (TMJ) bony pathology, dental anomalies, developmental and congenital jaw deformities, endodontic lesions, and upper airway dimensions. CBCT can also be used to prepare for orthognathic surgery, such as cases of craniofacial/cleft lip and palate and of oral and maxillofacial pathology.[4]

CBCT discloses not only concealed anatomy but also hidden pathology, decreasing the risk of neglecting a clinically significant disease.[5] Nakata et al.[6] found that CBCT may be used to discover the presence of undiagnosed intrabony lesions that previous clinical assessment and conventional radiographic imaging failed to discover.

An incidental radiographic finding is any finding identified by a diagnostic imaging modality, including computed tomography or CBCT, that is unconnected to the clinical indication for carrying out the imaging.[7,8] While reading CBCT scans, it is essential for clinicians to interpret the whole image volume rather than being bound to an assessment of the area of interest. Careful and systematic evaluation allows discovery of incidental findings with clinical significance.[9]

Some studies have examined the frequency of incidental findings outside the area of interest on CBCT scans in several patient samples.[3,8,10,11] Khojastepour et al.[12] concluded that all CBCT images need to be reviewed comprehensively, as in their study, 475 of 773 subjects showed at least one incidental finding, with an overall rate of these findings of 60%.[12] Another study performed in Turkey[8] showed that the frequency of incidental findings was 92.8% in 207 patients. Cha et al.[13] reported that the frequency of CBCT maxillofacial incidental findings among 500 consecutive patients was 24.6% and that the most common findings were in the airway area.[13]

The European Academy of Dentomaxillofacial Radiology and the American Academy of Oral and Maxillofacial Radiology declared that if the interpreting clinician is not highly qualified in CBCT interpretation, a proper referral to an oral

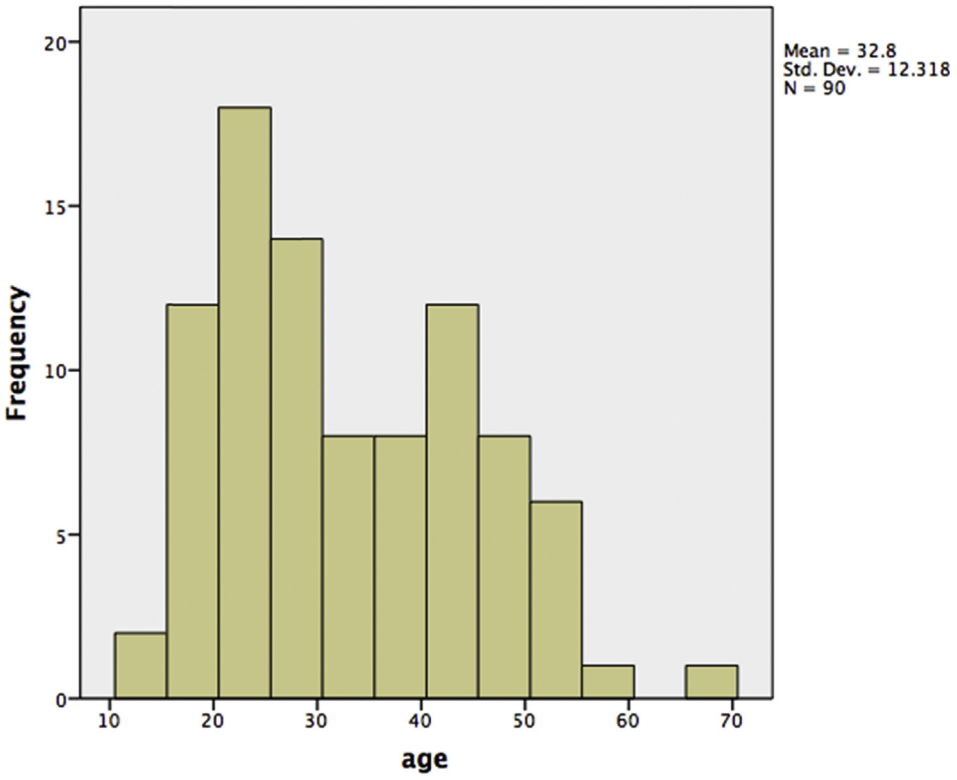

Figure 1: Histogram showing age distribution of the patients.

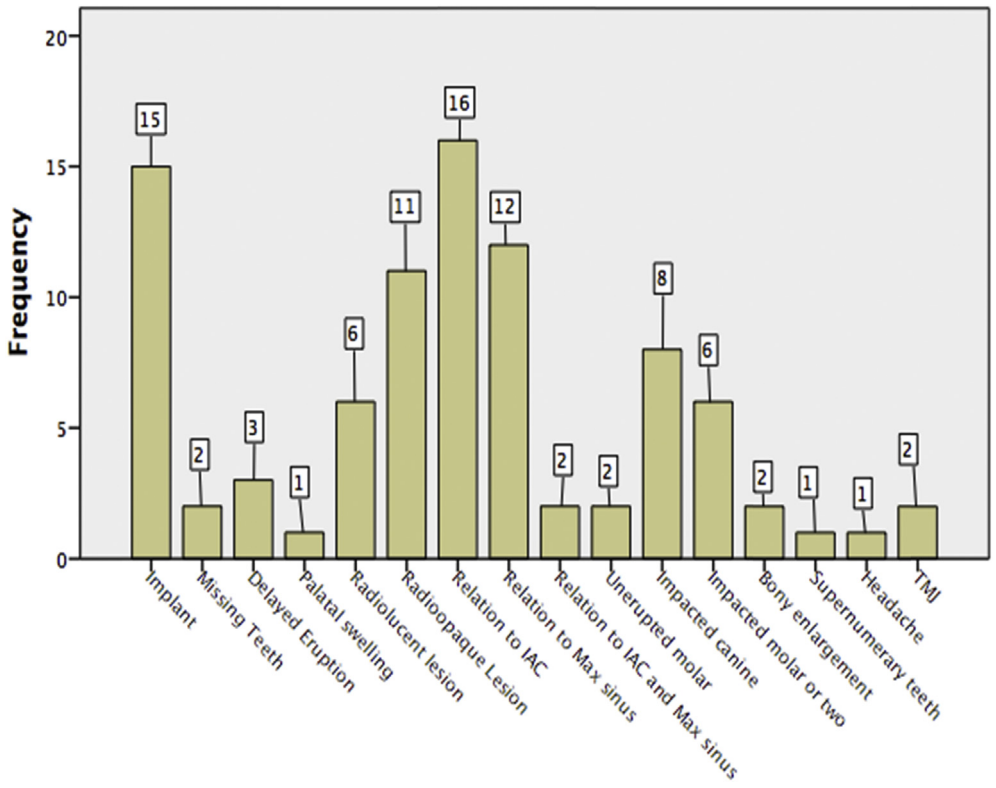

Figure 2: Indications for CBCT scans in the present study.

and maxillofacial radiologist for examination is compulsory and that the entire volume must be interpreted.[2,14]

Additional studies are required to further support this idea by defining incidental findings on CBCT scans by type to precisely assess potential findings and pathologies. Discovering these incidental findings by CBCT scan may help dentists recognize clinically significant lesions while at the same time lessening patient exposure to unnecessary additional invasive imaging methods used to identify lesions that require intervention or treatment.

Thus, we considered it imperative to study the prevalence of incidental radiographic findings in a sample of patients living in Almadinah Almunawwarah, KSA, especially since there is no database or screening data regarding this issue in this country. The aim of the present study was thus to retrospectively evaluate the prevalence, type, and location of incidental findings in CBCT scans performed for diagnostic purposes in female patients at Taibah University Dental Clinics (TUDC), Almadinah Almunawwarah, KSA.

Materials and Methods

Our study is a retrospective description of radiographic findings carried out at TUDC. All CBCT scans were retrieved from the archives of the Carestream (CS) R4 Clinical and Practice Management Software database (CS Health, Inc. Rochester, NY, USA) of TUDC and were acquired by a CS 9300 PREMIUM 3D CBCT device (Carestream SM 749, Rochester, NY, USA) set at 73 KV and 12 mA. All indications for a CBCT examination were specified in an official signed referral request at the TUDC Oral Radiology Unit. We retrospectively examined the CBCT scans of 150 consecutive female patients carried out by this unit from January 2014 to February 2016. Any detected radiographic finding that was not related to the purpose of the CBCT request was recorded as an incidental finding.

The patients' ages and indications for CBCT imaging were recorded. Incidental findings were categorized into five groups based on anatomical location: nasopharyngeal airway, TMJ, paranasal sinuses, dental findings, and alveolar region findings. Radiographic criteria for reviewing the incidental findings were applied according to the specifications for differential diagnosis of Wood and Goaz[15] and White and Pharoah.[16]

Findings such as dental caries, missing teeth, altered tooth morphology, and periodontal bone loss, were not recorded, and radiographic findings that were directly related to the primary indication for CBCT scans were excluded. Segmented CBCT scans were further excluded from the study because only the area of interest was included in these scans without any incidental findings. We also excluded CBCT scans without known indications or with positioning artefacts. We included 10 × 5 cm and 10 × 10 cm fields of view.

All scans were independently reviewed in the workstation by two oral and maxillofacial radiologists with extensive experience. All working conditions were similar and standardized during interpretation and any conflicts in the reviews were decided by consensus.

Each volume was seen in the three orthogonal planes (axial, coronal, and sagittal views). Oblique sections were also observed when a variation or pathology was found. A reformatted panoramic image for the jaws was reconstructed to view the maxillary and mandibular teeth. Custom slicing was used for TMJ examination. Cross-sections perpendicular to the reformatted panoramic image were observed to visualize

details. CBCT volumes were manipulated by InVivoDental version 5.4.3 software 2004–2015 from Anatomage, Inc.

The Taibah University College of Dentistry Research Ethics Committee approved this study on 14 November 2014. A waiver of consent was approved because this was a retrospective radiographic study, and all of the collected data were anonymous and coded. IBM SPSS statistical software (IBM SPSS Statistics for Macintosh, Version 22.0.Armonk, NY, USA: IBM Corp) was used to display frequency tables and graphs.

Results

The patients who had CBCT scans in our study ranged in age from 13 to 70 years, with a median age of 30 and a mean age of 32.8 (95% confidence interval 30.22–35.38; standard deviation 12.32). The age distribution was positively skewed to the younger age-group of 20 to 30-year-olds, as seen in Figure 1. The predominant indication for CBCT scans in our study was to investigate the relation of mandibular third molars to the inferior alveolar canal, which was found in 10.2% (n = 16) of patients. The second most common indication was implant treatment planning in 9.6% (n = 15) of patients. The least common CBCT indications were palatal swelling, headache, and missing teeth (Figure 2).

Of a total of 150 CBCT scans, 40 segmented scans, 12 scans without known indications, and 8 scans with artefacts were excluded. The remaining 90 CBCT scans were retrospectively reviewed for incidental findings. A total of 248 incidental findings were reported from 83 of 90 CBCT scans (2.76 findings/scan). The prevalence of all incidental findings in the present study was 92.2%.

The categories and frequency of incidental findings are shown in Table 1. The most prevalent incidental findings were those located in the paranasal sinuses and alveolar region, each representing 27.4% of all findings. The second most common findings were situated in the TMJ (22.9%), followed by findings in the nasopharyngeal airway (10.9%), dental findings (10.5%), and others (0.8%) (Table 2).

Among the paranasal sinus findings, the most predominant were mucosal thickening in the maxillary sinus (n = 31, 12.5%) (Figure 3a and e, short arrows). Among the rare findings were calcification in the maxillary sinus (Figure 3a, long arrows, b) and serrated or irregular nasal conchae (Figure 3c and d). The most prevalent alveolar finding was periapical pathosis (n = 38, 15.3%) (Figure 3e, long arrows). The main nasopharyngeal airway finding was a deviated nasal septum (n = 12, 4.8) (Figure 3f, short arrow). Condylar flattening was the highest incidental TMJ finding (Figure 4a–d). The most common dental findings were impacted teeth (n = 13, 5.2%) (Figure 5a and b) and the least common were supernumerary teeth (Figure 5c).

Table 1: Frequency and percentage of CBCT incidental findings among the five designated anatomic regions.

Incidental CBCT finding category	Frequency (n)	Percentage of incidental findings
Dental findings	**26**	**10.5%**
Impacted teeth	13	5.2%
Retained deciduous	6	2.4%
Dilacerations	4	1.6%
Supernumerary teeth	1	0.4%
Partial anodontia	1	0.4%
Dentinogenesis imperfecta	1	0.4%
Alveolar bone region	**68**	**27.4%**
Periapical radiolucent lesion	38	15.3%
Isolated radiolucent lesion	1	0.4%
Multiple radiolucent lesion	1	0.4%
Isolated radiopaque lesion	11	4.4%
Attached radiopaque lesion	9	3.6%
Multiple radiopaque lesions	2	0.8%
Mixed lesion	1	0.4%
Pericoronal lesion	1	0.4%
Widened marrow spaces	2	0.8%
Widened inferior alveolar canal	2	0.8%
Paranasal sinuses	**68**	**27.4%**
Maxillary sinus thickening	31	12.5%
Maxillary sinus opacification	5	2%
Maxillary sinus partial opacification	4	1.6%
Maxillary sinus polyp	1	0.4%
Ethmoid sinus opacification	17	6.8%
Frontal sinus opacification	5	2%
Sphenoid sinus opacification	3	1.2%
Maxillary sinus other (calcification)	2	0.8%
Nasopharyngeal airway	**27**	**10.9%**
Deviated nasal septum	12	4.8%
Concha hyperplasia	14	5.6%
Nasal cavity opacification	1	0.4%
Temporomandibular joint	**57**	**23%**
Condylar hypoplasia	11	4.4%
Physiological remodelling (flattening, sclerosis)	35	14.1%
Degenerative changes (erosion, osteophyte formation)	11	4.4%
Other	2	0.8%
Elongated styloid process	1	0.4%
Serrated (irregular) nasal conchae	1	0.4%
Total	**248**	**100%**

Discussion

CBCT scans have been progressively used in recent years for various applications in the dental field. Their value lies in the practitioner's ability to discover significant clinical findings beyond the area of interest for which CBCT was indicated.[8] Therefore, the aim of the present study was to retrospectively evaluate the prevalence, type, and location of incidental findings on CBCT scans performed for diagnostic purposes in female patients attending TUDC.

The primary indication for a CBCT scan in our study was for surgical procedures (n = 30), that is, to assess the relation of the mandibular third molar to the inferior alveolar canal

Table 2: Distribution of the five main CBCT incidental findings.

Incidental CBCT findings	Frequency (n)	Percentage
Paranasal sinuses	68	27.4%
Alveolar bone region	68	27.4%
Nasopharyngeal airway	27	10.9%
Dental findings	26	10.5%
Temporomandibular joint	57	22.9%
Other	2	0.8%

Figure 3: (a) Coronal CBCT slice showing mucosal thickening (short arrows) and calcification (long arrows) in maxillary sinus. (b) Axial CBCT view showing opacification of maxillary sinus (arrows). (c) Coronal CBCT slice showing irregular or serrated right and left inferior nasal concha (long arrows) with partial opacification of ethmoid sinus (short arrow). (d) Sagittal CBCT view of the right serrated concha. (e) Cropped reformatted panorama showing polypoid mucosal thickening of maxillary sinus (double arrows) and periapical radiolucency related to mandibular and maxillary left second molars (short arrow). (f) Coronal CBCT slices showing deviated nasal septum and hyperplasia of nasal conchae at right side (long arrow).

(n = 16), to the maxillary sinus (n = 12), or to both (n = 2). Therefore, in almost one-third of the sample, CBCT was indicated for surgical purposes. The second main indication was for dental implant planning (n = 12). In their studies, in contrast, Khojastepour et al.[12] and Price et al.[9] reported that implant planning was the main reason for a CBCT request, followed by surgery. This difference could be because implant surgery was not yet being performed at TUDC, and all of the required implants were being done at hospitals outside the university.

The predominance of incidental findings in the present study was 92.2%. This result is in agreement with the findings of Allareddy et al.,[17] who reported incidental findings of 94.3%, as well as those from studies performed by Çaglayan and Tozoglu[8] (92.8%) and Price et al.[9] (90.7%). The predominance of incidental findings in our study is higher, however, than that found in studies carried out by Cha et al.[13] (24.5%) and by Khojastepour et al.[12] (60%).

The highest rate of incidental findings in the present study was for alveolar bone (n = 68, 27.4%) and for paranasal

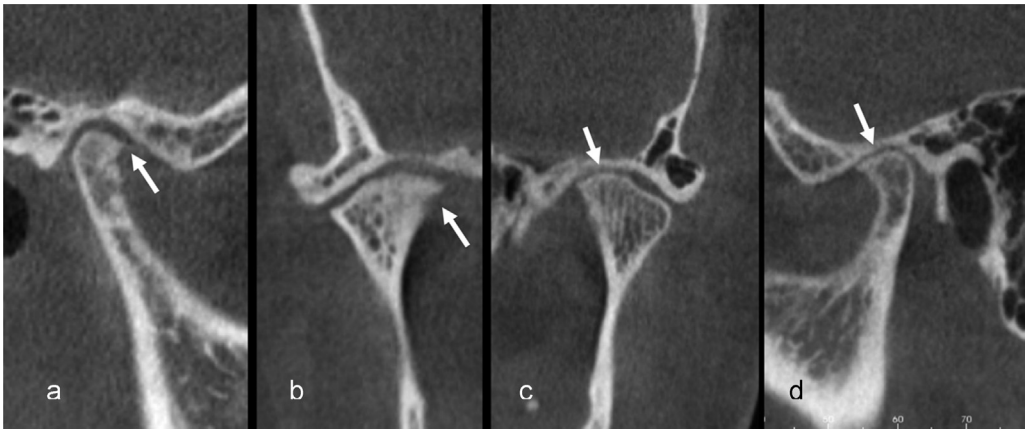

Figure 4: (a) and (b) Sagittal and coronal views of the right TMJ showing flattening and erosion of the medial pole. (c) and (d) Coronal and sagittal views of the left TMJ showing flattening, early osteophyte formation, and reduced joint space.

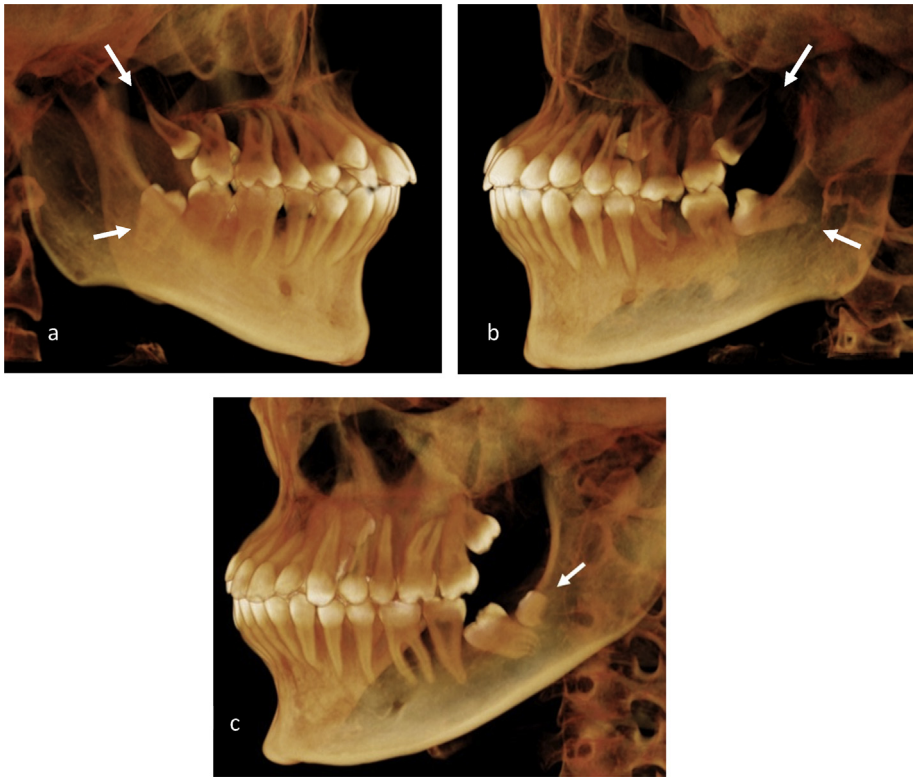

Figure 5: (a) and (b) Three-dimensional CBCT view showing impacted maxillary and mandibular right and left third molars. (c) Three-dimensional CBCT view showing supernumerary tooth at the left mandibular molar.

sinuses (n = 68, 27.4%). For alveolar bone, periapical pathosis was the most frequent finding (n = 38, 15.3%). Some patients had more than one periapical pathosis. This result is similar to that reported by Khojastepour et al.,[12] in which the percentage of periapical pathosis was reported to be 24.5%, but in contrast with other studies that reported a lower rate.[8,13] For paranasal sinuses, maxillary sinus mucosal thickening (12.5%) predominated. This finding is analogous to that in the study by Raghav et al.,[18] who reported that the highest rate of incidental findings was for mucosal thickening (35%), among other pathological findings. Moreover, this result is in agreement with the study by Çaglayan and Tozoglu,[8] who reported that mucosal thickening was the most common of the airway findings on CBCT scans.

The precise incidence of CBCT incidental findings differs extensively in the oral radiology literature. Cha et al.,[13] for example, reported that the highest rate of all incidental findings in their study was in the airway area (18.2%), followed by TMJ findings (3.4%), endodontic findings (1.8%), and others (1.2%), which differs from the prevalence of incidental radiographic findings in our study. These discrepancies may be due to variances in age groups, patient characteristics, and anatomical groupings.

TMJ findings were the second highest incidental finding in our study (22.9%), the main occurrences being physiological remodelling (14.1%), degenerative changes (4.4%), and condylar hyperplasia (4.4%). This result is in contrast to the observations of Edwards et al.,[19] who reported TMJ findings to be only 6.4% of all incidental findings. However, the same study[19] reported that physiological remodelling was the highest among the TMJ incidental findings, as was the case in our study. The percentage of TMJ degenerative changes in our study is in accordance with that found in a study by Çaglayan and Tozoglu,[8] who reported that erosion of the condyles presented 4.8% of incidental findings. Our result is, however, dissimilar to the higher rate of degenerative TMJ changes (39%) identified by Pette et al.,[3] who reported this rate in patients who had CBCT imaging principally for dental implant assessment. The reason for the low rate of TMJ degenerative changes in the study conducted by Edwards et al.[19] could be because their sample consisted of orthodontic patients who are usually young, as studies have shown that the severity of TMJ osseous changes increases with increasing age.[20,21] One reason for the relatively higher rate of TMJ degenerative changes in our study could be that the sample was female, and several studies have shown that the TMJ degenerative changes are higher among women.[20,22]

The nasopharyngeal airway findings in the current study were the third highest incidental finding (10.9%). In the study by Edwards et al.,[19] in contrast, this percentage was higher (42.3%), a deviated nasal septum having the highest occurrence (5.34%) and concha hyperplasia (0.12%) the lowest. In our study, we found concha hyperplasia to have the highest occurrence (5.6%) followed by a deviated nasal septum (4.8%). A deviated nasal septum and concha hyperplasia were also reported as high incidental findings in Çaglayan and Tozoglu's study.[8]

Dental findings (10.5%) followed nasopharyngeal findings in terms of rate of occurrence in our study. In contrast, the peak incidental findings on CBCT scans found by Drage et al.[23] were dental (32.43%); however, their dental findings included the periapical area. In the present study, if we added periapical pathosis (15.3%) to the dental findings, the result would be 25.8%, which would make it the third highest incidental finding. Drage et al.[23] affirmed that retained roots were the predominant dental finding (n = 24 from 120 dental findings, 20%), in harmony with our results regarding retained roots (n = 6 from 26 dental findings, 23%). The most prevalent dental finding in our study was impacted teeth (n = 13, 5.2%), unlike the results reported by Çaglayan and Tozoglu,[8] who observed a comparatively higher percentage of impacted teeth in their incidental findings (21.7%).

Our study has two limitations. One is that the sample size was small and comprised of females only. The sample size was, however, out of our hands. Although we included all patients who had a CBCT and attended the clinics within our college, the CBCT machine was installed only two years ago, and we had access only to the CBCT images for the female section of TUDC. In addition, the scanning process is highly controlled, as only justified and signed requests are scanned, and the process is limited to two maxillofacial radiologists. We recommend that further studies be carried out on a larger sample and on both genders. The other limitation is that the subjective procedure of classifying incidental findings into anatomical categories can be misleading when comparing the findings to those of previous studies in the literature. For example, comparing airway versus sinus findings or alveolar versus dental findings may lead to either overestimation or underestimation of the findings for a particular anatomical region. Standardization of anatomical classification of these regions will be helpful for comparison purposes in future CBCT studies.

Conclusion

In conclusion, this study confirms the high prevalence of incidental maxillofacial findings in CBCT scans in a sample of female patients at TUDC. This result emphasizes the need to thoroughly examine CBCT volumes for clinically significant findings not only inside the region of interest, but beyond it. This approach will both benefit the patient and protect the practitioner.

Conflict of interest

The authors have no conflict of interest to declare.

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Authors' contributions

EHZ wrote the literature review, collected the data, did the statistical analysis and tables, wrote the discussion and limitations, organized and formatted the references, did the final revision and approved the version to be published and the manuscript submission.

SME Designed the research idea, collected the data, wrote the methodology, interpreted the data, composed the results, helped in the discussion, adjusted figures and tables, and approved the final version to be published.

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