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Research Article

INCIDENTAL FINDINGS IN THE MAXILLOFACIAL REGION DETECTED BY CBCT: RETROSPECTIVE STUDY IN A UNIVERSITY TEACHING HOSPITAL PUNE, INDIA

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ABSTRACT

Background: Dental CBCT images provide views of anatomy that most dentists have never before seen. Early detection and improved diagnostic accuracy are essential for improving patient care and treatment out comes, as well as reducing treatment time,complexity, complications, and costs.

Objectives

1. To evaluate all types and prevalence of dentoalveolar findings on CBCT scans.
2. To evaluate all types and prevalence of maxillary sinus findings on CBCT scans.
3. To evaluate all types and prevalence of TMJ changes on CBCT scans
4. To evaluate all types and prevalence ofnasopharynx findings on CBCT scans.
5. To evaluate all types and prevalence of soft tissue calcifications on CBCT scans.

Materials and Methods

- Source from where the cases, patients, subjects or study material will be selected- CBCT scans would be obtained from Dr. D.Y. Patil dental college & hospital, Pune.
- Name and place where the study will be conducted- Dept. of Oral Medicine & Radiology, Dr. D.Y. Patil dental college & hospital, Pune.

Conclusion

This study confirms the frequent presence of incidental findings in maxillofacial CBCT scans. This finding under scores the need for dental practitioners and oral and maxillofacial radiologists to review the entire volume of the CBCT study to document the presence of clinically significant lesions that may require intervention, monitoring, or a referral to other specialists.

INTRODUCTION

During the past four decades, dentistry has seen a dramatic expansion and refinement of the periapical, bitewing and occlusal projections, are the basic (and often the only) imaging technique required for most dental pathologies.[1]

The development of panoramic radiography in the 1950s and its commercial introduction in 1965 led to the widespread adoption and use of the technology. Although widely used, these images have the same inherent limitations as other 2D projections, namely, magnification and minification of structures, superimposition of anatomical and/or pathological entities, and misrepresentation of structures.

CBCT was initially developed for angiography and is also popularly used for radiotherapy guidance and mammography as an alternative to conventional fan beam helical computed tomography (CT) machines to provide more rapid acquisition of a dataset of the entire field of view.

Since then CBCT technology has been integrated into the field of dentistry for visualization of the maxillofacial region in three-dimensional cone-beam volumetric images, for orthodontic and endodontic evaluation.[2]

Currently, the CBCT has various applications including evaluation of the temporo-mandibular joint (TMJ), visualization of impacted teeth and root resorption, assessment of the eruption path of the canine, virtual planning for implant placement, airway analysis, assessment of secondary alveolar bone grafting, treatment planning for craniofacial/cleft lip and palate cases.[3]

Most dento-maxillo-facial radiologists and dental practitioners are not trained to look beyond the area of interest, and therefore

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are likely to overlook abnormal findings. Such findings are called "incidental findings", and their identification may have significance in diagnosis and treatment planning. For effective identification of such incidental findings, it is important for users of CBCT scans to be familiar with their occurrence and prevalence. Only a few studies are available on this aspect of CBCT, and probably none in Indian population.

The purpose of this study is to make check lists for incidental findings which is not related to area of interest for dentist who is not radiologist. Dental CBCT images provide views of anatomy that most dentists have never before seen; in addition, they may reveal occult pathology, enabling more accurate and reliable diagnoses thereby reducing the possibility of missing clinically relevant disease. CBCT may aid in detecting the presence of previously undiagnosed peri-apical disease where prior clinical evaluation and conventional radiographs have failed to reveal pathology. Asymptomatic or occult pathology may lead to delayed diagnosis, which may adversely affect eventual treatment strategies and outcomes. Early detection and improved diagnostic accuracy are essential for improving patient care and treatment outcomes,as well as reducing treatment time, complexity, complications, and costs.

Aim and Objectives of the Study

Aim

To evaluate all types and prevalence of Incidental findings recorded by CBCT in Dr. D.Y Patil dental college and hospital pune,18

Objectives

1. To evaluate all types and prevalence of dentoalveolar findings on CBCT scans.
2. To evaluate all types and prevalence of maxillary sinus findings on CBCT scans.
3. To evaluate all types and prevalence of TMJ changes on CBCT scans
4. To evaluate all types and prevalence of nasopharynx findings on CBCT scans**.**
5. To evaluate all types and prevalence of soft tissue calcifications on CBCT scans.

REVIEW OF LITERATURE

Cone Beam Computed Tomography

Imaging is an important diagnostic adjunct to the clinical assessment of the dental patient. The introduction of panoramic radiography in the 1960s and its widespread adoption throughout the 1970s and 1980s heralded major progress in dental radiology, providing clinicians with a single comprehensive image of jaws and maxillofacial structures. However, intraoral and extraoral procedures, used individually or in combination, suffer from the same inherent limitations of all planar two-dimensional (2D) projections: magnification, distortion, superimposition, and misrepresentation of structures. Numerous efforts have been made toward three-dimensional (3D) radiographic imaging (eg, stereoscopy, tuned aperture CT) and although CT has been available, its application in dentistry has been limited because of cost, access, and dose considerations. The introduction of cone-beam computed tomography (CBCT) specifically dedicated to imaging the maxillofacial region heralds a true paradigm shift from a 2D to a 3D approach to data acquisition and image reconstruction.

Historical Background

The development of panoramic radiography in the 1950s and its commercial introduction in 1965 led to the widespread adoption and use of the technology. Although widely used, these images have the same inherent limitations as other 2D projections, namely, magnification and minification of structures, superimposition of anatomical and/or pathological entities, and misrepresentation of structures. However panoramic radiography is efficient at providing an overview of oral and maxillofacial hard tissues, including teeth, and may reveal associated pathoses of the jaws.

The original scanner, by EMI, was designed to make cross sectional images of the brain. It was made up of three basic components: a scanner gantry, a table for the patient, and a computer to perform the calculations. The scanner gantry was doughnut shaped device that contained a movable x-ray tube focused on a pair of parallel scintillation crystal x-ray detectors. The mathematical process, back projection that was used on the first scanners was described at the beginning of the century[1].

Modern, state-of-the-art CT scanners function much the same as the original EMI scanner. The patient is not held in a water bath but still must be restrained in a comfortable head holder to prevent even the slightest motion. The pair of detectors has been replaced by sophisticated array of detectors capable of making large numbers of simultaneous measurements of x-ray absorption. Spiral CT scanners can produce up to 30 slices, each 1.0mm in thickness, per minute. Modern CT images are much more detailed.

To overcome some of the above limitations cone beam computed tomography (CBCT) for the jaws was developed in the 1990s and is gaining widespread acceptance in dentistry, especially in the last 5 years.[2]

Introduction of cone-beam computed tomography (CBCT) specifically dedicated to imaging the maxillofacial region heralds a true paradigm shift from a 2D to a 3D approach to data acquisition and image reconstruction. Interest in CBCT from all fields of dentistry is unprecedented because it has created a revolution in maxillofacial imaging, facilitating the transition of dental diagnosis from 2D to 3D images and expanding the role of imaging from diagnosis to image guidance of operative and surgical procedures by way of third-party applications software.[3]

During the early development of CBCT, the technology was being advanced primarily for the dental office. Subsequently, many of the earlier units were modified to include designs that more readily fit within dental offices and clinics.[4]

The integration of CBCT imaging in dentistry has in some ways paralleled the transition of panoramic imaging x-ray machines into dental offices.[5] Early panoramic units were mainly sit-down but there was also a lay-down unit. Several other sit-down machines were manufactured, but eventually units were made whereby the patient could stand upright for the panoramic exposure.[4] Upright machines became preferable, as it is more convenient and takes less time to transfer patients into and out of these stand-up panoramic units. The physical

size and shape of CBCT units has paralleled this panoramic pathway.[6]

Principle of Cone Beam Computed Tomography

Cone beam imaging technology is most commonly referred to as cone beam computed tomography (CBCT). The terminology "cone beam" refers to the conical shape of the beam that scans the patient in a circular path around the vertical axis of the head, in contrast to the fan-shaped beam and more complex scanning movement of multi-detector-row computed tomography (MDCT) commonly used in medical imaging.

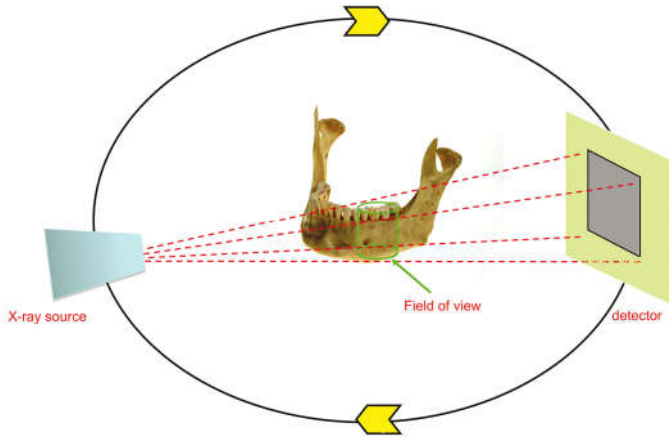


Figure showing X-ray source, Field of view and Detector

The geometric configuration and acquisition mechanics for the CBCT technique is theoretically simple. CBCT imaging is performed using a rotating platform or gantry carrying an x-ray source and detector. A divergent cone-shaped or pyramidal source of radiation is directed through the region of interest (ROI), and the residual attenuated radiation beam is projected onto an area x-ray detector x ray detector on the opposite side. These single projection images constitute the raw primary data and are individually referred to as basis, frame, or raw images. The basic images appear similar to Cephalometric radiographic images. These are usually several hundred two dimensional basis images from which the image volume is calculated and constructed. The complete series of images is referred to as the projection data. Because CBCT exposure incorporates the entire ROI, only one rotational scan of the gantry of 180-360 degree is necessary to acquire enough data for volumetric image construction.

Software programs incorporating sophisticated algorithms including filtered back projection are applied to these projection data to generate a volumetric data set which can be used to provide primary reconstruction images in three orthogonal planes (axial, sagittal, and coronal).

Incidental Findings on CBCT

An incidental finding is one that is unrelated to the present illness and is discovered unintentionally[1].Incidental Findings are detected relatively frequently in CBCT imaging, and considerable variation is evident in their frequency and nature.[5] The majority are extragnathic findings (that is, those found outside the region of the dentition and alveolus), thus emphasizing the need for complete and proper review of the entire image, regardless of field of view or region of interest.[7]

Popat H *et al*[8] 2008 reported two case who both underwent CBCT of the maxilla to aid dental diagnosis. Subsequent radiological reporting revealed rare anomalies of the cervical vertebrae. The implications of the findings are discussed and the importance of access to formal interpretation of CBCT for dental clinicians is highlighted and concluded that the use of CBCT provides an opportunity for dental practitioners to access three-dimensional radiographic assessment for their patients

Rogers SA *et al*[9] 2011 Reported on four incidental findings that appeared unrelated to the scan's original purpose arising in patients for whom CBCT was carried out for orthodontic purposes and concluded that the case series of incidental findings reported from maxillary CBCT scans of orthodontic patients highlighted the need for the complete scan to be interpreted by a radiologist or an appropriately trained clinician.

Pazera P 2011[10] conducted a study to determine the frequency of incidental maxillary sinus findings using cone-beam computed tomography (CBCT) images made for orthodontic purposes in which one hundred thirty-nine consecutive CBCTs taken from which 134 patients treated at the Department of Orthodontics and Dento-facial Orthopedics, University of Bern, Bern, Switzerland. CBCT were indicated for imaging included the localization of impacted teeth and root resorption related to impacted teeth. Two experienced observers reviewed the CBCT scans (fields of view: 4 × 4/6 × 6/8 × 8 cm) and recorded all incidental maxillary sinus findings according to standardized categories.

Kaeppler G[11] 2012 conducted a study to identify specific indications for dental cone-beam computed tomography (CBCT) in the field of oral and maxillofacial surgery. To this end, they compared the efficacy of CBCT to that of panoramic radiography, the standard imaging modality, for the evaluation of different surgical questions in the oral and maxillofacial region. Dental CBCT proved to be particularly useful in cases where visualization of a second plane is necessary for implant planning or for pre-surgical evaluation of retained and displaced teeth posing a risk to adjacent structures. It is also indicated for precise localization of luxated teeth and dental implants dislocated into surrounding areas, localization of the mandibular canal to assess its anatomical relationship to overfilled root canal filling materials, assessment of the extent of osseous lesions, and evaluation of patients with suspected mandibular or condylar fractures. The main advantages of CBCT are reduction of the risks of surgery due to the free selection of imaging planes, mandibular canal marking, 1:1 magnification, and the ability to use DICOM data in other implant or surgical planning software. Adequate user experience is important for proper evaluation of dental CBCT scans, as is the diagnosis of incidental findings falling into areas not primarily related to dentistry and therefore requiring additional investigation.

Allareddy V *et al* 2012[2]conducted a study to assess that the number of incidental findings on a CBCT scans is high both within and outside of the primary area of interest, thereby emphasizing the importance of interpretation of all areas visualized on the scan.

Caglayan and Tozoglu 2012[1]conducted a study to determine the location, nature, and occurrence of incidental maxillofacial findings on cone beam computed tomography (CBCT) scans performed for maxillofacial diagnostic purposes for that 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 and found 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%).

Gracco A *et al* [12] 2012 To determine the prevalence of incidental maxillary sinus findings in a large sample of orthodontic patients by cone-beam computed tomography (CBCT) with a wide field of view and assess the relationships of such abnormalities with age and gender in which five hundred thirteen CBCT scans obtained for orthodontic diagnosis and treatment planning in a Northern Italian population (N = 513; 292 female and 221 male subjects; 1,026 maxillary sinuses) were studied. The frequencies of pseudocysts and mucosal thickening of the maxillary sinus were recorded.

Pette GA *et al*[13] 2012 conducted a study on three hundred eighteen patients received CBCT scans prior to receiving implants, which were interpreted by blinded board-certified oral and maxillofacial radiologists. In these all incidental findings were defined as non-tooth-related pathologies or abnormalities. These findings were categorized and analyzed using descriptive statistics and found that men were 2.13 times more likely to have sinus pathology than women. Patients over age 65 were 5.01 times more likely to demonstrate vascular pathology (eg, carotid artery calcification) than patients ages 41 to 65; the likelihood versus patients ages 16 to 40 was 13.39. Women were 2.63 times more likely to display brain pathology (eg, pineal or pituitary calcifications). Controlling for gender, patients ages 41 to 65 were 3.17 times more likely to exhibit condylar pathology (eg, degenerative changes) than patients ages 16 to 40. Similarly, patients above age 65 were 3.53 times more likely to show condylar pathology than patients ages 16 to 40, and women were 1.61 times more likely to have condylar pathology than men. Versus patients ages 16 to 40, patients ages 41 to 65 were 17.69 times more likely to show signs of vertebral pathology (eg. degenerative disc changes) and patients over age 65 were 28.67 times more likely to display vertebral pathology and concluded that CBCT scans frequently reveal non-tooth-related pathologies and/or abnormalities in the head and neck region. Therefore, comprehensive review of the entire CBCT image set is necessary.

Drage N *et al*[14] 2013conducted a study to find out the incidence of incidental findings seen in cone beam computed tomography scans taken for orthodontic purposes and to see if these findings influence orthodontic treatment in which three hundred and twenty-nine consecutive scans carried out for orthodontic purposes using an i-CAT Classic were included in the study. Each scan was evaluated by a single radiologist and any incidental findings recorded. The incidental findings were further classified depending on whether the finding would influence orthodontic management and found that out of 370 scans, incidental findings were present in 329 scans, with at least one incidental finding in 66% of patients.

RheemS *et al*[7] 2013 conducted a study To record types and prevalence of incidental findings in the maxillofacial region, identified on CBCT scans and described in radiologist's consultation reports. For that total of 147 CBCT scan reports on 59 males and 88 females between June 2007 and February 2012 at University of California, San Francisco, were analyzed retrospectively and found that the overall rate of incidental findings was 40.1%. The age range of patients was from 8 years to 80 years. The highest rate of incidental findings was in the sinus region (51.7%), followed by dento-alveolar region (34.01%), TMJ region (26.53%), osseous region (15.64%), calcification of ligaments, pineal gland, and carotid artery (12.92%), dental anomalies (10.88%), nasal region (8.84%), and airway region (5.44%). According to logistic regression analysis, females were 2.58 times more likely to exhibit TMJ pathology compared to males and concluded that CBCT scans are beneficial in revealing incidental abnormalities in the head and neck region outside the scope of interest. Careful review of the entire CBCT image is essential to avoid under- or overestimation of potential complications in providing comprehensive health care.

Edward R *et al*[15] 2013 conducted a study to determine the frequency and nature of incidental findings (IFs) in cone-beam computed to. mographic (CBCT) scans of the head and neck region and concluded that IFs are detected relatively frequently in CBCT imaging, and considerable variation is evident in their frequency and nature. The majority are extragnathic findings (that is, those found outside the region of the dentition and alveolus), thus emphasizing the need for complete and proper review of the entire image, regardless of field of view or region of interest.

Jadhav AB *et al*[16] 2014 found an osteolytic lesion with a small central area of mineralization and sclerotic borders incidentally in the clivus on the cone-beam computed tomography (CBCT) of a 27-year-old male patient and concluded that the incidental skull base finding would be important for interpreting the entire volume of CBCT by a qualified oral and maxillofacial radiologist.

Khojastepour L *et al*[17] 2014 conducted a study to assess the nature and prevalence of incidental findings in cone beam computed tomography (CBCT) images of oral and maxillofacial patients. In this study 773 CBCT samples were retrieved from archives of a private Oral and Maxillo-facial Radiology center. Any findings that were not related to the reason of CBCT request was recorded in form designed originally for this study and found that 475 patients out of 773 had at least one incidental finding that composed about 60% of the patients. The largest frequency of incidental findings were cases of periapical lesions. (n = 189), followed by mucous thickening of maxillary sinus (n = 170), retained root (n = 32), impaction and 3rd molar (n = 26). Other incidental findings

were torus (n = 25), dental anomalies (n = 13), vertical root fracture (n = 5), intra bony lesion and periapical pathosis (n = 4) and the lowest frequency was sialoliths (n = 1) and finally concluded that about half of the subjects have had at least one incidental finding, so the precise review of the CBCT images seems to be necessary.

Shokri A *et al*[18] 2014 conducted a study to determine the CBCT findings of all paranasal sinuses in a defined group of Iranian patients in which CBCT images of 220 patients were evaluated to detect the incidental findings in paranasal sinuses and after excluding images not meeting the inclusion criteria, 100 CBCT images taken for evaluation of dental implants, position of impacted teeth and their association with vital structures, orthodontic treatment, maxillofacial surgery, and TMJ examination were interpreted by two observers. Data was analyzed with χ^2 test and found the most prevalent CBCT findings in the maxillary (68%), frontal (70%), and sphenoid (74%) sinuses was septation, whereas in the ethmoid sinus flat mucosal thickening found to be the most frequent one (28%).

RaghavM *et al*[19] 2014 conducted a study to infer and to record the prevalence of incidental maxillary sinus pathologies in patients presenting with dental problems using the cone-beam computed tomography (CBCT) scans performed for maxillofacial diagnostic purposes. For that they retrospectively studied 201 patients (402 maxillary sinuses consecutive CBCT) for various incidental maxillary sinus pathologies by two observers, and found that the prevalence for total incidental findings is 59.7%. The present study showed MT (35.1%) as most prevalent finding followed by OPA in (16.6%), PT in 7.2% and others in 0.7%.

Edward R etal[20] 2014 conducted a study to evaluate the nature and frequency of incidental findings in large-field maxillofacial cone beam computed tomography (CBCT). For that a total of 427 consecutive CBCT radiologic reports obtained for orthodontic purposes were retrospectively reviewed. Findings were summarized and categorized into six anatomic categories and found that a total of 842 incidental findings were reported in the 427 CBCT scans (1.97findings/scan). The most prevalent findings were those located in the airway (42.3%), followed by the paranasal sinuses (30.9%), dento-alveolar (14.7%), surrounding hard/soft tissues (4.0%), temporomandibular joint (TMJ) (6.4%), and cervical vertebrae (1.3%) regions and concluded that there was high occurrence of incidental findings in large-field maxillofacial CBCT scans in a sample of orthodontically referred cases. The majority were extragnathic findings, which can be normally considered outside the regions of interest of many dental clinicians. Specifically, incidental findings in the naso-oropharyngeal and paranasal air sinuses were the most frequent. This underscores the need for comprehensive review of the entire data volume and the requisite to properly document all findings, regardless of the region of interest.

Alejandro J *et al*[21] 2014 conducted a survey for the use of CBCT in children and young people in three Dental Hospitals in the United Kingdom (UK), with special attention paid to aspects of justification and optimization. For that a retrospective analysis of patient records over a 24-month period, looking at CBCT examinations performed on subjects under 18 years of age. Clinical indications, region of interest, scan field of view (FoV), incidental findings and exposure factors used were recorded and concluded that when planning a CBCT service for children and young people, a limited FoV machine would be the appropriate choice for the majority of clinical requirements. It would facilitate clinical evaluation of scans, would limit the number of incidental findings and contribute to optimization of radiation doses.

Dogramaci EJ *et al*[22] 2014 conducted a study to investigate the clinical importance of incidental findings reported for small-volume cone beam computed tomography (CBCT) scans of impacted maxillary canine teeth. In the study radiology reports of CBCT examinations performed as part of diagnosis and treatment planning for impacted or ectopically erupting maxillary canine teeth for 183 consecutive patients were assessed retrospectively. The scans were obtained with a small-volume unit (3 D Accuitomo 80) with a field of view that was either 40X40 or 60X60 mm. The findings were graded according to their clinical importance as low, intermediate, or high and found that three hundred and forty incidental findings were reported. One of the incidental findings was of high importance (0.3%), 97 were of intermediate importance (28.5%), and 242 were of low importance or anatomic variant (71.1%) and concluded that incidental findings reported on small-dimension CBCT scans of impacted maxillary canine teeth rarely require immediate attention; nonetheless, 28.8% would require follow-up.

Newaz ZA *et al*[23] 2015 Found two patients with incidental findings of skull-base abnormalities are presented. The orthodontic patient was tentatively diagnosed with a notochordal remnant in the clivus; the implant patient exhibited an empty sellaturcica. For the clivus lesion in the orthodontic patient, an artifact was ruled out after a second CBCT image and further distinguished from a fat-containing tumor after magnetic resonance imaging. The CBCT study for the implant patient demonstrated an enlarged sellaturcica and concluded that Orthodontists and implant surgeons may come across incidental findings outside their area of expertise on CBCT scans, highlighting the importance of appropriate consultation with maxillofacial radiologists.

Husain MA *et al*[24] 2015 Presented four cases of pneumato-cysts affecting the cervical vertebrae detected as incidental findings on cone beam computed tomography (CBCT). Given the increased use of CBCT in dentistry to evaluate the maxillofacial structures, it was likely that dentists would encounter this lesion on CBCT scans that encompass the superior cervical spine. Recognition of the pathognomic features of this benign, innocuous lesion is important to avoid unnecessary investigations and causing alarm to the patient.

Edwards R *et al*[15] 2015 conducted a study to assess interrater and intrarater agreement among orthodontic clinicians in their assessments of reported incidental findings in regard to both the need for additional follow-up and the impact on future orthodontic treatment in large-field maxillofacial cone-beam computed tomography (CBCT)Imaging in which sample consisted of 18 non-randomly selected large-field maxillofacial CBCT volumes containing a reported total of 88 radiographic findings. All scans were associated with formal radiologic reports. However, the suggestions of further follow-up were removed from the radiologic reports so as to not bias the 3 evaluating orthodontists in their subsequent decision making.

The evaluators had on average 7.6 years of CBCT usage and self-interpretation experience. Reliability was determined by quantifying the level of agreement between the evaluators' assessments for both research questions for all 88 findings using a binary response (yes/no) as the outcome measure. The Cohen kappa statistic was calculated to quantify intrarater and interrater agreement globally for both statements and found although interrater agreement was considerable, potential decisions with clinical impact were not consistent.

Bissoon AK *et al*[25] 2015 Reported on a case of incidental ethmoidal-osteoma diagnosed radio graphically from cone beam computed tomography (CBCT). The patient was subsequently referred for a cone beam computed tomography scan (CBCT) to further investigate the extent and effect of the mixed lesions on surrounding structures. A large field of view (FOV) CBCT scan was taken. The radiologist reporting on the scan also observed a well-defined, non-enhancing, high density, circular mass 2.6 mm x 2.9 mm present in the right ethmoidal sinus arising from the medial wall and concluded about the need for suitable training of those that report on CBCT images with emphasis on the large FOV scans that illustrate regions outside the teeth and their supporting structures.

Ahmed J *et al*[26] 2015 Reported a rare case for the incidence of presence of gubernacular canal on intraoral radiograph and role of CBCT in distinguishingly delineating the extent of the canal. The existence of both the gubernacular canal and cord has been proved in the permanent dentition with deciduous predecessor. As the gubernacular canal can serve as potential risk for adenomatoid-odontogenic tumor, the practice of preoperative investigations that include CBCT scan can improve accuracy by outlining the exact extent of the canal in different planes which will be helpful in better planning for extraction and removal of the entire gubernacular tissue associated with tooth.

Role	*Training content*
Dentist referring a patient for CBCT and receiving images for clinical use	**Theoretical instruction** • Radiation physics in relation to CBCT equipment • Radiation doses and risks with CBCT • Radiation protection in relation to CBCT equipment, including justification (referral/ selection criteria) and relevant aspects of optimization of exposures • CBCT equipment and apparatus **Radiological interpretation** • Principles and practice of interpretation of dentoalveolar CBCT images of the teeth, their supporting structures, the mandible and the maxilla up to the floor of the nose (*e.g.* 8 cm × 8 cm or smaller fields of view) • Normal radiological anatomy on CBCT images • Radiological interpretation of disease affecting the teeth and jaws on CBCT images • Artefacts on CBCT images
Dentist responsible for performing CBCT examinations	**Theoretical instruction** • Radiation physics in relation to CBCT equipment • Radiation doses and risks with CBCT • Radiation protection in relation to CBCT equipment, including justification (referral/ selection criteria), optimisation of exposures and staff protection • CBCT equipment and apparatus • CBCT image acquisition and processing **Practical instruction** • Principles of CBCT imaging • CBCT equipment • CBCT imaging techniques • Quality assurance for CBCT • Care of patients undergoing CBCT **Radiological interpretation** • Principles and practice of interpretation of dentoalveolar CBCT images of the teeth, their supporting structures, the mandible and the maxilla up to the floor of the nose (*e.g.* 8 cm × 8 cm or smaller fields of view) • Normal radiological anatomy on CBCT images • Radiological interpretation of disease affecting the teeth and jaws on CBCT images • Artefacts on CBCT images

MATERIALS AND METHODS

- Source from where the cases, patients, subjects or study material will be selected-CBCT scans would be obtained from Dr. D.Y. Patil dental college & hospital, Pune.
- Name and place where the study will be conducted-Dept. of Oral Medicine & Radiology, Dr. D.Y. Patil dental college & hospital, Pune.

Ethical clearance

Ethical clearance was obtained from ethical committee.

Duration of study- 2 years.

Type of study- Descriptive Retrospective study.

Specification of CBCT machine- I-CAT CBCT machine FOV-16cm×13cm

Voxel size- 0.25×0.25×0.25
Exposure Parameters- 70kv, 10ma, 14sec.
Tube voltage- 120kvp.
Current- 37.07ma
Exposure Time- 26.9sec-17.8sec.

Observer for the study- single observer. Qualification- 3rd year post graduate student.

Bias of the reporting removed by showing same incidental findings to the guide and other staff of the department.

Software used for analysis- i-cat vision.

All Axial, Coronal And Sagittal sections were screened out so that any landmark and incidental findings not missed out in this study.

Method of data collection

- Sampling technique used – Convenient sampling method
- Sample size – 300
- Inclusion criteria- CBCT scans made for any dental or maxillo-facial diagnostic or treatment planning purpose.
- Exclusion criteria- there is randomized collection of data from source, there is no any exclusion criteria.
- Enlist the materials/instruments /armamentarium to be used in the study- CBCT scans, CBCT machine
- Describe how the study will be done in a step-wise chronological sequence-

1. CBCT will be thorough evaluation, on the basis of check list formulated data collected shall be sorted and categorized based on the parameters recorded in Case record format.
2. Data shall be analyzed using descriptive statistical methods namely frequency and conditional distribution.

Parameter-wise percentage tables and graphs shall be used to present the data.

Illustrations

Dentoalveolar Incidental Findings

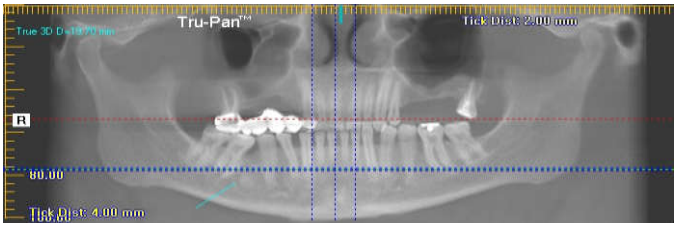


Fig 1 Panoramic reconstruction CBCT image showing osteo-scerosis of the bone

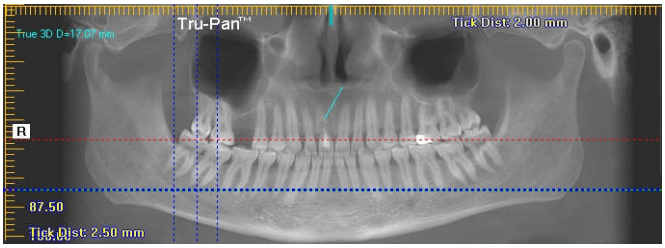


Fig 2 Panoramic reconstruction CBCT image showing fracture of the root

Incidental finding of maxillary sinus

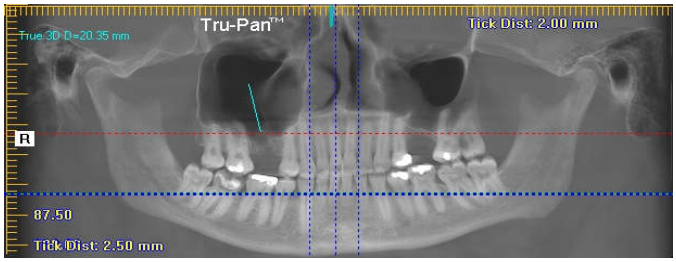


Fig 3 Panoramic reconstruction of CBCT image showing oroantral-fistula

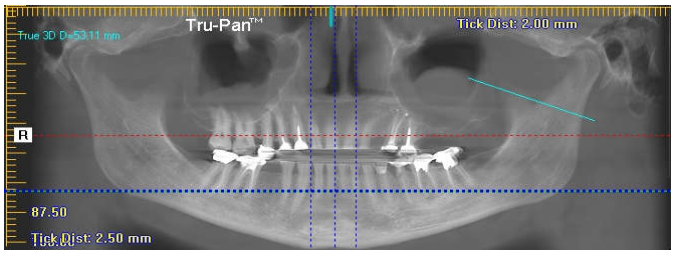


Fig 4 Panoramic reconstruction of CBCT image showing maxillary sinus polyp

Incidental finding of naso-pharynx

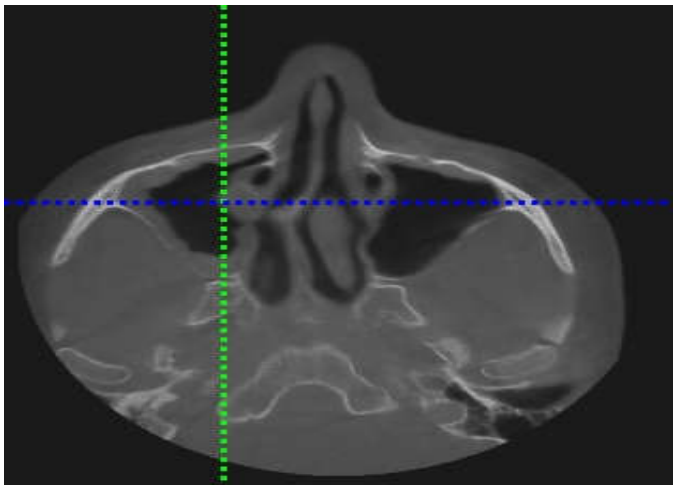


Fig 5 Axial section of CBCT showing deviated nasal septum

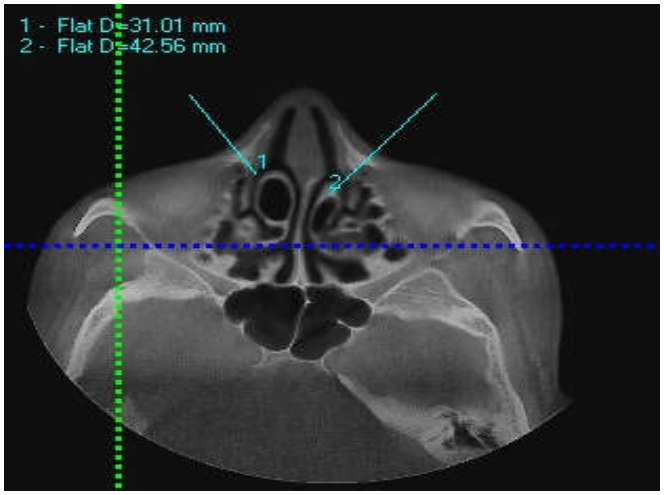


Fig 6 Axial section of CBCT showing choncha-bullosa

Incidental finding of soft tissue calcification

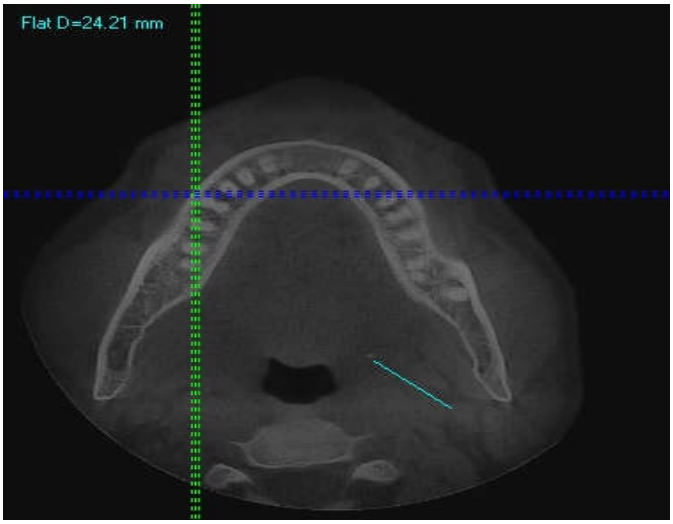


Fig 7 Transverse section for CBCT showing tonsilolith

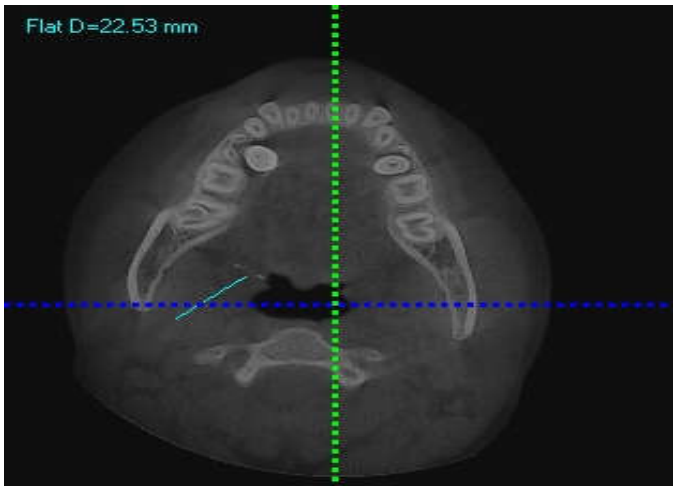


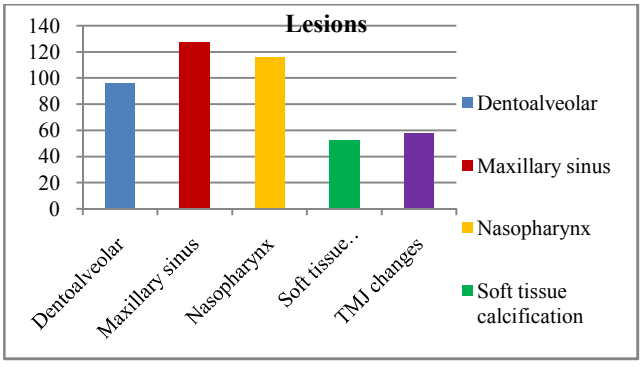
Fig 8 Transverse section of CBCT showing carotid artery calcification

Incidental finding of TMJ

Fig 9 Temporo-mandibuar joint finding in CBCT show arthritis changes

RESULTS

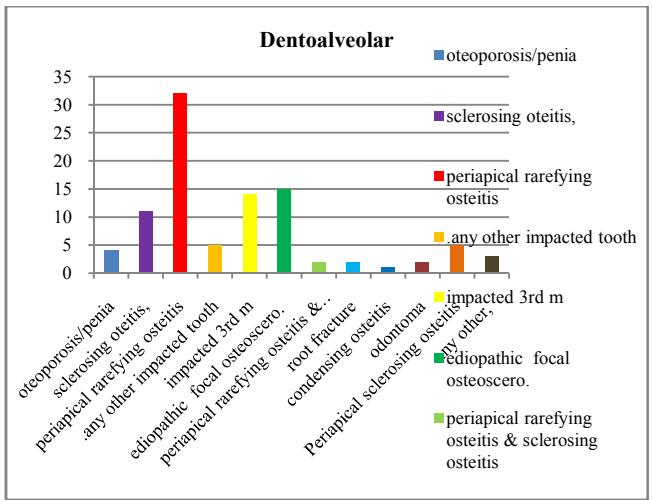
S.no	Type of lesion	Frequency	percentage
1	Dentoalveolar	96	32%
2	Maxillary sinus	127	42.33%
3	Nasopharynx	116	38.66%
4	Soft tissue calcification	52	17.33%
5	TMJ changes	58	19.33%



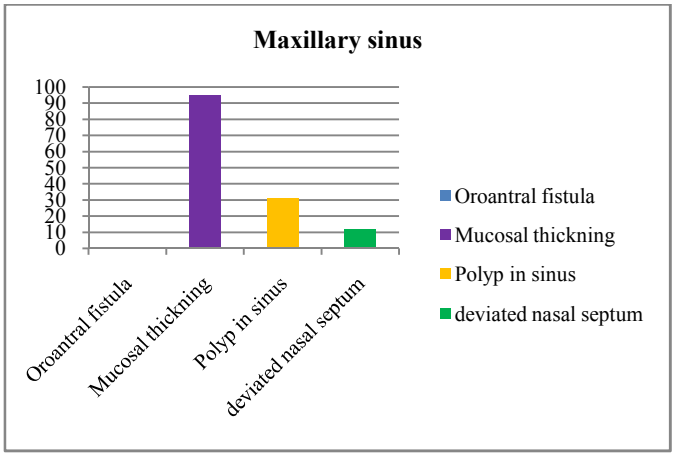
Graph 1 showing type of lesion, frequency & percentage of incidental findings

Table 2 Showing subtypes, frequency & percentage of incidental findings

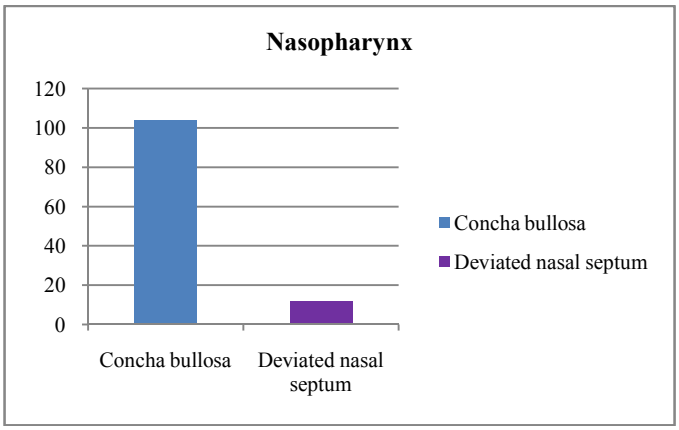
S.no	Type of lesion	Sub type	Frequency	Percentage
1	Dentoalveolar	Osteoporosis/penia	4	4.16%
		Sclerosingosteitis,	11	11.45%
		Periapical rarefying osteitis	32	33.33%
		Any other impacted tooth	5	5.20%
		Impacted 3rd m	14	14.58%
		Idiopathic focal osteosclerosis	15	15.62%
		Periapical rarefying osteitis&sclerosingosteitis	2	2.08%
		Root fracture	2	2.08%
		Condensing osteitis	1	1.04%
		Odontoma	2	2.08%
		Periapicalsclerosingosteitis	5	5.20%
		Any other	3	3.12%
2	Maxillary sinus	Oroantral fistula	1	0.78%
		Mucosal thickening	95	74.80%
		Polyp in sinus	31	24.40%
3	Nasopharynx	Concha bullosa	104	89.65%
		Deviated nasal septum	12	9.44%
4	Soft tissue calcification	Carotid artery calcification	18	34.61%
		Tonsilith	31	59.61%
		Any other	1	1.92%
		Sialolith	2	3.84%
5	TMJ changes	Condylar flatenning	55	94.82%
		Condylar erosion	2	3.44%
		Subcondylar sclerosis	1	1.72%



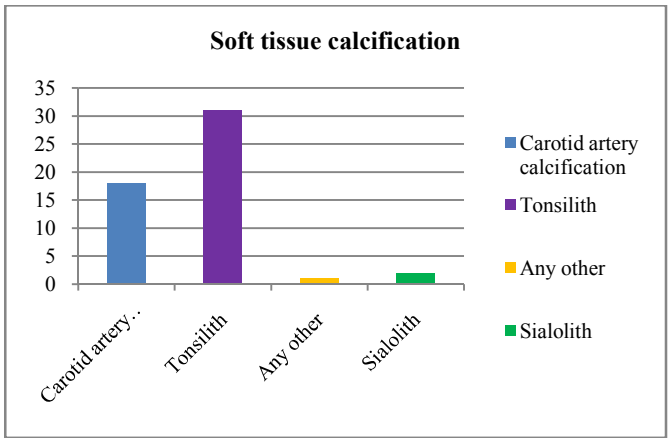
Graph showing sub types of incidental findings of dento-alveolar region



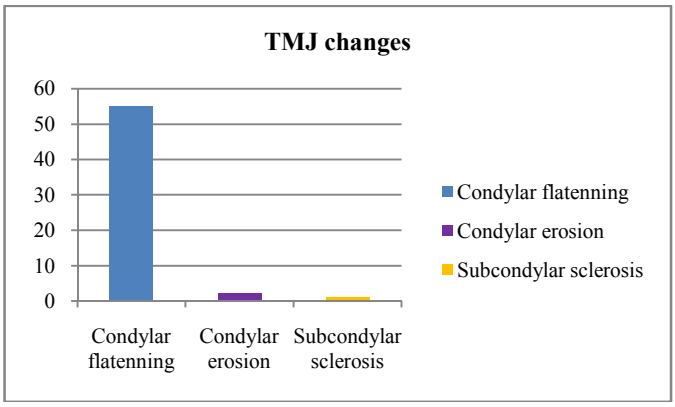
Graph showing sub types of incidental findings of Maxillary sinus region



Graph showing sub types of incidental findings of Nasopharynx region



Graph showing sub types of incidental findings of soft tissue calcification



Graph showing sub types of incidental findings of TMJ region

DISCUSSION

Cone beam CT has many diagnostic applications in dental and maxillofacial imaging. Occasionally, incidental findings are noted apart from the original diagnostic goal.[1]The purpose of this study was to investigate the characteristics and frequency of incidental findings determined retrospectively from maxillofacial 3D data.

This study recorded incidental findings from CBCT scans. These findings vary in their importance, from common benign lesions to significant pathological findings that may have an important impact on the health of the patient[2]. Those findings include normal anatomic variants, age-related findings, developmental findings, and occult pathological findings. Out of the three hundred CBCT scans reviewed, a remarkable 300

of the scans revealed a total of 449 (83.66%) incidental findings which were unrelated to the primary indication for the CBCT scan. Almost all the scans shows multiple incidental findings, percentage of each parameters are - 32% were found in the Dento-alveolar region, 42.33% in maxillary sinus, 38.66% in the nasopharynx. 17.33% in soft tissue calcification, 19.33% in TMJ changes were found. Similarly other studies done by Cha *et al*, Caglayan and Tozoglu and Price *et al*., found that incidental findings was 24.5%, 92.8% and 90.7% and respectively. The highest rate of incidental findings by Cha *et al*., was in the airway area (18.2%), followed by TMJ findings (3.4%), endodontic findings (1.8%), and others (1.2%) [16].The majority of the findings represent benign findings that do not require specific intervention[3]. However, a substantial portion of the incidental findings required intervention or referral. These findings discovered on CBCT scans affect the overall oral health of patients and reinforces the fact that a careful and thorough interpretation of CBCT images beyond the region of interest is necessary to avoid overlooking occult pathology. The frequency of incidental findings in CBCT varies widely among studies in the oral and maxillofacial radiology literature.

The maxillary sinus anatomy can be clearly viewed on CBCT scans. The maxillary sinus anatomy and potential pathology are critical in treatment planning and placement of dental implants in the posteriormaxilla.[4] The maxillary sinuses drain at the superiomedial wall of the osteomeatal complex, which leads to the middle nasal turbinate. They are formed partially from the ethmoid bone superiorly and by the uncinate process laterally. Patency of the osteomeatal complex is important during sinus grafting procedures, which are often used to facilitate dental implant placement in the posterior maxilla when there is limited bone height. Sinus health is important when augmentation procedures are being considered, because blockage of the osteomeatal complex may prevent aeration of the sinus cavity, resulting in accumulation of inflammatory products in the sinus cavity and increasing postoperativecomplications.[5]

In the study of caglayan F[1] 192 patients (92%) had incidental findings while In our study 83.66% patient had incidental findings. The incidental findings were most frequently seen inthe airway area, with mucosal thickening being the most common (31.3%) were our study found that 42.33%.The high frequency of airway findings demonstrates that CBCT can bean efficient tool for detecting airway changes, such as mucosal thickness, deviation of the nasal septum, conchalhypertrophy, 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%), in our study concha bullosa were found 89.65%.

In the study of allareddy[2], 1000 scans that were reviewed only 57 had no osseouspathosis or incidental findings. 943 scans showed findings in the primary regions of interest and/or outside the regions of interest and 77 different conditions were visualized in these scans both in and outside the areas of interest. Often the scans had incidental findings in more than one area. The percent of incidental findings in this study was (94.3) was similar to that of the the other studies done by Ca˘glayan and Tozo˘glu[1](92.8%) and Price *et al*. In the study of pette *et al*[5], as a result, many incidental findings have been observed. In this study, 318 consecutive CBCT scans from a privateperiodontal practice were reviewed by 1 of 13 oraland maxillofacial radiologists from a referral maxillofacial radiologic service; 93.42% of patients were found to have some form of non-odontogenic pathologic finding. In the study of warhekarS *et al*[4], In this study, 92.8% showed findings in the primary regions of interest and/or outside the regions of interest and 57(7.2%) different conditions were visualized in these scans both in and outside the areas of interest.

Jung yulcha[6] found, incidental findings was24.6% (123 patients of 500). The highest rate of incidental findings was in the airway area (18.2%), followed by TMJ findings (3.4%), endodontic findings (1.8%), and others (1.2%). In the orthodontic group, the incidences were airway findings, 21.4%; TMJ findings, 5.6%; and endodontic lesions, 2.3%. Only 22% of the airway findings, such as mucosal thickness, polyps, and retention cysts, were correlated with clinical signs and symptoms.

In this study soft tissue calcification found 17.33% while jeffy price found soft tissue calcifications (20%) in his study. 19.33% in tmj changes found while price found 15.4% tmj changes in his study.

This study found 83.66% of incidental findings and this is high percentage in early detection of disease related to the incidental findings seen in the scan of the patient. Due to the absence of superimposition of anatomical structures and the elimination of geometric distortion, CBCT scans can reveal many potential pathologic findings in the maxillofacial region more clearly than the panoramic radiograph or conventional tomography.[7] So, oral radiologists and dentists should be attentive to these incidental findings and comprehensively evaluate the complete image to avoid over or underestimation of underlying diseases in order to provide comprehensive health care for their patients. Limitations of this study is incidental findings seen only by single observer.

CONCLUSION

This study confirms the frequent presence of incidental findings in maxillofacial CBCT scans. This finding underscores the need for dental practitioners and oral and maxillofacial radiologists to review the entire volume of the CBCT study to document the presence of clinically significant lesions (outside the primary region of interest) that may require intervention, monitoring, or a referral to other specialists. Correct identification of incidental findings will reduce unnecessary further diagnostic evaluation for lesions that require no intervention or treatment. A careful and thorough interpretation of the CBCT images beyond the region of interest is necessary to avoid overlooking occult pathology.

As CBCT scan provides detailed information of maxillofacial region and patient is exposed to certain amount of radiation, the information related to non interested area have more importance in early diagnosis of other disease which is related to change in treatment plan e.g Carotid artery calcification, Sinusitis. So, Radiologist and dentist should check entire scan

for other valuable findings for early detection of disease which is already present in the cbct scan.

This work provides radio referral check list for Radiologist to see entire scan to avoid any other incidental findings in the scan.

Summary

Present study was conducted in department of oral medicine and radiology of Dr. D Y Patil dental college, pune. 300 scan was studied thoroughly and incidental findings was detected 83.66% percentage. This percentage is high in early detection of systemic diseases, so thorough study of scan is mandatory and important from the point of view of Radiologist.

Most dento-maxillo-facial radiologists and dental practitioners are not trained to look beyond the area of interest, and therefore are likely to overlook abnormal findings. Such findings are called "incidental findings", and their identification may have significance in diagnosis and treatment planning. For effective identification of such incidental findings, it is important for users of CBCT scans to be familiar with their occurrence and prevalence.

CBCT is well suited to dentistry because it provides excellent images of high-contrast structures such as maxillofacial bony anatomy and teeth at a potentially lower radiation dose and a lower cost to the patient as compared to computed tomography (CT). The CBCT also has advantages over two-dimensional conventional radiographs in that it eliminates two major problems associated with plain film radiography: geometric distortion and superimposition of surrounding anatomical structures.

Dental CBCT images provide views of anatomy that most dentists have never before seen; in addition, they may reveal occult pathology, enabling more accurate and reliable diagnoses thereby reducing the possibility of missing clinically relevant disease. CBCT may aid in detecting the presence of previously undiagnosed peri-apical disease where prior clinical evaluation and conventional radiographs have failed to reveal pathology. Asymptomatic or occult pathology may lead to delayed diagnosis, which may adversely affect eventual treatment strategies and outcomes. Early detection and improved diagnostic accuracy are essential for improving patient care and treatment outcomes, as well as reducing treatment time, complexity, complications, and costs.

In this study out of the three hundred CBCT scans reviewed, a remarkable 300 of the scans revealed a total of 449 (83.66%) incidental findings which were unrelated to the primary indication for the CBCT scan. Almost all the scans shows multiple incidental findings, percentage of each parameters are - 32% were found in the Dento-alveolar region, 42.33% in maxillary sinus, 38.66% in the naso-pharynx. 17.33% in soft tissue calcification, 19.33% in tmj changes were found.

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