



## ORIGINAL ARTICLE

# Incidental findings in maxillary sinus area on cone-beam-computed-tomographic-scans: A retrospective study with emphasis on gender and ethnicity

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Received 14 November 2019; revised 27 February 2020; accepted 2 March 2020  
Available online 18 March 2020

## KEYWORDS

Cone-beam computed tomography;  
Ethnicity;  
Gender;  
Incidental findings

**Abstract** *Aim:* The aim was to assess the presence of incidental-findings (IFs) on cone-beam computed tomography (CBCT) scans of faciomaxillary region with emphasis on gender and ethnicity.

*Materials and methods:* A retrospective analysis of incidental findings (IFs) in the maxillary sinus was performed. All CBCT-scans were performed using a Cone Beam 3D imaging system and examined using a software program. These images were taken for treatment planning for dental implant therapy of partially edentulous individuals. Four-hundred CBCT scans were retrospectively evaluated. Data regarding age, gender and ethnicity (Saudi Arabian, Egyptian, Filipino and Pakistani) of the patients was recorded. When P-value were lesser than 0.05, the difference was deemed significant.

*Results:* Four hundred CBCT-based scans were investigated. The IFs were seen in 30.2%, 32.1%, 35.1% and 34.4% individuals belonging to the Egyptian, Saudi Arabian, Pakistani and Filipino ethnicities, respectively. Mucosal-thickening was more often identified in Saudi-Arabian ( $P < 0.05$ ), Pakistani ( $P < 0.05$ ) and Filipino males ( $P < 0.05$ ) than females in the respective ethnic group. There was no difference in the identification of IFs (mucous retention cysts, opacifications, sinus septa and sinus floor discontinuation) related to the maxillary sinus region among males belonging to the Egyptian, Saudi-Arabian, Filipino and Pakistani ethnic groups.

*Interpretations and conclusion:* The CBCT-based technology is valuable resource for the identification of IFs.

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Peer review under responsibility of King Saud University.



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## 1. Introduction

The advent of cone-beam-computed-tomography (CBCT) has revolutionized modern dental radiology (Dawood et al., 2009; Vannier, 2003). The CBCT provides imaging at reduced radiation exposure and costs in contrast to traditional medical imaging (Al-Rawi et al., 2010). However, with the increased use of CBCT imaging in clinical dentistry and related research, the field of view (FOV) has led to the identification of findings (or incidental findings [IFs]) on the CBCT images of the maxillofacial region (Alsufyani, 2017; Clark et al., 2017; Oser et al., 2017). In the study by Avsever et al. (2018) assessed incidental findings in maxillofacial CBCT scans of 691 patients. The author observed 1109 IFs on 548 out of the 691 patients (Avsever et al., 2018). These findings encompassed concha bullosa, nasal septum deviation, and polypoid mucosal thickening in the maxillary sinus (Avsever et al., 2018). Similarly, Clark et al. (2017) 2323 CBCT images were assessed to determine implant positioning related to the maxillary sinus. The results showed that incidental nasal penetration in 19 cases and adjacent tooth injury in 15 patients (Clark et al., 2017). Furthermore, in the study by Edwards et al. (2014), 427 CBCT scans obtained for orthodontic purposes were retrospectively investigated. In this study, 842 IFs related to the airway, paranasal sinuses, temporomandibular joint, cervical vertebrae and alveolar bone (Edwards et al., 2014). In general, in comparison with the traditional two-dimensional imaging (such as panoramic radiography), CBCT scans capture a larger field of view, which enhances the probability to identify IFs.

To the authors' knowledge from indexed scientific literature, there is a dearth of scholarly articles that have investigated IFs on maxillofacial CBCT-based scans. Based upon the currently available scientific evidence, the association between patient demographic traits such as gender with maxillofacial imaging using CBCT scans has been investigated (Aktuna Belgin et al., 2019; Yeung et al., 2018). In the study by Aktuna Belgin et al. (2019) volume of maxillary sinus was observed on CBCT scans was significantly higher in males than females. It is known that an association exists between patients' gender and ethnicity and oral and maxillofacial inflammatory conditions (Yeung et al., 2018); however, the possibility of patient ethnicity being associated with identification of IFs on CBCT scans remains uninvestigated. The present study is based on the hypothesis that an association exists between gender and ethnicity regarding the identification of IFs on CBCT scans.

This retrospective observational study is to assess the IFs on CBCT scans of maxillofacial region with emphasis on gender and ethnicity.

## 2. Materials and methods

The Research Ethics Review Committee of the Princess Nourah Bint Abdulrahman University (PNU), Riyadh, Kingdom of Saudi Arabia granted approval for this study. All CBCT scans were performed between February 2018 and January 2019 using Cone-Beam imaging technology (Imaging Sciences International, Hatfield, PA, USA) using FOV ranging from 8 cm × 8 cm to 6 × 13 cm with voxel size 200–500 µm. The tube voltage and current were 80–90 KVP and 5 mA, respectively; and an exposure time of 40 s was used. The

CBCT-based Digital Imaging and Communications in Medicine (DICOM) images were examined using a software program (i-CAT FLX V-Series, Hatfield, PA 19440, USA). These images were taken for treatment planning for dental implant therapy of partially edentulous individuals. In total, CBCT scans of 400 consecutive patients were retrospectively evaluated by two trained and calibrated investigators (MB and SSA). After a washout period of 4 weeks, the CBCT scans were re-evaluated by the same investigators (MB and SSA); and the outcomes were comparable to the initial observations. The second set of observations obtained from one randomly selected investigator (SSA) were used as the final observation. Randomization was done by tossing a coin. Data regarding age, gender and ethnicity (Saudi Arabian, Egyptian, Filipino or Pakistani) of the patients was recorded.

### 2.1. Exclusion criteria

The following exclusion criteria were imposed: (a) CBCT-based scans of edentulous individuals; and (b) CBCT-based scans with a poor imaging quality.

### 2.2. Incidental findings

With reference to findings in the maxillary sinus, the IFs were categorized as follows: (a) mucosal thickening (MT), (b) opacifications; (c) mucous retention cysts; (d) sinus septa; and (e) floor discontinuation.

### 2.3. Statistics

Data was categorized based on gender, IFs and ethnicity of the patients. Age was presented as mean ± standard deviation. The IFs related to gender and ethnicity were presented as percentages and comparisons based on gender and ethnicity were performed using the Student *t*-test. For multiple comparisons, the Bonferroni Post-hoc adjustment Post-hoc test was performed. Furthermore, logistic regression was completed to test whether age and/or gender can be predictive of IFs in the study population. The inter- and intra-examiner reliability *kappa* scores were computed. When P-value were below 0.05, the difference was deemed significant.

## 3. Results

### 3.1. General characteristics

The inter- and intra-examiner reliability *kappa* scores were 0.88 and 0.92, respectively. In total, 400 scans from Egyptian (n = 96), Saudi Arabian (n = 109), Pakistani (n = 105) and Filipino (n = 90) subjects were assessed. The mean age of Egyptian, Saudi Arabian, Pakistani and Filipino patients was 42.2 ± 0.8, 46.7 ± 1.8, 44.5 ± 3.3 and 42.2 ± 1.4 years, respectively. There was a statistically significant difference in the number and mean ages of male and female subjects. The IFs were seen in 30.2%, 32.1%, 35.1% and 34.4% individuals belonging to the Egyptian, Saudi Arabian, Pakistani and Filipino ethnicities, respectively. Overall, there was no statistically significant difference in the identification of IFs among males and females in the study cohort (Table 1).

**Table 1** Characteristics of the CBCT-based patient groups.

Demographic parameters	Ethnicity			
	Egyptian	Saudi Arabian	Pakistani	Filipino
Number of CBCT-based scans	96	109	105	90
Gender (Male:Female)	51:45	54:55	57:48	49:41
Mean age of all patients	42.2 ± 0.8	46.7 ± 1.8	44.5 ± 3.3	42.2 ± 1.4
Mean age of males	43.5 ± 3.2	48.2 ± 4.7	47.6 ± 4.2	42.2 ± 2.7
Mean age of females	41.1 ± 2.4	43.3 ± 1.6	41.2 ± 0.8	43.2 ± 1.3
Incidental findings in all patients	29 (30.2%)	35 (32.1%)	38 (35.1%)	31(34.4%)
Incidental findings in males (n; %)	14 (48.3%)	20 (57.1%)	20 (52.6%)	21(67.7%)
Incidental findings in females (n; %)	15 (51.7%)	15 (42.9%)	18 (47.4%)	15 (32.2%)

### 3.2. Incidental findings with emphasis on gender and ethnicity

Mucosal thickening was more often identified in Saudi Arabian ( $P < 0.05$ ), Pakistani ( $P < 0.05$ ) and Filipino males ( $P < 0.05$ ) compared with females in the respective ethnic group. There was no significant difference in the identification of IFs (namely, mucous retention cysts, opacifications, sinus septa and sinus floor discontinuation) related to the maxillary sinus region among males belonging to the Egyptian, Saudi Arabian, Filipino and Pakistani ethnic groups. These results are shown in [Table 2](#).

## 4. Discussion

The CBCT-based scanning is a modern computer-based imaging technology that provides a three-dimensional scan of the region of interest. With the escalated use of CBCT imaging in clinical dentistry and related research, the number of studies ([Alsufyani, 2017](#); [Avsever et al., 2018](#); [Clark et al., 2017](#); [Edwards et al., 2014](#); [Oser et al., 2017](#)) published in this discipline have also increased. Results from a recent systematic review showed that although there is a high frequency of IFs; a vast majority of such IFs are non-life threatening and do not warrant immediate medical attention ([Dief et al., 2019](#)). It has also been reported that the use of CBCT-based imaging in patients undergoing orthodontic therapy can also help identify IFs ([Kocsis et al., 2019](#)). However, the association of

patients' gender and ethnicity regarding the identification of IFs on CBCT-based images remains unclear.

The present results demonstrated a statistically significant association between ethnicity and gender and identification of IFs related to the maxillary sinus. Although the present results showed a statistically significant relation between incidental identification of mucosal thickening in an ethnic group (Saudi Arabian males compared with females in the same ethnic group), it is pertinent to mention here that the primary objective of the present study was to emphasize on the importance of CBCT scans in identification of IFs and not merely on the region of interest. The authors support the study by [Raghav et al. \(2014\)](#), which assessed and recorded the prevalence of incidental maxillary sinus pathologies in patients presenting with dental problems using CBCT-based scans. In this study ([Raghav et al., 2014](#)), mucosal thickening was observed in approximately 35% of the scans assessed. In the current study, identification mucosal thickening ranged between approximately 26–70% in the scans assessed. Nevertheless, results of the present investigation should be interpreted with caution as the sample-size of the present investigation may not necessarily represent the general population. One explanation for this is that in the present study, CBCT-based scans of patients that we scheduled to undergo dental implant therapy were explored.

A limitation is that our results may not necessarily show similar results when other CBCT-based systems are used. It has been reported that CBCT-based device and scanning and

**Table 2** Incidental findings on CBCT-base scans with emphasis on gender and ethnicity.

Patients with incidental findings	Mucosal thickening	Mucous retention cysts	Opacifications	Sinus septa	Sinus floor discontinuation
Egyptian males (n = 14) (%)	4 (28.5%)	3 (21.4%)	1 (7.1%)	3 (21.4%)	3 (21.4%)
Egyptian females (n = 15) (%)	5 (33.3%)	4 (26.7%)	2 (13.3%)	3 (20%)	1 (6.7%)
Saudi Arabian males (n = 20) (%)	12* (60%)	3 (15%)	4 (20%)	1 (5%)	0
Saudi Arabian females (n = 15) (%)	6 (40%)	4 (26.7%)	2 (13.3%)	3 (20%)	0
Pakistani males (n = 20) (%)	14 <sup>†</sup> (70%)	4 (20%)	1 (5%)	1 (5%)	0
Pakistani females (n = 18) (%)	5 (27.8%)	5 (27.8%)	4 (22.2%)	4 (22.2%)	0
Filipino males (n = 21) (%)	15 <sup>‡</sup> (71.4%)	5 (23.8%)	0	1 (4.8%)	0
Filipino females (n = 15) (%)	4 (26.7%)	4 (26.7%)	2 (13.3%)	4 (26.7%)	1 (6.7%)

\* Compared with females in the same ethnic group ( $P = 0.02$ ).

<sup>†</sup> Compared with females in the same ethnic group ( $P = 0.01$ ).

<sup>‡</sup> Compared with females in the same ethnic group ( $P = 0.03$ ).

reconstruction parameters may directly affect the quality of the scan (Liang et al., 2010). This can jeopardize radiographic visualization of anatomical structures and image noise level (Liang et al., 2010). From an ethical perspective, it is illegal to expose the asymptomatic community to radiation to identify and possibly treat IFs. There is a likelihood that the IFs in some patients of our sample were asymptomatic; however, based upon the ethical principle of beneficence, the authors informed the patients of the incidental findings that were noticed on the CBCT-based scans and advised them to visit their healthcare providers in case of development of related symptoms including intra/extra-oral swelling, and discomfort. Another limitation of our study is that sample-size calculation was not performed. This can be attributed to the design of the present study which primarily aimed at identifying IFs on CBCT-based scans. However, a variation in gender and ethnicity may be expected in terms of gender, age and ethnicity with a more representative sample-size (power calculation). Additional studies that encompass all the IFs among the entire maxillofacial region, skull base and neck would be more valuable and hence additional research is warranted in this regard. Nevertheless, it is highly recommended that CBCT-based scans should be interpreted vigilantly to identify IFs that may have otherwise remained veiled.

## 5. Conclusion

The CBCT-based technology is valuable resource for the identification of IFs. Although the results of the current investigation showed that ethnicity and gender are associated with the identification of IFs on oral and maxillofacial CBCT-based images, the reported results may not generally represent an entire community or gender.

## Compliance with ethical standards

**Declaration of Competing Interest:** Munerah Binshabaib, Shatha Subhi ALHarthi, Rawan Alkraid, Sara Aljared, Abeer Alshami and Soad Mansour declare that they have no conflict of interest.

**Human and animal rights statement:** This study does not contain data with animal subjects performed by any of the authors. The reported data is based on observation of CBCT-based scans of human subjects.

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