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REVIEW

PREVALENCE OF INCIDENTAL FINDINGS IN ORAL AND MAXILLOFACIAL CONE-BEAM COMPUTED TOMOGRAPHY: A SYSTEMATIC REVIEW AND META-ANALYSIS

F. Abesi[1], M. Amouzadeh Omran[2], M. Zamani[2]

[1]Department of Oral and Maxillofacial Radiology, Dental Faculty, Babol University of Medical Sciences – Babol, Iran
[2]Student Research Committee, Babol University of Medical Sciences – Babol, Iran

Abstract. Background: *As the use of cone-beam computed tomography (CBCT) is increasing and the quality of images is enhanced, the likelihood of incidental findings detection in CBCT radiographs is raised. Variable frequency of incidental findings on oral and maxillofacial CBCT scans has been reported.* ***Aims:*** *To perform a systematic review and meta-analysis to resolve the conflicting results about the overall prevalence of incidental findings in oral and maxillofacial CBCT scans.* ***Methods:*** *We searched the literature in PubMed, Embase, and Scopus databases from inception to 31 October 2022 to identify studies that reported the frequency of incidental findings in the subjects undergoing CBCT imaging. We pooled the extracted data and reported the estimates as a percent with a 95% confidence interval (CI).* ***Results:*** *A total of 21 eligible studies were included, comprising 9,788 patients (54.2% women) and 10,625 CBCT scans. Analysis showed that the incidental findings were present in 69.1% (95% CI: 55.6-80.0) of the CBCT scans. There were 1.48 incidental findings per CBCT scan. Pooled prevalence of incidental findings in men was 50.2% (95% CI: 23.1-77.3), which was higher than in women (41.8% [95% CI: 16.5-72.2]).* ***Conclusion:*** *A considerable prevalence of incidental findings was observed in oral and maxillofacial CBCT scans.*

Key words: *incidental findings, oral and maxillofacial radiology, cone-beam computed tomography, systematic review*

Corresponding author: *Dr. Farida Abesi, Dental Materials Research Center, Department of Oral and Maxillofacial Radiology, Dental School, Babol University of Medical Sciences, Ganjafrooz street, Babol, Mazandaran, Iran, tel: +989113132388, e-mail: abesifarida1@gmail.com*

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INTRODUCTION

Cone-beam computed tomography (CBCT) is a medical radiographic imaging method with a lower radiation dose than traditional CT, which can provide three-dimensional images with high resolution [1, 2]. This technique has become widely used in dental practice over the past two decades, from orthodontics and pediatric dentistry to implantology and prosthetics [3, 4]. Therefore, the CBCT image data must be analyzed carefully to avoid missing any significant findings.

As the use of CBCT increases and the quality of images is enhanced, the likelihood of incidental findings detection in CBCT radiographs is raised. Incidental findings refer to any unexpected abnormality detected on imaging examinations unrelated to the reasons for requesting the diagnostic tests [5-7].

These findings can be normal without needing clinical/preclinical measures or pathological requiring further assessments [5, 8, 9]. Prior studies mentioned a variable frequency of incidental findings on CBCT scans [10-12]. For example, the study by Lopes et al. [10] interpreting 150 CBCT scans reported that the total number of incidental findings was n=560, which were observed in 138 scans. Also, Barghan et al. [11] stated that 653 incidental findings were identified in 77.3% of the 400 CBCT scans.

Despite different surveys investigating the prevalence of incidental findings in oral and maxillofacial CBCT images, there needs to be a comprehensive study trying to provide a conclusive answer to this issue. In the present study, we performed a systematic review and meta-analysis to resolve the conflicting results about the overall prevalence of incidental findings in CBCT scans.

METHODS

Search strategy and eligibility criteria

The present systematic review and meta-analysis has been reported based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline [13]. We searched the literature in PubMed, Embase, and Scopus databases from the inception to 31 October 2022 with no language restrictions using the following keywords: *cone-beam computed tomography* OR *CBCT* AND *incidental*. The search was applied to the Title/Abstract. We included studies published between 2007 and 2022 that reported the frequency of incidental findings in the subjects undergoing CBCT imaging. We also manually searched the references of the retrieved articles. The exclusion criteria included:

1. Reviews, case reports, editorials and letter to the editors
2. Duplicate articles
3. Surveys without extractable data on study outcome
4. Full-texts not being available

Study selection and data extraction

We independently screened titles and abstracts of all publications primarily identified by our search for suitability evaluation using pre-designed eligibility forms. We also retrieved full-texts of the papers that seemed relevant to the study outcome for detailed examination, where a decision could not be made based on title or abstract screening. Any discrepancies were resolved by consensus between the authors. For each eligible study finally included in this systematic review, we collected the following data: first author's name, publication year, study location (country), number of patients, number of men and women (if available), the mean age of the subjects, number of CBCT scans, number of incidental imaging findings. We used Google Translate for translating Non-English reports, where required.

Statistical analysis

We combined the CBCT scans with incidental findings in each study using a random-effects model to give a pooled prevalence for all studies. The estimates were presented as a percent with a 95% confidence interval (CI). The heterogeneity between the studies was investigated by the I-squared index, ranging from 0.0% to 100.0%; a p-value less than 0.10 was considered statistically significant [14]. Subgroup analyses were carried out according to sex and publication date. For the subgroup analysis by publication date, we split the publication year into 2007-2012, 2013-2017, and 2018-2022. The forest plots were used to visually illustrate the effect estimates of the enrolled studies. We also utilized a funnel plot to assess the publication bias. We conducted all statistical analyses using Comprehensive Meta-Analysis V2 software.

RESULTS

Search results and study selection

The search of the online databases initially yielded 471 citations. After removing duplicates and those not meeting the suitability criteria during the title/abstract screening, 34 articles remained, and their full-texts were obtained and assessed. After excluding ineligible papers, 21 studies were finally enrolled [6, 7, 9-12, 15-29]. A flowchart of the studies' identification, exclusion, and inclusion process at each phase is depicted in Fig. 1 as per the PRISMA.

Study characteristics

In total, 21 studies were included in this systematic review and meta-analysis, comprising 9,788 patients (54.2% women) and 10,625 CBCT scans. There were seven studies from the USA, three studies from India, two studies from Turkey, one study from Australia, one study from Brazil, one study from Canada, one study from Germany, one study from Iran, one study from Italy, one study from Korea, one study from Saudi Arabia, one study from the UK. The language of all papers was English. The publication date was from 2007 to 2022. The basic characteristics of the included studies are represented in Table 1.

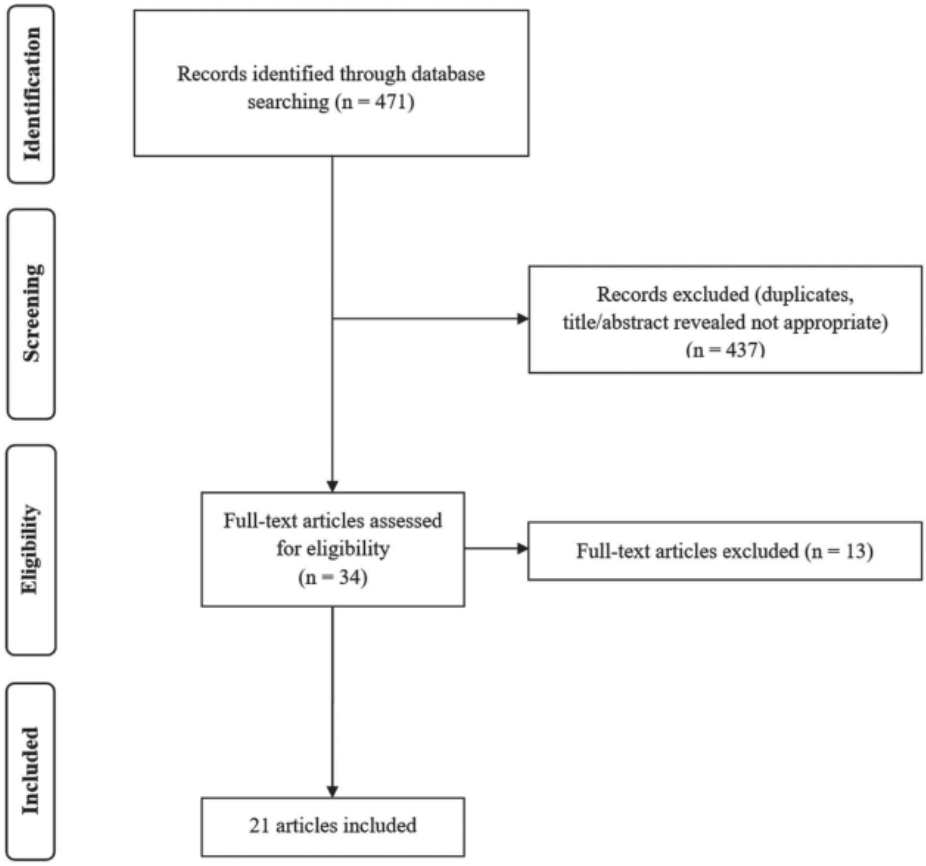

Fig. 1. PRISMA flow diagram

Table 1. Baseline information of the studies included

Study	Country	Subjects (n)	Men (n)	Women (n)	Mean age (years)	CBCT scans (n)
Allareddy, 2012 [6]	USA	1000	382	618	NA	1000
AlSakr, 2021 [15]	USA	208	101	107	62	303
Barghan, 2016 [11]	USA	400	146	254	47.1	400
Binshabaib, 2021 [16]	Saudi Arabia	400	211	189	44.1	400
Braun, 2022 [17]	Germany	374	165	209	50.9	374
Cağlayan, 2012 [18]	Turkey	207	78	129	30.3	207
Cha, 2007 [9]	USA	500	227	273	39.3	500
Choi, 2021 [19]	Korea	1020	400	620	21.7	1020
Doğramacı, 2014 [20]	Australia	183	54	129	18.3	183
Drage, 2013 [21]	UK	329	145	184	14.5	329
Edwards, 2014 [12]	Canada	427	180	247	14.2	427
Giaccaglia, 2022 [7]	Italy	61	32	29	11	61
Kachlan, 2021 [22]	USA	1002	406	596	NA	1002
Kurtuldu, 2020 [23]	Turkey	300	148	152	46.7	300
Lopes, 2017 [10]	Brazil	150	68	82	37	150
Mehdizadeh, 2020 [24]	Iran	384	184	200	36.8	384
Mutalik, 2018 [25]	USA	500	214	286	62	500
Price, 2011 [26]	USA	300	135	165	49.3	300
Singh, 2021 [27]	India	1108	685	423	NA	1850
Ul, 2021 [28]	India	140	67	73	NA	140
Warhekar, 2015 [29]	India	795	451	344	37.2	795

Abbr.: CBCT, cone-beam computed tomography

Prevalence of incidental findings

Analysis of studies showed that the incidental findings were present in 69.1% (95% CI: 55.6-80.0; I-squared = 99.2%, p < 0.001) of the CBCT scans (Fig. 2). The funnel plot was suggestive of publication bias (Fig. 3). The overall estimate indicated that there were 1.48 incidental findings per CBCT scan. The pooled prevalence of incidental findings in men was 50.2% (95% CI: 23.1-77.3; I-squared = 92.0%, p < 0.001), which was higher than in women (41.8% [95% CI: 16.5-72.2; I-squared = 94.5%, p < 0.001]). The pooled prevalence of incidental findings in CBCT images was 83.5% (95% CI: 33.7-98.1; I-squared = 99.5%, p < 0.001) for studies published during 2007-2012, 69.4% (95% CI: 36.7-89.9; I-squared = 99.3%, p < 0.001) for studies published during 2013-2017, and 60.8% (95% CI: 44.0-75.3; I-squared = 99.1%, p < 0.001) for studies published during 2018-2022.

DISCUSSION

Incidental findings could be identified on CBCT imaging examinations in dental practice, with various prevalence rates reported in different studies worldwide [10, 23, 26-28]. In this study, we aimed to systematically review the available data to provide an overall estimate of the prevalence of incidental findings in oral and maxillofacial CBCT images. For this purpose, we screened hundreds of sources initially generated by database search using strict suitability criteria. Finally, a total of 21 studies (containing more than 10 thousand CBCT scans) were eligible for inclusion in this systematic review and meta-analysis. Based on the analyses, more than two-thirds of the CBCT images demonstrated incidental findings (1.48 incidental findings per CBCT scan). In addition, the prevalence of incidental findings was higher in men than in women. Finally, the pooled prevalence was highest for studies published between 2007 and 2012 and least for those published during 2018-2022.

To the best of our knowledge, this is the first systematic review and meta-analysis that endeavored to give an overall estimate for the incidental findings prevalence in maxillofacial CBCT imaging. In the review article by Khalifa and Felemban [30], the authors assessed five studies on the nature and potential clinical significance of incidental CBCT findings. They categorized the incidental findings as seven anatomic regions, including cervical vertebrae, intracranial, dentoalveolar, temporomandibular joint (TMJ), pharyngeal airway, sinonasal, and soft tissue of the neck. The authors also divided the clinical significance of the incidental findings into high (requiring intervention or referral, such as airway issues and carotid atherosclerosis), moderate (requiring monitoring or follow-up, such as TMJ osteophyte and flattening condyle), and low (such as sinonasal polyps and tonsillolith). They finally declared that most of the incidental findings were normal variants or had low clinical significance.

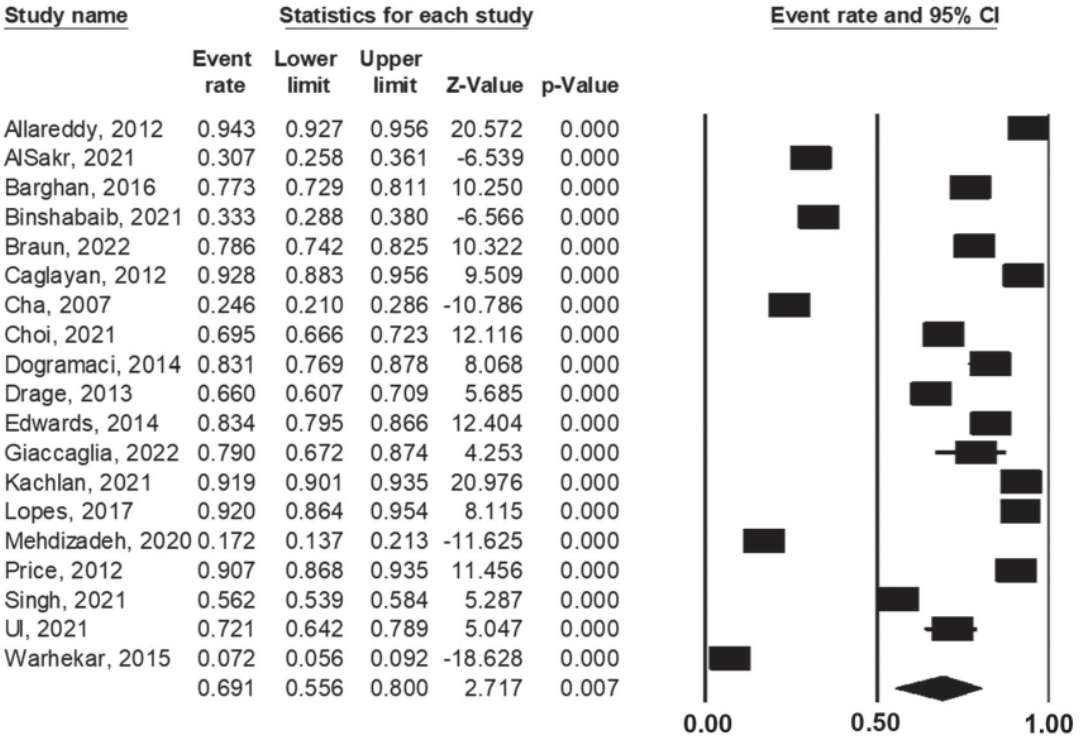

Fig. 2. Pooled prevalence of incidental findings in oral and maxillofacial cone-beam computed tomography

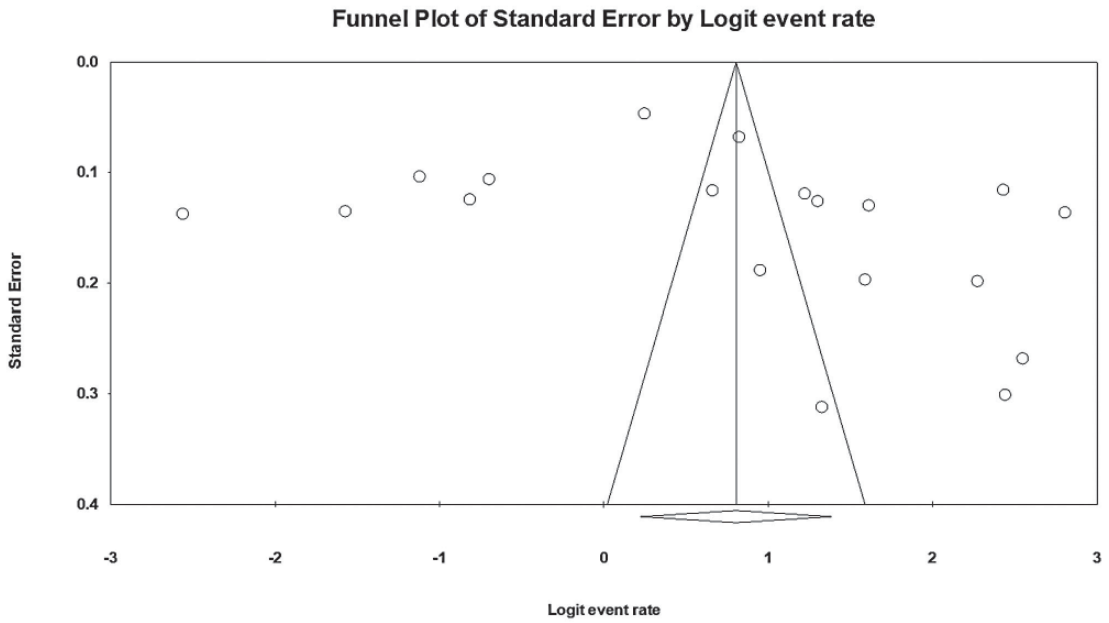

Fig. 3. Funnel plot to assess publication bias across studies assessing incidental findings in oral and maxillofacial cone-beam computed tomography

In the present study, we found a high prevalence of incidental findings reported in CBCT images; however, only some might be notable. Reporting clinically insignificant incidental findings can probably lead to excessive anxiety and stress in the patients, as well as unnecessary clinical/paraclinical procedures. In addition, a lack of sufficient training in CBCT data analysis can result in false-positive detections. On the other hand, according to ethical and legal regulations, clinicians need to report all relevant medical information to patients [31, 32]. Therefore, it is suggested to standardize the threshold of what defines clinically significant incidental findings by professional radiological bodies.

A limitation of the present study was the high heterogeneity between the included surveys, which could be explained by variations in study location, populations, etc. Of course, it should be mentioned that the heterogeneity was not justified by the subgroup analysis according to sex and publications date. On the other hand, publication bias could explain the heterogeneity. It is proposed to perform more homogeneous studies.

CONCLUSION

This systematic review and meta-analysis revealed a considerable prevalence of incidental findings in oral and maxillofacial CBCT scans. Medical and dental specialties need to collaborate to establish professional guidelines on the diagnostic approach, clinical significance, and management of incidental findings in CBCT images.

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