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ACCURACY VALUES OF CONE-BEAM COMPUTED TOMOGRAPHIC IMAGING AND PERIAPICAL RADIOGRAPHS REGARDING APICAL PERIODONTITIS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Abstract :

The present study seeks to examine newer studies over the past decade because with advances in science and technology, changes in radiographs have occurred. Therefore the aim of current study was evaluate accuracy values of Cone-beam Computed Tomographic Imaging and Periapical Radiographs on discrimination of Apical Periodontitis.

Keywords: Accuracy values, Cone-beam Computed Tomographic, Periapical Radiographs, Apic

Introduction

Apical periodontitis is a chronic inflammatory disorder of periradicular tissues caused by a etiological agents of endodontic origin(1). Periapical bone resorption is mainly induced by inflammation resulting from an infected root canal. However, chemical and physical stimuli can also cause periapical bone resorption and prevents the spread of infection and appears on radiolucent radiographs (2, 3). AP is usually asymptomatic and can usually be diagnosed during a routine radiographic examination(4). For early detection of AP, radiography is very important, over time, the use of periapical and panoramic radiographs for early detection of AP have been considered(5). These two methods have inherent limitations, including the placement and distortion of important structures that usually hide lesions(6). As a result, lesions in cancellous bone cannot be detected with these two radiographic techniques (7). Therefore, in some cases, extensive bone resorption may be present even when there is no radiographic

evidence (8). Cone beam computed tomography (CBCT) is a special type of x-ray equipment used when regular dental or facial x-rays are not sufficient (9). CBCT has the ability to visualize anatomical structures in 3 dimensions with higher resolution, this advantage increases the power of detection(10). In endodontic practice, CBCT imaging with limited field of view (FOV) has been suggested for diagnosis in patients with contradictory or nonspecific clinical signs and symptoms(11). It is important to review radiographic procedures because dentists' knowledge of all the procedures can be important in choosing a method that gives them the most reliable information about bone resorption around the AP. Previous meta-analysis study (12) have been performed in this regard, however, insufficient evidence has been provided in this regard. The present study seeks to examine newer studies over the past decade because with advances in science and technology, changes in radiographs have occurred. Therefore the aim of current study was evaluate accuracy values of Cone-beam Computed Tomographic Imaging and Periapical Radiographs on discrimination of Apical Periodontitis.

Method

Search strategy

From the electronic databases, PubMed, Scopus, Web of Science, EBSCO, and Embase have been used to perform a systematic literature over the last ten years between 2011 and September 2021. The reason for choosing studies in the last ten years is to be able to provide sufficient evidence in this area and use newer studies. Therefore, a software program (Endnote X8) has been utilized for managing the electronic titles. From the electronic databases, PubMed, Scopus, LILACS, Web of Science, EBSCO, LIVIVO, and Embase have been used to perform a systematic literature over the last ten years between 2011 and September 2021. Effect size with 95% confidence interval, random effect model and REML method were calculated. The Meta analysis have been evaluated with the statistical software Stata/MP v.16 (The fastest version of Stata).

Searches were performed with mesh terms:

("Radiography, Dental, Digital"[Mesh] AND "Radiography, Dental"[Mesh]) AND ("Radiography, Panoramic/classification"[Mesh] OR "Radiography, Panoramic/methods"[Mesh] OR "Radiography, Panoramic/statistics and numerical data"[Mesh])) OR "Radiography, Panoramic"[Mesh]) AND "Cone-Beam Computed Tomography"[Mesh]) OR ("Cone-Beam Computed Tomography/classification"[Mesh] OR "Cone-Beam Computed Tomography/instrumentation"[Mesh] OR "Cone-Beam Computed Tomography/methods"[Mesh] OR "Cone-Beam Computed Tomography/statistics and numerical data"[Mesh])) AND "Periapical Periodontitis"[Mesh]) OR ("Periapical Periodontitis/diagnosis"[Mesh] OR "Periapical Periodontitis/diagnostic imaging"[Mesh])) OR ("Periapical Diseases/diagnosis"[Mesh] OR "Periapical Diseases/diagnostic imaging"[Mesh])) OR ("Periapical Tissue/diagnosis"[Mesh] OR

"Periapical Tissue/diagnostic imaging"[Mesh])) OR "Dental Implantation, Endosseous, Endodontic"[Mesh]) AND "Data Accuracy/statistics and numerical data"[Mesh]) OR "Data Accuracy"[Mesh]) OR "Sensitivity and Specificity"[Mesh].

This systematic review has been conducted on the basis of the key consideration of the PRISMA Statement–Perfumed Reporting Items for the Systematic Review and Meta-analysis(13), and PECO strategy (Table1).

Selection criteria

Inclusion criteria: Randomized controlled trials studies, controlled clinical trials; Prospective and retrospective cohort studies, observational study, case control studies, In vitro studies; in human; diagnosis of actual or artificial AP with no lesions; case reports and reviews; studies without control group; ultrasonography were excluded from the study.

Table 1. PECO strategy.

PECO strategy	Description
P	Population: Teeth with Apical Periodontitis
E	Exposure: CBCT
C	Comparison: Periapical Radiographs
O	Outcome: diagnostic accuracy value

Data Extraction and analysis method :

The data were extracted from the research included years, sample size, Index test, Observers.

Quality Assessment Tool for Diagnostic Accuracy Studies-2 (QUADAS-2) (14), used to assessed quality of the studies that included in present meta-analysis, Risk of bias was judged as ‘‘low’’ , ‘‘high’’ or ‘‘unclear”.

For Data extraction, two reviewers blind and independently extracted data from abstract and full text of studies that included. Prior to the screening, kappa statistics was carried out in order to verify the agreement level between the reviewers. The kappa values were higher than 0.80.

Effect size with 95% confidence interval (CI), random or fixed effect model and REML and inverse-variance method were calculated. Random effects were used to deal with potential heterogeneity and I^2 showed heterogeneity. I^2 values above 50% signified moderate-to-high heterogeneity. The Meta analysis have been evaluated with the statistical software Stata/MP v.16 (The fastest version of Stata).

Results :

In the initial review of the existing literature and based on keywords related to the subject of the study, first 343 studies were found in databases. After deleting similar and duplicate studies, the abstract of 331 studies was reviewed. At this stage, studies that did not meet the inclusion criteria were excluded from the study (285 studies). The full text of 46 studies was reviewed and 41 studies were excluded, finally five studies were selected. 331 studies were selected to review the abstracts, the full text of 46 studies was reviewed; finally, five studies were selected.

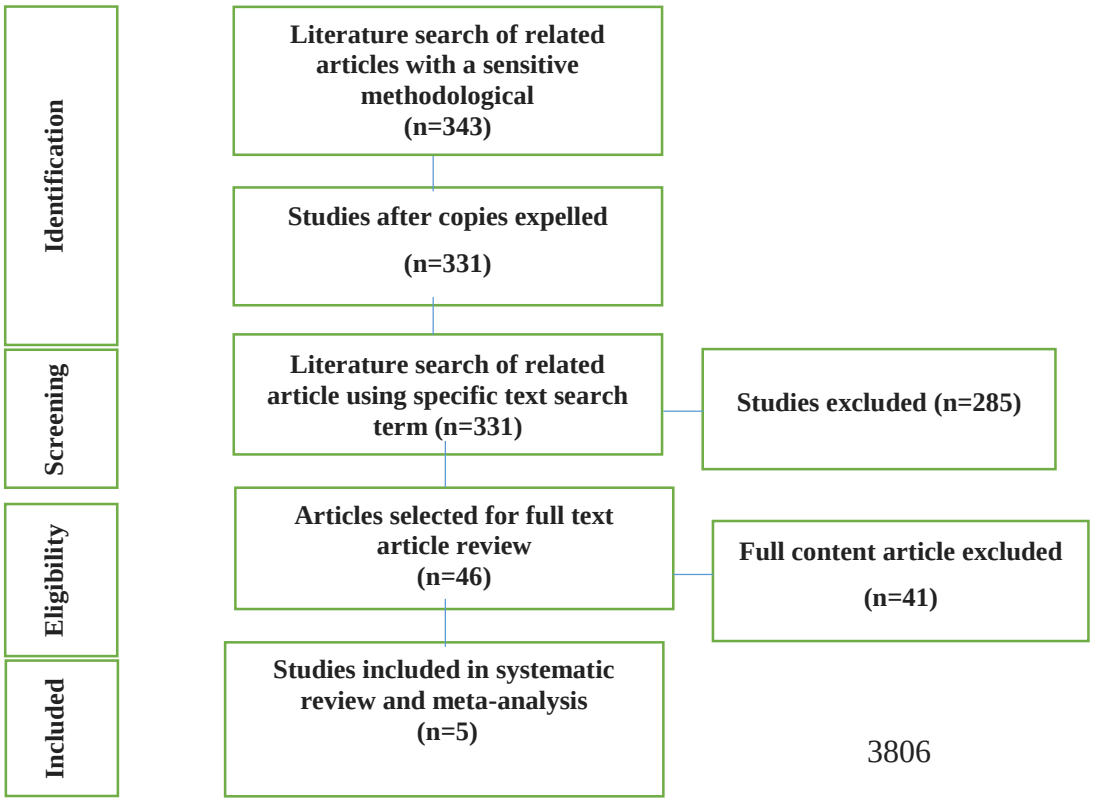

Figure 1. Flowchart of the literature search and selection criteria

Characteristics :

Five studies have been included in present article. The number of teeth a total was 269. Other characteristics of the selected studies are reported in Table 2.

Assessing risk of bias :

According to QUADAS-2 tool, all studies for patient selection have a high risk of bias and a low risk of bias for Reference standard and Flow and timing.

Table2. Studies selected for systematic review and meta-analysis.

Study. Years	Number of teeth	Number of images		CBCT imaging				Index test
		CBCT	Control	voxel resolution	field of view	Acquisition time	pixel resolution	
Gudac et al.,2020 (15)	176	128	162	84 kV, 5 mA, 0.3 mm	6×16 cm	18.3 sec	2,560 x 1,440	CBCT DPR
Kanagasingam et al.,2017 (16)	67	67	67	60 kVp, 2 mA and 10.8 s	50 mm	NR	NR	DPR CBCT
Liang et al, 2014 (17)	15	63	37	70 kVp, 3–5 , 0.125-mm	4×4 cm	17.5 sec	NR	DPR CBCT
Tsai et al, 2012 (18)	6	80	16	80 kVP, 7 mA, 0.125-mm	40×40 mm	NR	NR	DPR CBCT
Lennon et al, 2011 (19)	5	10	10	90 kV, 2 mA	4×4 cm	NR	NR	CBCT

DPR: Digital Periapical Radiography

Table3. Bias assessment According to QUADAS-2

Study. Years	Patient selection	Index test	Reference standard	Flow and timing
Gudac et al.,2020 (15)	-	+	+	+
Kanagasingam et al.,2017 (16)	-	?	+	+

Liang et al, 2014 (17)	-	?	+	+
Tsai et al, 2012 (18)	-	+	+	+
Lennon et al, 2011 (19)	-	-	+	+

Low (+), unclear (?), high (-)

Sensitivity of CBCT :

Sensitivity of CBCT on discrimination of Apical Periodontitis was 92% (ES 92%; 95% CI 78%, 100%) among five studies with low heterogeneity (I^2 <0%; P =0.99) (Figure2).

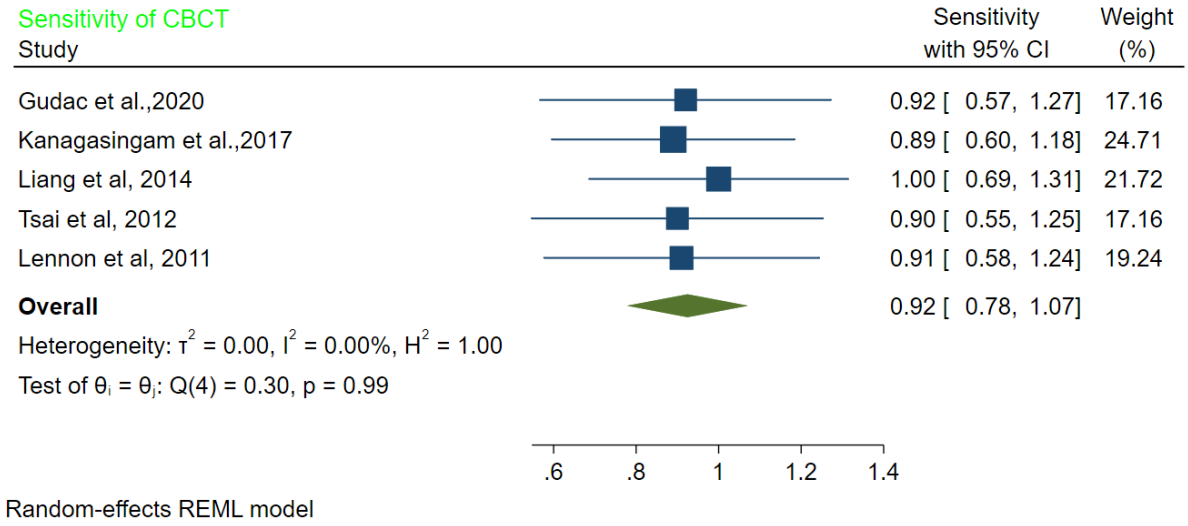

Figure2. Forest plot showed Sensitivity of CBCT on discrimination of Apical Periodontitis

Specificity of CBCT :

Specificity of CBCT on discrimination of Apical Periodontitis was 92% (ES, 92%; 95% CI 77%, 100%) among five studies with low heterogeneity (I^2 = 0%; P =0.69) (Figure3).

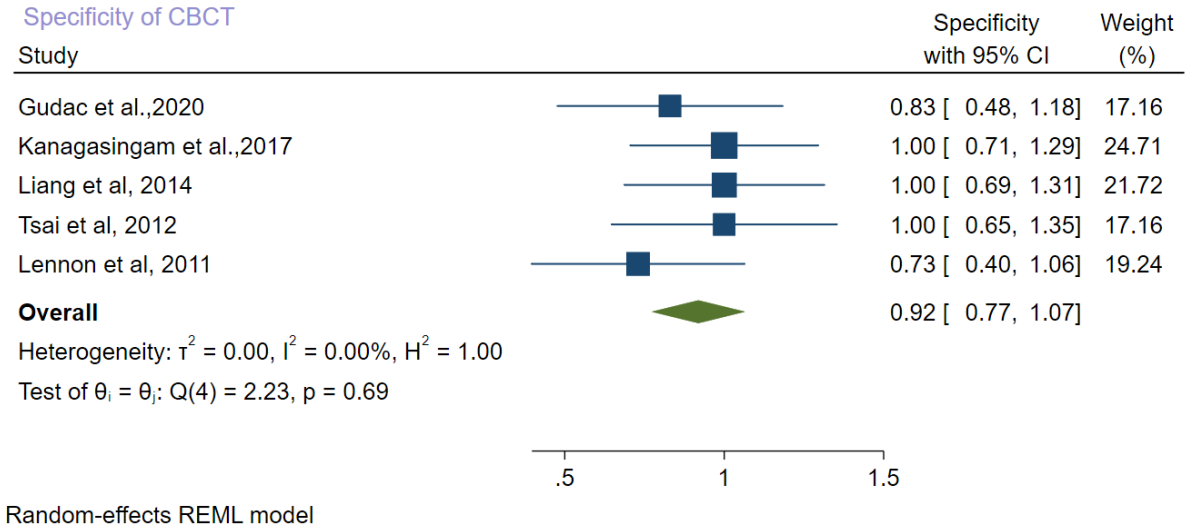

Figure3. Forest plot showed Specificity of CBCT on discrimination of Apical Periodontitis

Sensitivity of DPR :

Sensitivity of DPR on discrimination of Apical Periodontitis was 50% (ES, 50%; 95% CI 33%, 67%) among five studies with low heterogeneity (I^2 = 29.47%; P =0.24) (Figure4).

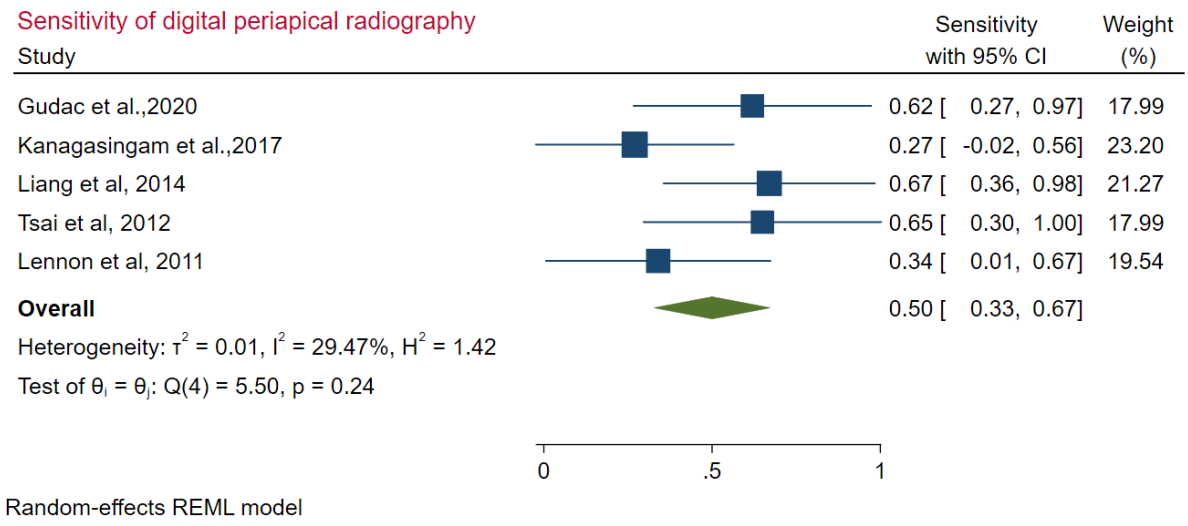

Figure4. Forest plot showed Sensitivity of DPR on discrimination of Apical Periodontitis

Specificity of DPR :

Specificity of DPR on discrimination of Apical Periodontitis was 91% (ES, 91%; 95% CI 77%, 100%) among five studies with low heterogeneity (I^2 = 0%; P =0.81) (Figure5).

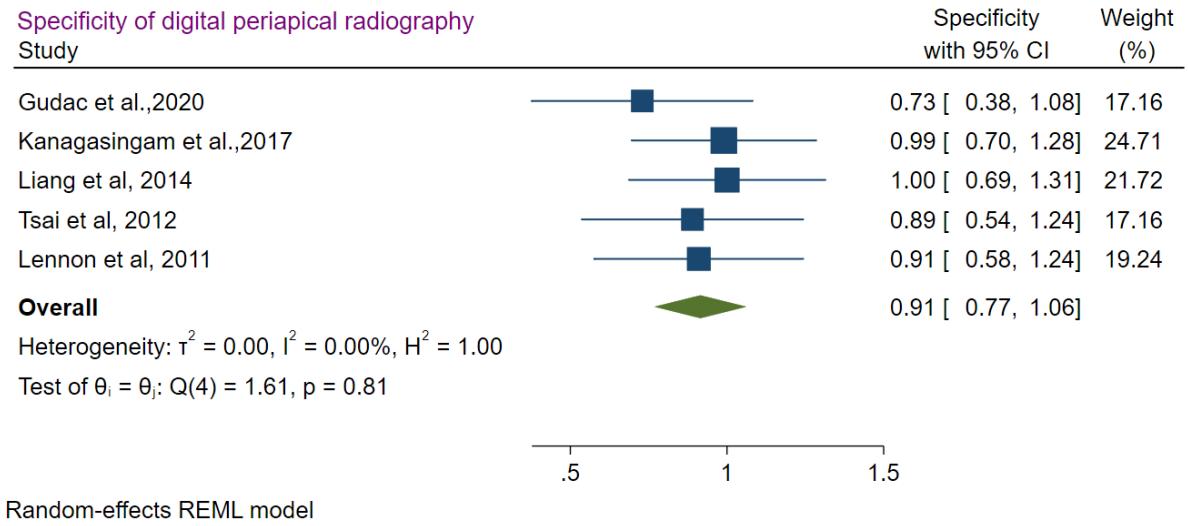

Figure4. Forest plot showed Specificity of DPR on discrimination of Apical Periodontitis

Discussion :

The aim of current systematic review and meta-analysis study was evaluate accuracy values of Cone-beam Computed Tomographic Imaging and Periapical Radiographs on discrimination of Apical Periodontitis. Sensitivity and specificity values for DPR and CBCT varied from study to study, however, low heterogeneity was observed between study results. The difference in values could be related to the variation in the size of the bone lesions, the anatomical area under study. In almost all studies on agreement between observers, little information was reported. Regarding the anatomic region examined in each study, lesions in cortical bone were detected with greater accuracy than in trabecular bone(20). In matching to the common belief that CBCT is able to detect significantly more periapical lesions (21), data showed differences between two radiographic examination methods with regard to the lesion presence. Studies have shown that diagnostic accuracy is more pronounced in larger lesions regardless of the type of radiographic system used(22). Studies have shown that the DOR values of the reported index tests indicate that CBCT imaging had better discriminant test performance (23-25). In a clinical setting, it is important for specialists to know which of the diagnostic radiographic methods is more effective in diagnosing patients than healthy ones; however, all of these radiographic examinations can only detect the presence or absence of bone resorption(26, 27). In the present study, meta-analysis reported the best results of diagnostic accuracy when using CBCT imaging. If CBCT imaging is chosen to diagnose AP, FOV adjustment should be considered to use the lowest possible radiation dose in the patient(28, 29). Given the fact that the CBCT technique provides high radiation doses for the patients, the DPR imaging should be the first choice radiography method as an adjunct to clinical acumen in decision-making process before the endodontic treatment. Only in selected cases, when the character of detectable pathology

is questioned by DPR and by clinical tests, additional radiographic examination using CBCT should be considered. These assumptions are in agreement with the position statement of the European Society of Endodontology on the use of CBCT in endodontics (30). The main methodological limitation of current systematic review and meta-analysis was that all included studies used in vitro methods in which artificial AP were induced in the skeletal material by drilled holes or acid applied at the periapical bone tissue.

Conclusion :

Current study reported Cone-beam Computed Tomographic Imaging has better diagnostic accuracy (Sensitivity and Specificity) on discrimination of Apical Periodontitis than Periapical Radiographs, in general it can be said that Cone-beam Computed Tomographic imaging reports values with excellent accuracy.

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