Comparison of cone beam computed tomography and intra oral periapical radiography in detecting periapical lesions – A systematic review

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Abstract:
Introduction: Cone-beam computerized tomography (CBCT) is a medical image acquisition technique based on a cone-shaped X-ray beam centered on a two-dimensional (2D) detector. The source-detector system performs one rotation around the object producing a series of 2D images. The images are reconstructed in a three-dimensional (3D) data set using a modification of the original cone-beam algorithm developed by Feldkamp et al in 1984. This technique is widely used in different industrial and biomedical applications such as micro-CT. Among the first clinical applications were single photon emission computerized tomography (SPECT), angiography and image-guided radiotherapy. Dedicated cone-beam computerized tomography scanners for the oral and maxillofacial (OMF) region were pioneered in the late 1990s independently by Arai et al. in Japan.

This Systematic review aims at comparing cone-beam computerized tomography and periapical radiography in detection of periapical lesion.

Objective: To compare the accuracy of cone beam computed tomography (CBCT) and intra oral periapical radiography (IOPA) in diagnosis of periapical pathology

Search Strategy: Database such as Pubmed Central and Medline were searched for the related topics from February 1996 till July 2013.

Selection Criteria: Trials were selected if they met the following criteria: Clinical trials comparing the accuracy of Cone beam computed tomography (CBCT) and intra oral periapical radiography (IOPA).

Data Collection and Analysis: All the studies included were based on the data extraction and analysis of the studies for quality and publication bias. The data collection form was customized. The primary outcome is to compare Cone beam computed tomography (CBCT) and intra oral periapical radiography (IOPA) in detection of periapical lesions.

Main Results: The review concluded that cone beam computed tomography is superior to conventional intra oral periapical radiography in detection of periapical lesions.

Conclusion: The probability of detecting periapical lesions was more in case of cone-beam computed tomography when compared to conventional intra oral periapical radiography where external factors such as anatomical noise and poor irradiation geometry which are not in operators control are eliminated.

I. Background
Traditionally, the diagnosis of periapical lesion was based on clinical and radiographic presentations; confirmatory diagnosis was only by a biopsy which was highly impossible in the case of a non surgical procedure. If biopsy is taken the treatment is no longer a non surgical procedure (Simon et al 1980). Intra oral periapical radiograph could determine only the mesiodistal aspect of the periapical lesion (Kaffe et al 1988) since it is a two dimensional representation of a three dimensional object. Periapical lesions confined within cancellous bone were not usually detected in periapical radiography. It has been reported that CBCT scans detected periapical lesions in many cases which is absent in periapical radiograph. Moreover CBCT helps in detection of extent of lesion not only mesiodistally but also buccolingually.

AIM
The aim of this systematic review was to compare the accuracy of cone beam computed tomography (CBCT) and intra oral periapical radiography (IOPA) in the diagnosis of periapical lesions.

Structured Questions
Comparison of cone beam computed tomography and intra oral periapical radiography in ....

Is there any difference in detecting periapical radiolucency between Cone beam computed tomography and intra oral periapical radiography in detection of periapical lesion?

Pico Analysis

- **Population**: Patients with periapical pathology.
- **Intervention**: Cone beam computed tomography
- **Comparison**: Intra oral periapical radiography.
- **Outcome**: Detection of periapical lesion.

Null Hypothesis

There is no difference in detection between Cone beam computed tomography and intra oral periapical radiography.

II. Materials And Methods

Sources Used

For identification of studies included and considered in this review, a detailed search strategy was developed for the database searched. The MEDLINE search used the combination of controlled vocabulary and free text terms.

Searched Databases

- PUBMED (From February 1996 till July 2013)
- PUBMED Advanced Search (From February 1996 till July 2013)
- MEDLINE

Language

No language restrictions

Hand Searching

All issues of the following journals were hand searched as being of particular importance to the review.

- Journal of Endodontics
- International Endodontic Journal
- Journal of American Dental Association
- Journal of Dentistry
- Oral Medicine, Oral Pathology, Oral Surgery, Oral Radiology and Endodontics.
- British Dental Journal
- Endodontic Topics

III. Search Methodology

History

Download historyClear history

Recent queries

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<tr>
<th>Search ID</th>
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</table>
Comparison of cone beam computed tomography and intra oral periapical radiography in ....

Inclusion Criteria
Criteria for considering studies for this review
Types of Studies
1. Comparing both conventional Cone beam computed tomography and intra oral periapical radiography

Types of Participants
Patients of age greater than 16 years having necrotic teeth and apical periodontitis.

Types of Interventions
Cone beam computed tomography and intra oral periapical radiography.

Types of Outcome Measures
Detection of periapical radiolucencies of both the method.
Exclusion Criteria
The following studies were excluded,
- Case reports/case series
- Animal studies
- In vitro studies

Table 1: Variables Of Interest

<table>
<thead>
<tr>
<th>S. No</th>
<th>Variables Of Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Detection of periapical lesion</td>
</tr>
</tbody>
</table>

Table 2: Characteristics Of Excluded Studies

<table>
<thead>
<tr>
<th>S. No</th>
<th>Author</th>
<th>Year</th>
<th>Reason for Exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Abella et al</td>
<td>2013</td>
<td>CBCT compared with digital radiography</td>
</tr>
<tr>
<td>2.</td>
<td>Balasundaram et al</td>
<td>2012</td>
<td>Only extent of lesion determined not the detection of lesion</td>
</tr>
<tr>
<td>3.</td>
<td>Tsai P et al</td>
<td>2012</td>
<td>In vitro</td>
</tr>
<tr>
<td>4.</td>
<td>Abella et al</td>
<td>2012</td>
<td>Age group not satisfied</td>
</tr>
<tr>
<td>5.</td>
<td>Lemon S et al</td>
<td>2011</td>
<td>Only CBCT with different angles done not compared with periapical radiograph</td>
</tr>
<tr>
<td>6.</td>
<td>Paula –Silva et al</td>
<td>2009</td>
<td>Animal study</td>
</tr>
<tr>
<td>7.</td>
<td>Patel S et al</td>
<td>2009</td>
<td>In vitro</td>
</tr>
<tr>
<td>8.</td>
<td>Jorge et al</td>
<td>2008</td>
<td>Animal study</td>
</tr>
<tr>
<td>9.</td>
<td>Velvart et al</td>
<td>2001</td>
<td>Study done with CT not CBCT</td>
</tr>
</tbody>
</table>

IV. Results
Description of Studies
The search identified 224 publications out of which 211 were excluded after reviewing the title or abstract. Full articles were obtained for 13 studies, 8 of these publications were excluded after reading the full text article,1 article is obtained by hand search therefore a total of 6 publications fulfilled all criteria for inclusion.

Table 3: General Information Of Selected Articles
Comparison of cone beam computed tomography and intra oral periapical radiography in....

Table 4: Results

<table>
<thead>
<tr>
<th>S. No</th>
<th>Author and Year</th>
<th>Diagnostic Method Used</th>
<th>Results</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Sara Lofthag et al 2007</td>
<td>Cone beam computed tomography and intra oral periapical radiography.</td>
<td>Intra oral periapical radiograph-69.56% Cone beam computed tomography -91.3%</td>
<td>Cone beam computed tomography is superior to intra oral periapical radiography.</td>
</tr>
<tr>
<td>2.</td>
<td>Kenneth M.T et al 2008</td>
<td>Cone beam computed tomography and intra oral periapical radiography.</td>
<td>Intra oral periapical radiograph -46.1% Cone beam computed tomography -69.8%</td>
<td>Cone beam computed tomography is superior to intra oral periapical radiography.</td>
</tr>
<tr>
<td>3.</td>
<td>Estrela et al 2008</td>
<td>Cone beam computed tomography and intra oral periapical radiography.</td>
<td>Intra oral periapical radiograph -39.5% Cone beam computed tomography -60.9%</td>
<td>Cone beam computed tomography is superior to intra oral periapical radiography.</td>
</tr>
<tr>
<td>4.</td>
<td>Estrela et al 2008</td>
<td>Cone beam computed tomography and intra oral periapical radiography.</td>
<td>Intra oral periapical radiograph -35.3% Cone beam computed tomography -63.9%</td>
<td>Cone beam computed tomography is superior to intra oral periapical radiography.</td>
</tr>
<tr>
<td>5.</td>
<td>S.patel et al 2011</td>
<td>Cone beam computed tomography and intra oral periapical radiography.</td>
<td>Intra oral periapical radiograph -20% Cone beam computed tomography -48%</td>
<td>Cone beam computed tomography is superior to intra oral periapical radiography.</td>
</tr>
<tr>
<td>6.</td>
<td>Rafael Fernandez et al 2013</td>
<td>Cone beam computed tomography and intra oral periapical radiography.</td>
<td>Intra oral periapical radiograph -5.7% Cone beam computed tomography -18.7%</td>
<td>Cone beam computed tomography is superior to intra oral periapical radiography.</td>
</tr>
</tbody>
</table>
Quality Assessment
The quality assessment of included trials was undertaken independently as a part of data extraction process. Four main quality criteria were examined:

1. Method of Randomization, recorded as
   a. Yes – Adequate as described in the text
   b. No – Inadequate as described in the text
   c. Unclear in the text

2. Allocation Concealment, recorded as
   a. Yes – Adequate as described in the text
   b. No – Inadequate as described in the text
   c. Unclear in the text

3. Outcomes assessors blinded to intervention, recorded as
   a. Yes – Adequate as described in the text
   b. No – Inadequate as described in the text
   c. Unclear in the text

4. Completeness of follow-up (was there a clear explanation for withdrawals and dropouts in each treatment group) assessed as:
   a. Yes-Dropouts were explained
   b. No-Dropouts were not explained
   c. None -No Dropouts or withdrawals

Other methodological criteria examined included:

1. Presence or absence of sample size calculation
2. Comparability of groups at the start
3. Clear inclusion/ exclusion criteria

Presence/ absence of estimate of measurement error. The validity and reproducibility of the method of assessment.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Author</th>
<th>Year</th>
<th>Study Design</th>
<th>Level of Evidence</th>
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<tbody>
<tr>
<td>1.</td>
<td>Sara lofthag et al</td>
<td>2007</td>
<td>Clinical Trial</td>
<td>Level 3</td>
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<td>2.</td>
<td>Kenneth M T et al</td>
<td>2008</td>
<td>Clinical Trial</td>
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<td>2011</td>
<td>Clinical Trial</td>
<td>Level 3</td>
</tr>
<tr>
<td>6.</td>
<td>Rafael Fernandez et al</td>
<td>2013</td>
<td>Clinical Trial</td>
<td>Level 3</td>
</tr>
</tbody>
</table>

Graph 1: Number Of Studies
Risk of Bias in Included Studies

The assessments for the four main methodological quality items are shown in table. The study was assessed to have a “High risk” of bias if it did not record a “Yes” in three or more of the four main categories, “Moderate” if two out of four categories did not record a “Yes” and “Low” if randomization assessor blinding and completeness of follow – up were considered adequate.

<table>
<thead>
<tr>
<th>Study</th>
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<th>Allocation Concealed</th>
<th>Assessor Blinding</th>
<th>Dropouts Described</th>
<th>Risk of Bias</th>
</tr>
</thead>
<tbody>
<tr>
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<td>No</td>
<td>No</td>
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<tr>
<td>Kenneth M T et al 2008</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>High</td>
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<tr>
<td>Estrela et al 2008</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>None</td>
<td>High</td>
</tr>
<tr>
<td>Estrela et al 2008</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>High</td>
</tr>
<tr>
<td>S Patel et al 2011</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>High</td>
</tr>
<tr>
<td>Rafael Fernandez et al 2013</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>None</td>
<td>High</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Justified</th>
<th>Baseline Comparison</th>
<th>I/ E Criteria</th>
<th>Method Error</th>
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<tbody>
<tr>
<td>Sara Lofthag et al 2007</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Kenneth M T et al 2008</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
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<td>Estrela et al 2008</td>
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<tr>
<td>S Patel et al 2011</td>
<td>No</td>
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<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Abella et al 2012</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Rafael Fernandez et al 2013</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

V. Discussion

Interpretation of Results

First trial SaraLofthag-Hansen et al6 (2007),in a clinical trial analyzed 46 teeth out of which 5 had a clinical diagnosis of apical periodontitis 41 were endodontically treated ,of which 23 had a post in one or more root canals. Among 46 teeth 32(69.5%) teeth were identified with periapical lesion in intra oral periapical radiography radiograph and 42(91.3%) teeth were identified with periapical lesion in cone beam computed tomography

Second trial Kenneth M T et al11 (2008), in a clinical trial, analyzed 74 teeth yielding 156 roots with clinical signs of apical periodontitis. Among 156 roots 72(46.1%) teeth were identified with periapical lesion in intra oral periapical radiography radiograph and 109(69.8%) teeth were identified with periapical lesion in cone beam computed tomography

Third trial Carols Estela et al12 (2008), in a clinical trial, analyzed 1014 teeth with clinical signs of apical periodontitis. Among 1014 teeth 401(39.5%) teeth were identified with periapical lesion in intra oral periapical radiography radiograph and 618 (60.9%) teeth were identified with periapical lesion in cone beam computed tomography

Fourth trial Carols Estela et al7 (2008) in a clinical trial, analyzed 1508 teeth with clinical signs of apical periodontitis. Among 1508 teeth, 533 (35.5%) teeth were identified with periapical lesion in intra oral periapical radiography radiograph and 964 (63.9%) teeth were identified with periapical lesion in cone beam computed tomography

Fifth trial S Patel et al13 (2011) in a clinical trial, analyzed 132 teeth (208) roots which is endodontically treated. Among 273 teeth, 55 (20%) teeth were indentified with periapical lesion in intra oral periapical radiography radiograph and 130 (48%) teeth were identified with periapical lesion in cone beam computed tomography
Sixth clinical trial by Rafael et al, 2013, in a clinical trial, analyzed roots with clinical signs of apical periodontitis. Among teeth, 12 (5.7%) % teeth were identified with periapical lesion in intra oral periapical radiography and 39 (18.7%) teeth were identified with periapical lesion in cone beam computed tomography.

Six clinical trials compared the accuracy of cone beam computed tomography and intra oral periapical radiography in determining periapical lesion all the studies states that cone beam computed tomography is superior to intra oral periapical radiography in detection of periapical lesion with significant difference.

Defending the Results
Ex vivo studies in which the detection of simulated periapical lesions has been assessed with cone beam computed tomography images and intraoral radiographs have all confirmed the superior diagnostic ability of cone beam computed tomography images over intraoral periapical radiographs (Stavropoulos and Wenzel 2007, Ozen et al 2009, Patel et al 2009, Sogur et al2009). These findings have been reinforced by more recent in vivo dog studies (Paula-Silva et al 2009). Intentionally created periapical lesions were induced around the roots of dog’s teeth (one group had vital pulps to serve as a positive control). After 180 days (another group was left untreated to serve a negative control), intraoral radiographs and cone beam computed tomography scans were taken after which the animals were sacrificed, and the root apices and surrounding periapical tissues were evaluated histologically. CBCT helps in diagnosis of lesions extending lingually behind the tooth structure whereas IOPA cannot as it is a two dimensional image. These studies confirmed that cone beam computed tomography not only was more sensitive at detecting periapical lesions, but also had a higher overall accuracy when compared with intraoral periapical radiographs.

VI. Inference
Implications for Practice
There is enough evidence that cone beam computed tomography is superior to intra oral periapical radiography in detection of periapical lesion with the only disadvantage being radiation exposure.

Implications for Research
Since there are adequate studies stating that cone beam computed tomography is superior to intra oral periapical radiography in detection of periapical lesion further research can be done by comparing cone beam computed tomography with other methods such as ultrasound etc.,

Report of Outlier Data
No outlier data obtained.

VII. Summary
The aim of this systematic review was to compare accuracy of cone beam computed tomography (CBCT) and intra oral periapical radiography on diagnosis of periapical pathology. Trials were selected if they met the following criteria. Clinical trials comparing cone beam computed tomography with conventional intra oral periapical radiography. The databases PUBMED CENTRAL and MEDLINE were searched for the related topic from 1996 till July 2013. The search identified 224 publications out of which 211 were excluded after reviewing the title or abstract. Full articles were obtained for 13 studies, 8 of these publications were excluded after reading the full text article,1 article is obtained by hand search therefore a total of 6 publications fulfilled all criteria for inclusion.

VIII. Conclusion
There is enough evidence that cone beam computed tomography is superior to intraoral periapical radiography in detection of periapical lesion with the only disadvantage being radiation exposure.

References
Comparison of cone beam computed tomography and intra oral periapical radiography in ....


