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# DIAGNOSTIC ACCURACY OF CBCT VERSUS PANORAMIC RADIOGRAPHY IN PREOPERATIVE ASSESSMENT OF IMPACTED THIRD MANDIBULAR MOLARS PROXIMITY TO INFERIOR ALVEOLAR NERVE: A SYSTEMATIC REVIEW

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*Cone Beam Computed Tomography (CBCT), Orthopantomogram (OPG), Mandibular third molar, Inferior alveolar nerve, diagnostic accuracy.*

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**Abstract**

***Background:*** *The risk of Inferior alveolar nerve injury is the biggest risk factor in surgical extraction of mandibular third molars. A pre-operative assessment can minimize this issue greatly. The most widely used radiographic technique is OPG which due to its 2D nature over and under diagnoses the risk. Cone Beam Computed Tomography (CBCT) provides three-dimensional imaging that overcomes these spatial limitations.*

***Objective:*** *To assess the diagnostic accuracy of CBCT in comparison to panoramic radiography in preoperative assessment of impacted third mandibular molars and its relation to Inferior Alveolar Nerve.*

***Materials and Methods:*** *Electronic databases (PubMed/MEDLINE, Embase, Scopus, and the Cochrane Library) were searched for studies published up to 2026 following PRISMA guidelines. Risk of bias was assessed using the QUADAS-2 tool. Studies evaluating the proximity of inferior alveolar nerve to mandibular third molar were included.*

***Results:*** *A total of 5 studies were included that met the inclusion criteria. Five studies meeting the criteria were included. On the OPG "darkening of roots" and "interruption of the canal white line" correlated significantly with the loss of cortication on the CBCT. Panoramic radiograph demonstrated high sensitivity but low specificity. This was opposed to the CBCT findings where true root to canal contact was observed in 58.6% to 76.6% of radiographically high-risk cases. Moreover, CBCT correctly produced reproducible results with results to lingual canal path which often resulted in*

*perforation. OPG was also significantly inadequate for detecting multiple roots ($P < 0.05$).*

***Conclusion**: CBCT provides vastly superior diagnostic accuracy in determining the proximity of the nerve to the third mandibular molar root, lingual canal pathway, multiple roots and true canal perforation.*

## INTRODUCTION

The most common Oral and Maxillofacial surgery is surgical extraction of Third Molars(1). The biggest complication in such surgeries is the damage to the Inferior Alveolar Nerve which sometimes leads to neurosensory deficits(1, 2). Securing a pre-operative radiograph, most commonly Orthopantomogram (OPG) has been a prevalent practice(3). It has been widely used because of low cost, low radiation exposure, and availability(4). It is a two-dimensional radiographic technique which leads to introduction of distortion, magnification discrepancies, and a complete absence of buccolingual spatial projection(1, 4, 5). This leads to an incorrect prediction of the root to canal relationship(4).

Cone Beam Computed Tomography (CBCT) is a three-dimensional radiographic technique(6, 7). This modality eliminates the overlap of structures and is very efficient at showing the level of cortication between the nerves and the root(8-11). The reason it is not widely used is the cost and high radiation dose(8, 12).

This systematic review seeks to comprehensively evaluate and synthesize published clinical evidence examining the diagnostic accuracy of CBCT versus panoramic radiography. By focusing entirely on studies that verified imaging findings through direct intraoperative observation of the nerve during surgery, this review provides a definitive qualitative synthesis of the true predictive capacity of both modalities.

### Material and Methods

#### Data Sources and Search Strategy

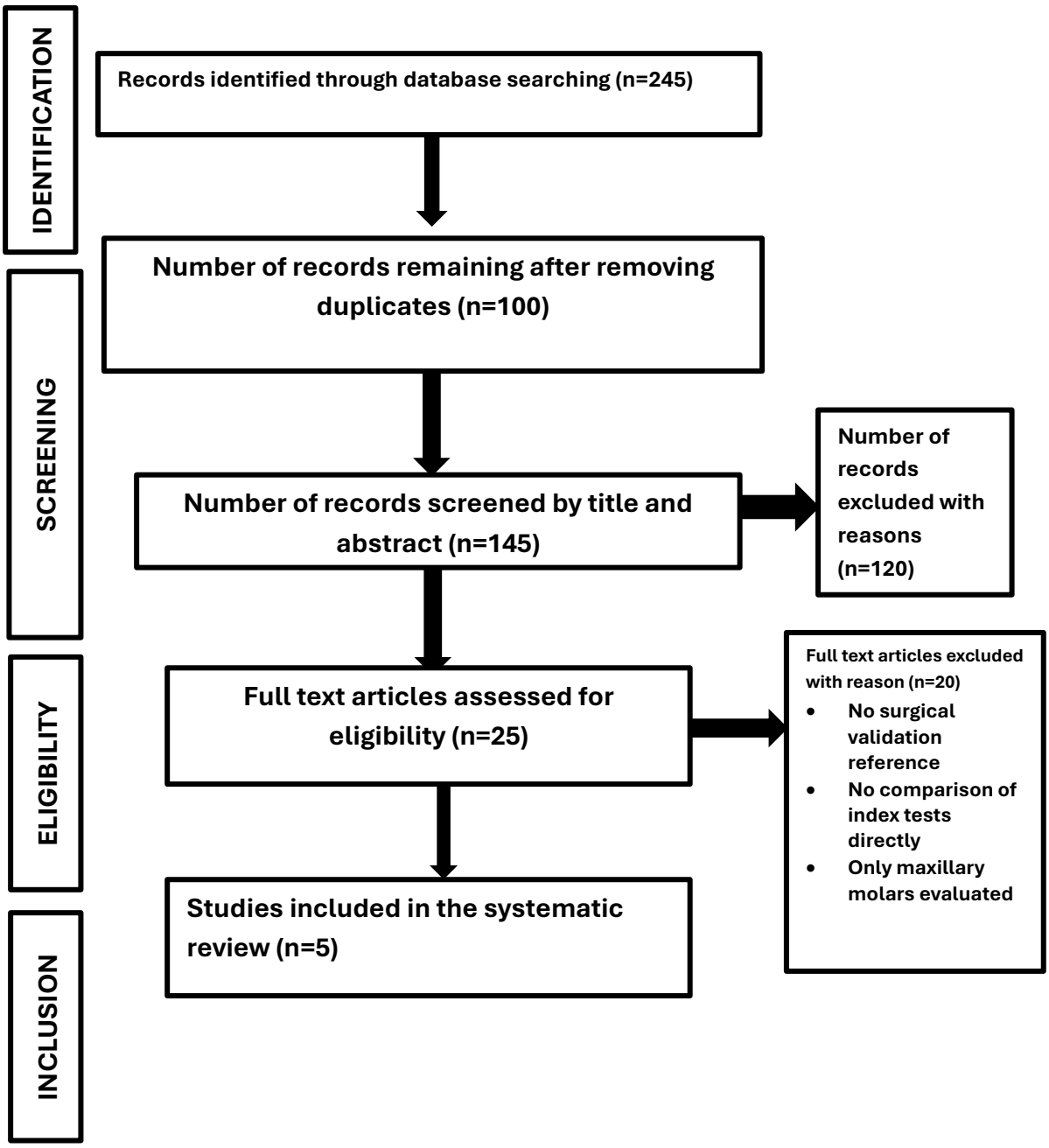
The electronic search was conducted on platforms including PubMed/MEDLINE, Embase, Scopus, and the Cochrane Library. The studies published up to 2026 were published. A combination of medical subject headings (MeSH) and keywords optimized for diagnostic accuracy and oral maxillofacial imaging were used.

The primary search string utilized was ("Cone-Beam Computed Tomography" OR "CBCT") AND ("Radiography, Panoramic" OR "panoramic radiography" OR "OPG" OR "orthopantomogram") AND ("Third Molar" OR "wisdom tooth" OR "mandibular third molar") AND ("diagnostic accuracy" OR "sensitivity" OR "specificity" OR "nerve exposure")

#### PRISMA Flowchart

The selection and screening cascade followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) structural framework.

FIGURE 1: CHART OUTLINING THE BIBLIOGRPHAIC SEARCH USING PRISMA GUIDELINES




**Inclusion Criteria**

- Diagnostic cross-sectional trials and clinical cohorts involving humans
- Securing pre-surgical OPG and CBCT for the targeted tooth before surgery
- Sufficient raw data to deduce the sensitivity, specificity, or true positive/negative values

**Exclusion Criteria**

- Reviews, editorials, case reports, and animal model studies
- Investigation that focused on general pathologies without considering IAN exposure.

**Quality Assessment**

Quality of the studies and risk of bias was conducted across selected trials using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) tool across four domains of bias and three of applicability. Overall, the included studies demonstrated moderate to good quality and low risk of bias as shown in table 1.

**Table 1: Quality assessment and risk of bias of included studies**

| Author/ year | Patient Selection (ROB) | Index Test: OPG (ROB) | Reference Standard (ROB) | Flow and Timing (ROB) | Patient Selection (Applicability) | Index Test: OPG (Applicability) | Reference Standard (Applicability) | Overall Quality & Narrative Conclusion | Reference |
|---|---|---|---|---|---|---|---|---|---|
| **Patel PS et al., 2020** | Low | Unclear | Low | Low | Low | Low | Low | Good Quality (low verification bias) | (13) |
| **Saha N et al., 2019** | Low | Low | Low | Low | Low | Low | Low | Excellent Quality (no major domains of bias) | (14) |
| **Dalili Z et al., 2011** | Unclear | Unclear | Low | Low | High | Low | Low | Moderate Quality (Spectrum Bias) | (15) |
| **Peker I et al., 2014** | Low | Low | Low | Low | Low | Low | Low | Excellent Quality | (16) |
| **Elkhateeb SM et al., 2018** | High | Low | Low | Low | High | Low | Low | Moderate Quality (Selection Bias) | (17) |

**Results**

The combined diagnostic data from 781 impacted mandibular third molars (IMTM) highlighted a distinct clinical consensus regarding the predictive accuracy of panoramic high-risk signs when validated against 3D cross-sectional CBCT imaging.

All the studies reported, the most significant predictors of absence of cortication and no contact were the "darkening of the roots" and "interruption of the canal's radiopaque white line" on CBCT ($P < 0.05$). the appearance of these signs on the OPG rose the chances of tooth to canal contact upto 83% Elkhateeb et al. (2018) (17). In some cases, the tooth to canal contact was 100% true positive when an OPG predicted

narrowing of the canal Elkhateeb et al. (2018) (17). Neurovascular involvement was not predicted successfully by signs of canal diversion, superimposition, and root deflection (Saha et al., 2019; Peker et al., 2014) (14) (16).

Exact limitations in prediction of spatial course and cortical integrity of inferior alveolar canal faced by OPG were corrected by CBCT. CBCT verified the high-risk cases of true anatomical contact 58.6% (Elkhateeb et al., 2018) (17) up to 76.6% (Dalili et al., 2011) (15). It also identified the lingual course a primary path for the third molar roots in 65.4% cases Peker et al. (2014) (16) and 83.7% in Dalili et al. (2011) (15), frequently presenting alongside severe lingual cortical thinning or physical bone perforation (Patel et al., 2020) (13). OPG was also significantly inadequate to identify multiple roots ($P < 0.05$) Peker et al. (2014) (14), further proving its superior clinical utility under advanced efficacy models (Patel et al., 2020) (13) as shown in table 2.

**Table 2: Data extraction of the included studies**

| Author (year) | Study Design | Sample Size (Teeth/Patients) | | Key Radiographic Findings | | Outcomes | Reference |
|---|---|---|---|---|---|---|---|
| | | Teeth | patients | OPG High-Risk Signs | OPG Low-Risk Signs | | |
| **Patel PS et al., (2020)** | Retrospective cross sectional | **200** | 120 | • Interruption of the white line,<br>• Darkening/deflection of the root,<br>• Narrowing/diversion of the canal,<br>• Winter's horizontal/distoangular positions, and<br>• Pell & Gregory classes 1B–3C significantly correlate with an **absence of IAN corticalization** on CBCT. | • No relation<br>• super imposition<br>• Winter's vertical/mesioangular positions, and<br>• Pell & Gregory Class 1A correlate with a **preserved cortical line**. | • **Diagnostic Accuracy:** OPG showed high **sensitivity (98.55%)** but low **specificity (48.39%)** for close IAN relationships<br>• **Anatomical Status:** CBCT revealed **lingual cortical thinning (n=72) and lingual perforation (n=72)** as the most common structural findings.<br>• **Efficacy:** CBCT demonstrated statistically superior diagnostic efficacy over OPG under the Fryback & Thornbury model. | (13) |

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| **Saha N et al. (2019)** | Prospective comparative diagnostic cohort | **30** | 30 | • **Isolated darkening of roots** (P = 0.001)<br>• **Combination with white line interruption** (P < 0.001) significantly correlate with an **absence of corticalization** on CBCT. | • Isolated white line interruption (P = 0.69),<br>• Deflection of roots, and<br>• Bifid root apex were poor individual predictors. | • **Diagnostic Accuracy:** OPG signs have **poor overall reliability** for predicting absolute tooth-to-canal involvement compared to CBCT.<br><br>• **Anatomical Status:** CBCT confirmed **only 13.3% (4/30)** of positive OPG screenings had a true **absence of corticalization**.<br><br>• **Specific Association Data:** All 4 non-corticalized cases presented with concurrent darkening and white line interruption on OPG (Raw data: TP=4, FP=5, FN=0, TN=21). | (14) |

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| **Dalili Z et al. (2011)** | Cross-sectional diagnostic | **43** | 29 | • **Deviation of the canal** and<br>• **Darkening of the roots**<br>• Shows a **100% contact rate** with the mandibular canal on CBCT. | Presence or absence of canal narrowing on OPG varied significantly from true CBCT narrowing (P = 0.01). Superimposition was highly frequent (67.4%) but a poor lone predictor. | • **Diagnostic Accuracy:** Canal deviation and root darkening are highly valuable predictors of absolute **canal proximity and root grooving**.<br><br>• **Anatomical Status:** CBCT confirmed true root-to-canal **contact in 76.6**% of cases. **Contact/thinning of the lingual cortex** was overwhelmingly predominant (**83.7**%).<br><br>• **Anatomical Course:** The **lingual course of the canal** was the most common path across all OPG indicators. | (15) |
| **Peker I et al., (2014)** | Retrospective diagnostic cohort | **298** | 191 | • **Darkening of the roots** and<br>• **Interruption of the white line** on OPG were significantly associated with true anatomical contact on CBCT (P < 0.05). | Diversion and narrowing of the canal did not show a statistically significant association with CBCT contact status (P > 0.05). | • **Diagnostic Accuracy:** When darkening of the roots and white line interruption are observed on OPG, there is a significantly **increased likelihood of direct contact** between the IMTM and | (16) |

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|---|---|---|---|---|---|---|---|
| | | | | | | the canal.<br><br>• **Anatomical Status:** CBCT confirmed true **contact in 71.5**% of the evaluated sample (213 out of 298 teeth). The canal was most frequently located on the **lingual side** of the tooth (65.4%).<br><br>• **Root Detection:** OPG was shown to be **inadequate for detecting multiple roots**, whereas CBCT accurately identified multi-rooted anatomy ($P < 0.05$) | |

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|---|---|---|---|---|---|---|---|
| **Elkhateeb SM et al., (2018)** | Retrospective diagnostic | **210** | **135** | • Interruption of the canal white line was the most frequent sign (60%).<br>• Isolated narrowing of the canal, darkening of root apices, and interruption paired with narrowing, diversion, or darkening significantly correlate with direct CBCT contact ($P < 0.001$). | • **Other Signs:** Isolated diversion of the canal was a poor predictor of direct contact on its own. | **Diagnostic Accuracy:** Isolated narrowing of the canal on OPG yielded a 100% true positive rate for contact on CBCT (Raw data: TP=12, FP=0). Combined signs drastically increased the rate of verified contact (up to 83% for interruption + narrowing).<br>• **Anatomical Status:** CBCT confirmed true tooth-to-canal contact in 58.6% of cases (123 out of 210 teeth).<br>• **Anatomical Course:** The canal followed a predominantly inferior path (48.6%), followed by a lingual course (27%). | (17) |

**DISCUSSION**

Panoramic views lack the cross-sectional resolution that are required for confirming nerve isolation(18). This is in line with the findings of our included study by Patel et al. (2020) which reports high sensitivity (98.55%) combined with exceptionally low specificity (48.39%)(13). This study reveals that while OPG shows nerve exposure which when viewed on 3D imaging reveals intact boundaries(13). Panoramic

radiographs are 2D, it misdiagnoses the nerve proximity owing to superimposition. Therefore, if clinician only assess the patient suing OPG pre-surgically, there is a chance over-diagnoses Saha et al. (2019) (14). Saha et al. (2019) reported that 13.3% of positive panoramic screenings in your dataset had a true absence of corticalization on CBCT(14). All the studies included in this systematic review considered the "darkening of the roots" and "interruption of the canal white line" as valuable and strong predictors of tracking nerve exposure. Darkening of the roots was considered one of the most sensitive predictors to tooth to canal contact by previous studies(19).

According to our studies, the lingual canal path was more prevalent (83.7% in Dalili et al. and 65.4% in Peker et al.) which in turn was more frequently associated with lingual cortical perforation(15, 16). These findings are very similar to the study by Wang et al., where deep mandibular impactions were prone to lingual side canal positioning making perforation highly likely by Wang et al(20). Their mapping confirms that deep mandibular impactions are heavily prone to severe lingual-side canal positioning, making absence of cortication a highly probable outcome(20).

When on CBCT sections, there Is significant loss of cortication and lingual course, the chances of neurosensory damage surgical extraction are very high. Leung and Cheung propose coronectomy as means to alleviate this risk and spare the nerve**.** Crown removal facilitates leaving the roots undisturbed and minimize the risk of injury to the nerve(20).

**Conclusion**

OPG owing to its high sensitivity can serve as a primary screening tool but due to its low specificity, it leads to many false positive results. CBCT provides vastly superior diagnostic accuracy in determining the proximity of the nerve to the third mandibular molar root, lingual canal pathway, multiple roots and true canal perforation.

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