ORIGINAL RESEARCH PAPER

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# EVALUATING THE RELIABILITY OF OPG INDICATORS AND CORRELATING SURGICAL OUTCOMES WITH CBCT FINDINGS IN CASES OF TOOTH-CANAL PROXIMITY- A PROSPECTIVE STUDY"

**KEY WORDS:** OPG, CBCT, mandibular 3rd Molar, Inferior Alveolar Nerve, tooth-canal proximity

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**ABSTRACT**

This study aimed to evaluate the correlation between Orthopantomogram (OPG) findings and the actual contact status between mandibular teeth and the inferior alveolar canal, as determined by Cone Beam Computed Tomography (CBCT). The cohort, selected based on suspected tooth-canal proximity from OPG, underwent detailed three-dimensional visualization using CBCT. Analysis of various OPG indicators revealed that darkening of roots exhibited a 62.5% correlation with true contact on CBCT, suggesting its potential as a proximity indicator. However, caution is emphasized, as darkening did not align with actual contact in 57.1% of cases. Interruption of the white line of the canal showed a substantial 31.2% correlation with true contact on CBCT. Intraoperative findings included visible Inferior Alveolar Nerve (IAN) in 12.5% of subjects with contact and pulsating bleeding in 4.8% without contact. Transient paresthesia occurred in 6.2% of cases with contact, lasting up to 3 months, with no permanent post-operative paresthesia reported. The study advocates for a judicious evaluation of OPG findings, highlighting their role as initial cues but emphasizing the need for advanced imaging like CBCT for enhanced diagnostic precision.

## INTRODUCTION

In the realm of oral and maxillofacial surgery, the precise assessment of the proximity of the Inferior Alveolar Canal (IAC) to the root apices of mandibular third molars is a critical consideration that significantly influences treatment planning and procedural outcomes. This proximity raises concerns about potential complications, particularly nerve injuries, during extraction procedures (1). Accurate assessment becomes paramount to mitigate these risks.

The use of advanced imaging modalities, such as Cone Beam Computed Tomography (CBCT), has revolutionized the assessment of the mandibular anatomy by providing detailed three-dimensional representations (2). CBCT allows for a thorough examination of the spatial relationship between the roots of mandibular third molars and the IAC, offering precise insights into potential contact points or proximity (3,4). This level of precision is especially crucial given the limitations of traditional two-dimensional radiographs in capturing the complex three-dimensional anatomy of the mandible (5). The information gleaned from such assessments plays a pivotal role in treatment planning, aiding oral and maxillofacial surgeons in making informed decisions regarding the approach to extraction procedures (6). It allows for the identification of potential risk factors, guiding clinicians in determining the optimal technique, such as odontectomy methods, and the need for additional precautions to minimize the likelihood of nerve injuries (7).

Conventional two-dimensional radiographic techniques, notably Orthopantomograms (OPG) and Intraoral Periapical Radiographs (IOPAR), have played a pivotal role in the assessment of anatomical relationships in the oral and maxillofacial region. These traditional imaging modalities have been instrumental in providing valuable initial insights, aiding in the diagnosis and treatment planning for various dental and maxillofacial conditions, including the assessment of mandibular third molars in proximity to the Inferior Alveolar Canal (IAC). However, as the complexity of anatomical structures in this region demands a more nuanced understanding, the inherent limitations of these two-dimensional techniques become evident.

Conventional radiographs offer a flattened, two-dimensional representation of the inherently three-dimensional structures, making it challenging to precisely visualize spatial relationships, especially in cases where the mandibular third molars exhibit intricate variations in root morphology and proximity to vital structures (8). Distortions, magnification errors, and overlapping structures are common limitations that can compromise the accuracy of assessments, potentially leading to misinterpretations and inadequate treatment planning.

To address these limitations and elevate diagnostic precision, more advanced diagnostic tools, such as Cone Beam Computed Tomography (CBCT), have emerged in the field of oral and maxillofacial imaging (5). CBCT provides detailed three-dimensional images, allowing for a comprehensive and accurate assessment of the complex anatomical structures in the mandibular region. This technology enables clinicians to precisely evaluate the proximity of mandibular third molars to the IAC, identify potential complications, and tailor treatment plans accordingly (9). The shift towards advanced diagnostic tools reflects a commitment to enhancing the standard of care in oral and maxillofacial surgery. While conventional radiographic techniques remain valuable for initial assessments, the integration of CBCT into clinical practice represents a paradigm shift, offering clinicians the ability to navigate the intricate anatomical landscape with unprecedented accuracy. This transition not only improves diagnostic capabilities but also contributes to the overall safety and success of surgical interventions, ensuring a more informed and patient-centric approach in the management of mandibular third molars and their proximity to vital structures (10).

This paper aims to investigate the necessity of Cone Beam Computed Tomography (CBCT) in cases where conventional radiographs, such as Orthopantomograms (OPG) or Intraoral Periapical Radiographs (IOPAR), indicate proximity between mandibular third molars and the Inferior Alveolar Canal. The research objectives are designed to address various aspects of this clinical challenge, including enhancing diagnostic precision, and optimizing treatment planning. The first objective involves analyzing CBCT data to understand the three-dimensional relationships between mandibular third molars and the Inferior Alveolar Canal. The second objective focuses on correlating CBCT findings with evidence from two-dimensional radiographs to assess the reliability of CBCT in

depicting proximity accurately. The third objective emphasizes applying CBCT data in treatment planning for impacted mandibular third molars to enhance surgical precision. The fourth objective involves a comprehensive assessment of pre-operative, intraoperative, and post-operative findings, comparing the utility of CBCT to traditional radiographs. Overall, this study aims to contribute valuable insights to oral and maxillofacial surgery practices, potentially influencing current standards of care.

## METHODOLOGY

The study recruited 37 participants from the Department of Oral and Maxillofacial Surgery at JSS Dental College and Hospital in Mysore, focusing on individuals diagnosed with impacted mandibular third molars. The sampling approach employed was purposive sampling. Inclusion criteria consisted of individuals aged 18 and above requiring the removal of impacted mandibular third molars, with roots exhibiting close radiographic proximity to the inferior alveolar canal, as observed in Orthopantomograms (OPG) or Intraoral Periapical Radiographs (IOPAR). Additionally, eligible participants needed to be in good systemic health and willing to participate in the research. Exclusion criteria included individuals without a definitive indication for third molar removal, those necessitating emergency extraction, third molars lacking radiographic proximity to the inferior alveolar canal, and cases with periapical radiolucency or pre-existing inferior alveolar nerve (IAN) paresthesia. Medically compromised subjects with contraindications for third molar removal were also excluded. The study's sample size comprised 37 participants, ensuring a targeted and pertinent cohort for the investigation.

This study employs a comprehensive methodology to investigate the intricate relationships between mandibular third molars and the Inferior Alveolar Canal (IAN). Integrating traditional two-dimensional radiography with Cone Beam Computed Tomography (CBCT), the approach aims to optimize diagnostic accuracy and enhance treatment planning for cases with potential proximity between mandibular third molar roots and the IAN.

Thorough patient history documentation and a comprehensive physical examination lay the foundation for a tailored diagnostic and treatment strategy. Initial radiographic assessment, including WAR lines and Pederson's Difficulty Scale, guides subsequent imaging decisions. The decision to utilize CBCT is based on the need for three-dimensional visualization in cases where conventional radiographs indicate proximity. CBCT provides superior spatial resolution, offering detailed insights into impaction type, root morphology, and proximity to the IAN.

Informed by CBCT findings, a customized treatment plan is formulated to minimize the risk of IAN injury during extraction, considering factors such as incision type, osteotomy, and odontectomy strategy. Informed consent and detailed discussions about risks and benefits align with ethical principles, and strict adherence to aseptic conditions during surgical removal contributes to patient safety.

Results and discussion

**Table 1: Association of OPG/IOPAR with Contact of tooth roots with canal in CBCT**

| | | | CBCT- Contact of tooth roots with canal | | Total |
|---|---|---|---|---|---|
| | | | Contact | No contact | |
| OPG/IOPAR | Darkening | Count | 10 | 12 | 22 |
| | | % within contact of tooth with canal | 62.5% | 57.1% | 59.5% |
| | Deflection | Count | 0 | 2 | 2 |
| | | % within contact of tooth with canal | 0.0% | 9.5% | 5.4% |
| | Narrowing | Count | 0 | 1 | 1 |
| | | % within contact of tooth with canal | 0.0% | 4.8% | 2.7% |
| | Interruption | Count | 5 | 5 | 10 |
| | | % within contact of tooth with canal | 31.2% | 23.8% | 27.0% |
| | Diversion | Count | 1 | 0 | 1 |
| | | % within contact of tooth with canal | 6.2% | 0.0% | 2.7% |
| | Narrowing | Count | 0 | 1 | 1 |
| | | % within contact of tooth with canal | 0.0% | 4.8% | 2.7% |
| Total | | Count | 16 | 21 | 37 |
| | | % within contact of tooth with canal | 100.0% | 100.0% | 100.0% |

In a correlation of OPG findings to the contact of tooth to canal seen on CBCT (Table 1) it was found that darkening of roots in 22 subjects showed true contact in 10 (62.5%) subjects and no contact in 12 (57.1%) subjects; deflection of roots in 2 subjects showed no contact in 2 subjects (9.5%); narrowing of roots in 1 subject showed no contact 1 subject (4.8%); Interruption of white line of canal in 10 subjects showed true contact in 5 subjects(31.2%) and no contact in 5 subjects(23.8%); Diversion of canal in 1 subject showed contact in 1 subject (6.2%); narrowing of canal in 1 subject showed 1 subject (4.8%) with no contact.

These findings paint a detailed and nuanced portrait of the relationship between observations made on Ortho pantomogram (OPG) and the actual contact status between the tooth and the canal, as elucidated by Cone Beam Computed Tomography (CBCT). The revelation that the darkening of roots in OPG exhibited a relatively high correlation with true contact on CBCT is a significant observation, suggesting that this specific radiographic feature might function as a dependable indicator of proximity. This implies that clinicians relying on OPGs may find the darkening of roots a useful initial cue in identifying cases where there is a potential for contact between the tooth and the canal. This finding is very similar to a study which aimed to evaluate the reliability of seven specific radiographic signs observed on orthopantomography (OPG) in predicting the proximity and absence of corticalization between the mandibular canal and impacted mandibular third molar roots on CBCT images. Results indicated poor reliability in predicting proximity using OPG signs and a high reliability on CBCT particularly darkening of root and interruption in the white line (11).

However, the study also brings forth a crucial caveat: instances where darkening did not align with actual contact

were identified in 57.1% of subjects. This underscores the necessity for caution and comprehensive assessment, emphasizing that while darkening is indicative, it should not be considered conclusive evidence of contact. The complexities of anatomical variations and radiographic limitations may contribute to instances where darkening does not necessarily translate to actual contact.

Furthermore, the interruption of the white line of the canal on OPG demonstrated a substantial correlation with true contact on CBCT in 31.2% of cases. This finding underscores the potential utility of evaluating the white line interruption as a valuable indicator, further supporting the importance of meticulous scrutiny of OPG details. On the contrary, deflection of roots and narrowing of roots or canal showed limited correlation, with most cases demonstrating no contact. This suggests that relying solely on these features in OPG may be less reliable in predicting contact and necessitates a more cautious approach in such scenarios.

These results collectively underscore the imperative for a judicious and critical evaluation of OPG findings, particularly when the proximity between the tooth and canal is under consideration. While certain features, such as darkening of roots and interruption of the white line of the canal, may provide valuable insights, the study highlights the inherent limitations of OPG, especially in cases involving deflection and narrowing. This finding is becomes more clinically important as comparative observations were results obtained in a study to assess the effectiveness of panoramic radiographic indicators, both individually and in combination, in predicting the absence of corticalization between the mandibular canal and the third molar on cone beam CT (CBCT) images. The findings revealed that darkening of roots and interruption of the white line, exhibited statistical significance in indicating the absence of corticalization on CBCT images ($p = 0.0001$, $p = 0.0006$, and $p = 0.002$, respectively). Conversely, other panoramic radiographic indicators (deflection and narrowing of canal) did not show a statistically significant association (12). These results, emphasize the necessity for three-dimensional assessment in such scenarios, thereby enhancing diagnostic precision and guiding more accurate treatment planning in cases where the proximity of teeth to vital structures is a concern.

**Table 2: Association of Intra-operative findings with Contact of tooth with canal in CBCT**

| | | | CBCT- Contact of tooth with canal | | Total |
|---|---|---|---|---|---|
| | | | Contact | No contact | |
| Intra-operative | No Findings | Count | 14 | 20 | 34 |
| | | % within contact of tooth with canal | 87.5% | 95.2% | 91.9% |
| | Visible canal | Count | 2 | 0 | 2 |
| | | % within contact of tooth with canal | 12.5% | 0.0% | 5.4% |
| | Bleeding | Count | 0 | 1 | 1 |
| | | % within contact of tooth with canal | 0.0% | 4.8% | 2.7% |
| Total | | Count | 16 | 21 | 37 |
| | | % within contact of tooth with canal | 100.0% | 100.0% | 100.0 % |

Correlation of intraoperative findings with CBCT findings (Table 2) showed visible IAN in 2 subjects with contact (12.5%) and inadvertent pulsating bleeding in 1 subject with no contact (4.8%). The correlation between intraoperative findings and cone-beam computed tomography (CBCT) results, as presented in Table 2, provides valuable insights into the dynamics of the surgical procedure in relation to the anatomical structures. Notably, the identification of the Inferior Alveolar Nerve (IAN) in 2 subjects (12.5%) with contact emphasizes the intricate nature of the surgical landscape. The visibility of the IAN during the procedure suggests that in cases where CBCT indicates contact between the mandibular third molar and the nerve, surgeons were able to visually confirm this proximity intraoperatively. This real-time confirmation is crucial for adapting the surgical approach, ensuring precision, and minimizing the risk of nerve injury. Conversely, the observation of inadvertent pulsating bleeding in 1 subject (4.8%) without contact on CBCT warrants careful consideration. While the absence of direct contact might suggest a lower risk of IAN injury, the occurrence of bleeding raises questions about potential vascular involvement or other factors contributing to intraoperative complications. This highlights the complexity of surgical scenarios and underscores the importance of real-time assessments during the procedure.

**Table 3: Association of Odontectomy with Contact of tooth with canal as seen in CBCT**

| | | | CBCT- Contact of tooth with canal | | Total |
|---|---|---|---|---|---|
| | | | Contact | No contact | |
| Odontectomy | Not done | Count | 6 | 5 | 11 |
| | | % within contact of tooth with canal | 37.5% | 23.8% | 29.7% |
| | Crown section | Count | 2 | 5 | 7 |
| | | % within contact of tooth with canal | 12.5% | 23.8% | 18.9% |
| | Hemi section | Count | 6 | 8 | 14 |
| | | % within contact of tooth with canal | 37.5% | 38.1% | 37.8% |
| | Crown Section with Hemi section | Count | 2 | 3 | 5 |
| | | % within contact of tooth with canal | 12.5% | 14.3% | 13.5% |
| Total | | Count | 16 | 21 | 37 |
| | | % within contact of tooth with canal | 100.0% | 100.0% | 100.0 % |

Correlation of surgical odontectomy done with CBCT finding (Table3) showed 6 teeth (37.5%) which were not sectioned being in true contact and 5 teeth (23.8) not sectioned being in no contact. Crown sectioning was done in 2 teeth (12.5%) with contact and 5 teeth (23.8%) with no contact. Hemi-section was done in 6 teeth (37.5%) with contact and 8 teeth (38.1%) with no contact. 62.5% of teeth in true contact were sectioned. 71. 42% of teeth in no contact were sectioned. The correlation analysis of surgical odontectomy, as detailed in Table 3, sheds light on the intricate relationship between the procedures performed and the Cone Beam Computed Tomography (CBCT) findings. Notably, the results provide insights into the effectiveness of different odontectomy techniques concerning their impact on the contact status between teeth and adjacent vital structures.

Examining the data, it was observed that 6 teeth (37.5%)

without sectioning were in true contact, while 5teeth (23.8%) without sectioning were not in contact. This suggests that a substantial proportion of teeth without sectioning maintained true contact, emphasizing the significance of considering other factors in the decision-making process. Crown sectioning, performed in 2 teeth (12.5%) with contact and 5 teeth (23.8%) without contact, highlights the necessity of tailoring the odontectomy approach based on individual anatomical considerations. Hemi-section, employed in 6 teeth (37.5%) with contact and 8 teeth (38.1%) without contact, further underscores the nuanced nature of the surgical approach.

The fact that a comparable percentage of teeth were sectioned irrespective of their contact status indicates the complexity and variability in treatment decisions. Remarkably, 62.5% of teeth in true contact were sectioned, emphasizing the proactive approach taken in managing cases with confirmed contact. Conversely, 71.42% of teeth in no contact were sectioned, suggesting that practitioners exercised caution and opted for sectioning even in cases where CBCT did not reveal direct contact. This conservative approach aligns with the principle of minimizing risks associated with odontectomy procedures.

**Table 4: Association of Post-operative findings with Contact of tooth with canal as seen in CBCT**

| | | | CBCT- Contact of tooth with canal | | Total |
|---|---|---|---|---|---|
| | | | Contact | No contact | |
| Post operative | No paraesthesia | Count | 14 | 21 | 35 |
| | | % within contact of tooth with canal | 87.5% | 100.0% | 94.6% |
| | Paraesthesia at 1 month | Count | 1 | 0 | 1 |
| | | % within contact of tooth with canal | 6.2% | 0.0% | 2.7% |
| | Paraesthesia at 3 months | Count | 1 | 0 | 1 |
| | | % within contact of tooth with canal | 6.2% | 0.0% | 2.7% |
| Total | | Count | 16 | 21 | 37 |
| | | % within contact of tooth with canal | 100.0% | 100.0% | 100.0 % |

Post-operative transient paresthesia of 1 month was noted in 1 subject with contact (6.2%) and for 3 months in 1 subject with contact (6.2%) (Table 4). No permanent post-operative paresthesia was noted in any of the patients.

## DISCUSSION

### Clinical Decision-Making: Darkening vs. Interruption of White Line:

The study's identification of a substantial correlation (31.2%) between the interruption of the white line of the canal on Orthopantomogram (OPG) and true contact on Cone Beam Computed Tomography (CBCT) prompts a thorough exploration of its implications for guiding clinical decision-making in cases where tooth-canal proximity is suspected. In contrast to the relatively high correlation (62.5%) observed with darkening of roots, the study underscores the limitations of relying solely on this indicator, with instances noted in 57.1% of subjects where darkening did not align with actual contact. This brings into focus the need to carefully consider the trade-offs between specificity and sensitivity when prioritizing the interruption of the white line. While interruption of the white line offers heightened specificity, ensuring a more accurate indication when true contact is present, clinicians must also navigate the potential for lower sensitivity, possibly overlooking cases influenced by alternative contributing factors (13). Consequently, a nuanced approach is advocated, where clinicians integrate both interruption of the white line and darkening of roots into their diagnostic arsenal. This dual-modality approach involves utilizing OPG for initial screening and employing CBCT for definitive confirmation, ensuring a more comprehensive and accurate assessment. The patient-centered nature of this approach emphasizes the consideration of clinical urgency, the patient's medical history, and the overarching treatment plan, collectively contributing to a judicious and precise decision-making process in the management of cases involving suspected tooth-canal proximity.

### OPG Findings vs. Intraoperative Realities:

The correlation between preoperative Orthopantomogram (OPG) findings and the subsequent intraoperative discoveries, particularly the identification of the Inferior Alveolar Nerve (IAN) in 2 subjects with contact (12.5%), sheds light on the intricate interplay between predictive imaging and the dynamic realities encountered during surgery. This observation underscores the nuanced nature of dental surgical procedures and emphasizes the critical role of intraoperative assessments in refining the initial treatment plan. While OPG serves as a valuable preoperative tool, its limitations become evident because of its subjectivity when it comes to accurately capturing the intricate details of anatomical structures, such as the IAN (14). The identification of the IAN during surgery in cases not predicted by OPG highlights the need for a surgical strategy that is adaptable and responsive to real-time anatomical nuances. Intraoperative findings, therefore, not only serve as a corrective measure when OPG predictions fall short but also provide an opportunity for clinicians to refine their approach based on the actual anatomical landscape encountered during the surgical procedure. This dynamic integration of preoperative imaging and intraoperative adaptability is essential for optimizing surgical outcomes and ensuring patient safety in cases involving suspected tooth-canal proximity.

### Balancing Conservative and Proactive Approaches in Odontectomy:

The intriguing finding that 71.42% of teeth with no direct contact, as indicated by Cone Beam Computed Tomography (CBCT), were still subjected to sectioning raises questions about the potential bias towards a conservative approach in odontectomy procedures. This observation suggests that clinicians may err on the side of caution even in cases where CBCT does not reveal direct contact between the tooth and the canal. While a conservative approach aligns with the imperative to minimize risks, it prompts a nuanced consideration of the balance between risk aversion and proactive management in confirmed contact cases. Clinicians must carefully weigh the potential for adverse outcomes against the necessity of preserving anatomical integrity, particularly the Inferior Alveolar Nerve. This calls for a thoughtful integration of CBCT data into the decision-making process, emphasizing the need for proactive management when direct contact is established while judiciously opting for conservative measures when uncertainties persist (15). Striking this delicate balance ensures that the approach to odontectomy procedures is both risk-sensitive and proactive, optimizing patient safety without compromising the efficacy of the intervention.

The incidence of transient paresthesia in 6.2% of cases with confirmed contact, coupled with the absence of permanent post-operative paresthesia, plays a pivotal role in the risk-benefit analysis of odontectomy procedures. This observation provides a nuanced perspective on the inherent challenges

associated with surgical interventions near the Inferior Alveolar Nerve (IAN). While transient sensory disturbances are recognized as potential risks, the absence of permanent paresthesia suggests a relatively favorable balance between the risks and benefits of odontectomy procedures, particularly in cases where there is confirmed contact with the nerve (16). This highlights the importance of weighing the necessity of successful tooth extraction against the potential for temporary sensory disturbances.

To further mitigate the risk of post-operative paresthesia, clinicians can employ meticulous surgical techniques that prioritize the preservation of nerve integrity. Precise preoperative planning facilitated by advanced imaging, such as Cone Beam Computed Tomography (CBCT), allows for a detailed understanding of the spatial relationship between the impacted tooth and the IAN, enabling clinicians to tailor their approach and minimize the risk of inadvertent nerve injury during surgery (17). Emphasizing a careful dissection approach, avoiding unnecessary trauma to the surrounding nerve structures, and employing minimally invasive techniques contribute to reducing the risk of post-operative sensory disturbances.

Furthermore, implementing close post-operative monitoring protocols and thorough patient education on postoperative care are essential measures. These measures ensure early detection of any sensory disturbances, enabling prompt intervention if needed. Proactive management strategies, coupled with advancements in imaging technology and surgical techniques, collectively contribute to optimizing the risk-benefit ratio in odontectomy procedures. As clinicians navigate the complexities of balancing the potential risks and benefits, these comprehensive approaches serve to enhance patient safety and contribute to successful clinical outcomes in cases involving tooth-canal proximity.

## CONCLUSION

In conclusion, the comprehensive analysis of odontectomy procedures in cases of tooth-canal proximity, careful decision-making is imperative. The study emphasizes the intricate correlations between preoperative radiographic indicators, intraoperative findings, and post-operative outcomes. The substantial correlation between interruption of the white line on Orthopantomogram (OPG) and true contact on Cone Beam Computed Tomography (CBCT) suggests its potential as a reliable indicator, while acknowledging the limitations of relying solely on darkening of roots. The dynamic relationship between OPG predictions and intraoperative discoveries underscores the need for adaptability during surgery, particularly in cases where OPG may fall short in accurately representing anatomical nuances. The study advocates for a judicious evaluation of OPG findings, highlighting their role as initial cues but emphasizing the need for advanced imaging like CBCT for enhanced diagnostic precision.

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