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Original Research Article

Comparison of Dental Panoramic Tomography (DPT) and CBCT for Assessment of Anatomic Relationship Between Mandibular Impacted Third Molars and Inferior Alveolar Nerve

Momina Ghani*, Zubair Durrani

Department of Oral and Maxillofacial Surgery, Rehman College of Dentistry (RCD), Rehman Medical Institute (RMI), Peshawar, Pakistan
**Corresponding author`s email address:* momina.ghani95@gmail.com

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Abstract: *The inferior alveolar nerve (IAN) injury is one of the common complications of surgical extraction of impacted mandibular third molars. The third molar and IAN are very important to be evaluated on proper imaging to evaluate their relation with anatomical distribution.* ***Objective:*** *To determine the diagnostic accuracy of Dental Panoramic Tomography (DPT) in assessing proximity between impacted mandibular third molars and the IAN, using Cone Beam Computed Tomography (CBCT) as the gold standard.* ***Methods:*** *The cross-sectional study was carried out between November 2024 and April 2025 at Rehman College of Dentistry. The 107 patients aged between 20 and 35 years old had both DPT and CBCT imaging. Radiographic findings on DPT were compared to CBCT to obtain the sensitivity, specificity, and overall accuracy.* ***Results:*** *DPT ranged from 75.3 percent sensitivity, 64.7 percent specificity, and 71.9 percent diagnostic accuracy. CBCT was better at detecting the location of nerves, in particular lingual canal positioning.* ***Conclusion:*** *CBCT provides remarkably better visualization of anatomy as compared to DPT and must be considered in high-risk scenarios.*

Keywords: Impacted third molar, inferior alveolar nerve, panoramic radiography, CBCT, diagnostic accuracy

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Introduction

The surgical procedure involved in the removal of the impacted mandibular third molars is not uncommon in the oral and maxillofacial surgery practice. Still, there is a high risk of damaging the inferior alveolar nerve (IAN), causing temporary or permanent sensory or sensory loss, i.e., paresthesia, dysesthesia, anesthesia of the lower lip, chin, and teeth (1). The spatial positioning of the third molar and the IAN should be determined by accurate preoperative imaging to reduce the chances of nerve damage. Panoramic radiography, also known as dental panoramic tomography (DPT), is commonly used due to its cost-effectiveness and comparatively low radiation dose. However, its use is frequently questioned because of inaccurate identification of buccolingual relationships and proximity to the mandibular canal (2). The three dimensional imaging device such as Cone Beam Computed Tomography (CBCT) has proven to be a possible superior alternative but can give detailed spatial information with regards to where the impacted tooth is located in relationship to the IAN (3).

Although convenient and widely used, DPT has a significant limitation in accurately representing complex anatomical relationships, and this has led clinicians and researchers to consider the use of CBCT to increase diagnostic precision. Apaydin et al. highlighted the drawbacks of conventional imaging in terms of the three-dimensional orientation of impacted third molars along with surrounding mentioned structures, and it suggested more accurate imaging in case the proximity of nerves is a cause of concern (1). In a similar vein, Issrani et al. compared digital orthopantomograms (OPGs) and cone-beam computed tomography (CBCT) in identifying risk indicators of IAN injury, emphasizing the profound differences between the two approaches (2). The CBCT proved to provide superior differentiation of such anatomic landmarks as canal diversion, darkening of roots, and bifid apex, which can be indicative of near contact with the IAN (2,3).

Several pilot studies indicated that panoramic signs - discontinuing of the white line of the mandibular canal, darkening or deflection of the third molar roots are unreliable evidence of the actual contact of the nerve, in particular with the application of the CBCT (3,4). Joshi et al. established significant variability in the comparison of DPT and CBCT in determining the distance to the mandibular canal, indicating that high-resolution three-dimensional imaging is necessary to accurately determine the extent of surgical risk (3). Verma et al. shared these sentiments and reported that panoramic radiographs are likely to underestimate the risk when the nerve is in a buccal or lingual direction to the third molar, which DPT cannot sufficiently depict (4). Furtherness, Öztürk et al. demonstrated that the diagnostic accuracy of DPT may even be hindered by the anatomical variety and intricacy of the mandibular canal, especially in individuals with thick cortical bones or harboring overlapping components (5).

Impaction angulation, root morphology, and bone density have been found to have a significant influence on the risk of incurring IAN injury and the confidence of radiographic interpretation, as noted in recent studies. According to Vasegh et al., more severe and profound impactions, particularly mesioangular or horizontal impactions, are likely to be closer to the inferior alveolar nerve (IAN), and CBCT is the only imaging software that defines this relationship most clearly (6). Yang et al. demonstrated how CBCT can be used to classify third molars according to their three-dimensional position in relation to the nerve canal, which enables more confident diagnosis and informs surgical planning (7). Also, Jesudas et al. in their retrospective analysis of 120 cases, reported that CBCT could better follow the path of the IAN to predict and treat the risks of nerve injury during the intraoperative period (8).

Another essential consideration is anatomical variation. Vranckx et al. explored the clinical significance of bifid canals and uncommon paths of the mandibular canal, examining how they may predispose patients to nerve damage. They noted that these features are typically undetected on panoramic imaging but are visible on CBCT (9). Similar findings were reported by Mousa et al., who also highlighted the CBCT advantage as improved detection combined with precise localization of the nerve in all planes, allowing the surgical procedure to be conducted with reduced patient risk (10). Rai et al. attempted to compare the sensitivity and

specificity of DPT and CBCT. They found that DPT is not sensitive and specific enough to be used as a single diagnostic modality in situations when there is a high risk of injury (11). This difference was proven by Naeem et al., who recommended CBCT to be applied, especially when DPT results are inconclusive or if there are signs of high risks (12).

Moreover, Mehanny et al. compared panoramic radiograph markers to those obtained in CBCT and added that DPT could only indicate the possibility of risk. In contrast, the precise location and distance between the root and the IAN could only be verified through the use of CBCT (13). Sehgal et al. confirmed these findings on a clinical basis and suggested adding CBCT as a supplementary option for further assessment, particularly in cases where preoperative risk stratification is needed (14). Kim et al. studied a fraction of the Korean population's anatomical risk factors and again enforced the need for a personalized risk assessment as CBCT was the key finding regarding the position of lingual or buccal canals not detectable on DPT (15).

A radiographic comparison by Mohammadpour et al. resulted in significant between-group differences between CBCT and panoramic radiography in assessing nerve proximity. Thus, they concluded that it might be possible to underestimate the risk of nerve injury by relying on DPT alone (16). A retrospective study with similar findings by Ogbozor et al. indicated that significant proportions of adverse postoperative nerve injuries reported could have been foreseeable with the use of CBCT as an imaging modality (17). Likewise, Remulla et al. managed to illustrate that periapical radiographs and DPT might imply the potential contact with the third molar and IAN but only occurred in CBCT when they showed conclusive evidence of closeness, which supports its status as a gold standard in high-risk cases (18).

This area is also receiving the input of emerging technologies. Beck et al. compared CBCT and MRI in the mapping of the IAN and found that, although MRI has better features, CBCT has the advantages of being more viable due to its higher resolution and accessibility (19). Choi et al. used artificial intelligence to assess the work of improving DPT interpretation, concluding that AI drove more consistency but admit that these improvements remain inferior in clarity to what is provided by CBCT (20). Thus, although panoramic radiography remains a first-line imaging technique due to its accessibility and affordability, CBCT emerges as the recommended or even better option in cases where proper risk evaluation of IAN invasion is imperative.

Objective: To determine the diagnostic accuracy of dental panoramic tomography (DPT) in assessing the proximity of the inferior alveolar nerve to impacted mandibular third molars, using CBCT as the gold standard.

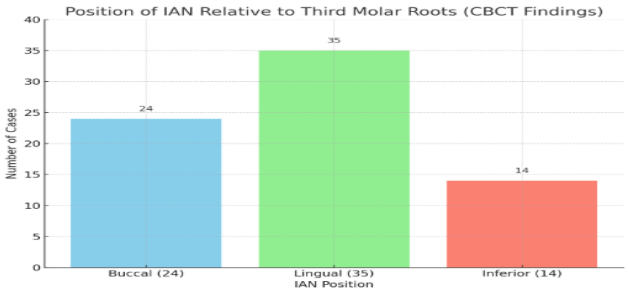
Methodology

Cross-sectional Validative Study. The research was carried out in Rehman college of Dentistry, Peshawar. The study duration spanned six months, from November 2024 to April 2025. It involved patients between 20 and 35 years old who had to be surgically removed due to impacted mandibular third molars. Men as well as women, were chosen as patients. Any form of impaction, based on winter classification (mesioangular, horizontal, vertical, and distoangular), was taken into consideration. The examination was of right- and left-sided impactions, single- and multiple-rooted molars, and patients only with an informed consent to participation. Those patients that were missing mandibular molars had distal caries in second molars and affected third molar positions, had genetic disorders (e.g., neurofibromatosis), tumors involving the IAN, or had mandibular fractures that affected the nerve or had rare anatomical variations like a bifid IAN canal were excluded. All the qualifying patients who approached the Oral and Maxillofacial Surgery Department of Rehman College of Dentistry within the duration of the study were considered using Dental Panoramic Tomography (DPT) and the Cone Beam Computed Tomography (CBCT). Patients were entered into this study after completing a data collection form, which was filled out upon seeking ethical approval and obtaining informed consent. The form included patient demographics, impaction classification, and radiographic findings. On DPT, the interruption of the white line of the IAN canal, darkening and deflection, the narrowing of the roots, diversion of the canal, and the presence of a bifid apex were evaluated. They carried out CBCT scans in every patient to define the actual anatomical positioning of the impacted third molars and the IAN, which revealed the closeness of the nerve in buccal, lingual, inferior, program follows, or distal planes. A gold standard was the CBCT findings. Statistical analysis was done to determine sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy of DPT in relation to CBCT.

Results

The study was carried out on 107 patients aged 20-35 years. The average age of participants constituted 27.4 +/- 3.6 years. Out of this, 58 (54.2%) were men and 49 (45.8%) women. The most affected 3rd molar type included mesioangular, vertical, distangular, horizontal categories.

The most frequently observed radiographic signs on Dental Panoramic Tomography (DPT) of the close relationship between third molar roots with the inferior alveolar nerve (IAN) were the interruption of the white line (witnessed in 61 cases), darkening of roots (49 cases), and deflection of the canal (33 cases). The root deflection and narrowing were not so frequent. The results of the CBCT investigation showed that 73 patients (68.2%) had direct contacts or proximity (within 1 mm) of the roots of the third molar to the IAN. Of these, 35 belonged to lingual positioning of the IAN in relation to molar root, 24 were buccal, and 14 were inferior. DPT could not detect 18 cases subsequently, and proven to be contacted with IAN on CBCT, which is false negative.Based on these values, the diagnostic accuracy metrics of DPT compared to CBCT were calculated: Sensitivity = 75.3% Specificity = 64.7% Positive Predictive Value (PPV) = 82.1% Negative Predictive Value (NPV) = 55.0% Overall Accuracy = 71.9%. The analysis of gender revealed no difference in the accuracy of the diagnosis between males and females. Nevertheless, stratified by age, there was a slight increase in the rate of false negatives among those who were older than 30 years, which may be attributed to greater bone or root density that interfered with DPT interpretation. The arrangement of IAN positioning (buccal, lingual, inferior) relative to third molars to depict the way of spatial anatomy and influence on detecting it diagnostically was also visualized. The false negatives on DPT most often were related to lingual placement. Finally, the research demonstrated that although DPT has moderate levels of sensitivity and a satisfactory positive predictive value (PPV), it is insufficiently specific and has a negative predictive value (NPV) that limits its use in cases of high-risk. CBCT superior anatomical imaging was observed, particularly when the IAN was either lingual or run close enough to the roots. These findings support the importance of the selective use of CBCT on judicially selected patients where, especially when the DPT results are equivocal, or radiographic high-risk features are noted.



Graph 1: Position of IAN Relative to Third Molar Roots (CBCT Findings)

(Bar chart with X-axis: Position — Buccal, Lingual, Inferior; Y-axis: Number of Cases).

Table 1: Distribution of Patients According to Molar Impaction Type

Impaction Type	Frequency (n)	Percentage (%)
Mesioangular	42	39.3
Vertical	27	25.2
Distoangular	22	20.6
Horizontal	16	15.0
Total	107	100

Table 2: Frequency of DPT Radiographic Risk Indicators

Radiographic Sign	Frequency (n)	Percentage (%)
Interruption of white line	61	57.0
Darkening of root	49	45.8
Diversion of canal	33	30.8
Deflection of root	21	19.6
Narrowing of canal/root	17	15.9
Bifid apex	11	10.3

Table 3: Comparison between DPT and CBCT Findings

	CBCT Positive	CBCT Negative	Total
DPT Positive	55 (TP)	12 (FP)	67
DPT Negative	18 (FN)	22 (TN)	40
Total	73	34	107

Table 4: Diagnostic Accuracy of DPT against CBCT

Metric	Value (%)
Sensitivity	75.3
Specificity	64.7
Positive Predictive Value	82.1
Negative Predictive Value	55.0
Overall Accuracy	71.9

Discussion

It is essential to determine accurately the anatomical relation of the impacted mandibular third molars and the inferior alveolar nerve (IAN) to reduce the possibility of nerve injuries in case of surgical extraction efforts. In comparison to this, this study was conducted to evaluate the diagnostic capability of Dental Panoramic Tomography (DPT) vs Cone Beam Computed Tomography (CBCT). The findings indicated that CBCT had a significantly higher diagnostic value than DPT in detecting the actual closeness between the molar root and the IAN, a finding also reported in other literature (1,2). The findings revealed that DPT demonstrated a sensitivity of 75.3% and a specificity of 64.7%, where true positives could be detected with a high degree of accuracy but failed to exclude the non-existence of non-contact cases, resulting in a relatively high false-negative rate. Such results are similar to the study of Issrani et al. which concluded that DPT could not identify all high-risk cases with precision and that it was not to be used as a sole source of determining risk level (2).

Similarly, Joshi et al. demonstrated that DPT overlooked vital anatomy in areas where the IAN ran lingually or towards the inferior aspects of the roots, which is most easily visualized on cross-sectional imaging (3). The most frequent manifestation that was identified in this study regarding the proximity of IAN was an interruption of the white line of the mandibular canal on DPT, with the root darkening and canal diversion coming next. Such radiographic signs have been extensively mentioned as potential risk factors in previous reports (4,5). In addition to the inaccuracy of such signs in predicting direct nerve contact, which was discussed above, Öztürk et al. also pointed out that although signs are useful, they are inaccurate in some cases (5).

CBCT was an exception, though, which made it relatively easy to classify the position of the nerve to the tooth (buccal, lingual, inferior, mesial, or distal) since it offered detailed 3D visualization of the molar root and IAN relationship. This accuracy is particularly relevant in instances of intricate impactions, including mesioangular or horizontal impactions, which were encountered most often in the study. Vasegh et al. highlighted the importance of CBCT in displaying these orientations and the associated risks, which can be identified faster and more accurately compared to DPT (6). Additionally, Yang et al. have demonstrated that with the help of CBCT, the proximity of the nerve can be classified into different zones, which has a profound impact on surgical planning and approach (7). The false negative rate of DPT (18 cases in this study) is of particular concern. These were the incidences when DPT could not determine the presence of nerve proximity, which was subsequently identified on CBCT. This is an essential clinical observation as it states that failure to use DPT alone might lead to underestimation of surgery risk, and nerve roving injury may occur.

Jesudas et al. also reached the same conclusion the fact that CBCT was essential when the proper course of nerve can only be achieved when pre-operative outcomes of panoramic images were found to be ambiguous (8). Vranckx et al. supplemented that anatomical anomalies, such as bifid canals or irregular pathways of the IAN, were often unnoticeable on DPT, which supported the high sensitivity of CBCT (9). The results of IAN positioning also demonstrated the inadequacy of DPT. Both Mousa et al. and Rai et al. revealed that DPT tends to ignore lingual nerve routes, so CBCT is of vital importance in such cases (10,11). Lingual position in our study was linked with most false negatives with DPT, stressing the importance of CBCT particularly in cases where lingual positioning is suspected.

The sensitivity and specificity of DPT were found to be similar in our study to those reported by Naeem et al., which were approximately 70 percent, suggesting the use of CBCT in situations of diagnostic confusion or extreme surgical risk (12). Mehanny et al. also emphasized that cross-checking DPT results using CBCT is crucial for establishing the right risk profile of every patient (13). A study by Sehgal et al. noted that the presence of clinical assessment alongside CBCT results in a significant reduction in the occurrence of postoperative complications compared to the use of DPT alone (14). Our results support the notion that DPT is an efficient initial option due to its affordability, low radiation dose, and widespread availability. The idea promoted by Kim et al., was that DPT could be initially employed. However, CBCT should be implemented when there are indicators to a relevant involvement of IAN (15).

Mohammadpour et al. came to the same conclusion that panoramic imaging seems to be insufficiently resolved and depth-wise to serve as a sole surgical planning diagnostic tool in similar instances (16). The amount of radiation exposure to CBCT is also a problem. Nevertheless, since the potential morbidity associated with nerve injury is weighed against the potential benefit of detailed imaging, detailed imaging is often justified in high-risk situations. According to Ogbozor et al., many cases of postoperative IAN injuries might have been avoided if a proper CBCT assessment had developed before the surgery (17). Moreover, Remulla et al. emphasized that CBCT was utilized to determine nerve proximity and prevent surgical mishaps in situations where false confidence was provided by DPT (18). Advancements also aid the importance of three-dimensional imaging in imaging and diagnostic technology. Beck et al. also investigated the possibilities of the MRI, however, admitted of limited accessibility and affordability, and CBCT remained the most reasonable option in the majority of dental environments (19). In the meantime, artificial intelligence on panoramic radiographs, the topic of study by Choi et al., demonstrated an approach to achieving improved accuracy regarding diagnosis, but not as capable as that applied to CBCT due to the lack of such spatial performance (20).

Conclusion

This research paper also shows the deficiency of Dental Panoramic Tomography (DPT) that does not assess reliably the anatomical relationship of impacted mandibular third molars to the nerve called inferior alveolar nerve (IAN). Though DPT is still among the most affordable and available imaging protocols, it lacks sufficient diagnostic power to detect the state of lingual or inferior nerve positioning in case of the high risk category. Conversely, Cone Beam Computed Tomography (CBCT) proved to have better sensitivity, specificity and overall accuracy due to three dimensional visualization of root-nerve proximity. The research endorses the employment of CBCT as an added measure alongside DPT in occasions of inconclusive panoramic impression or when the danger of surgery is suspected. Use of CBCT during preoperative planning in carefully chosen patients can greatly diminish chances of nerve damage, direct proper surgical pathways and enhance better outcomes of patients. Nonetheless, it should be used moderately after weighing it against radiation and cost. Hence, the role of case-based assessment cannot be disregarded in defining the need to use advanced imaging.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

MG

Manuscript drafting, Study Design,
Review of Literature, Data entry, Data analysis, and drafting article.

ZD

Conception of Study, Development of Research Methodology Design, Study Design, manuscript review, critical input.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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