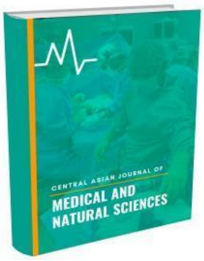

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Article

The Diagnostic Accuracy of 3D Imaging in Identifying Impacted Third Molars and Their Proximity to the Inferior Alveolar Nerve: A Retrospective Study of Radiographic Features

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Abstract: Damage to the inferior alveolar nerve during the extraction of the third molar of the mandibular teeth can lead to an irreversible loss of sensation in up to 7.8%. The two-dimensional nature of panoramic radiography undermines the ability to assess the relationship between nerves and the tooth, whereas the use of CBCT as the routine modality is controversial and is affected by cost demands. To compare the accuracy of CBCT with that of panoramic radiography in the detection of the proximity between mandibular third molars and the inferior alveolar nerve by utilizing findings of surgical intervention as the standard of reference. Retrospective analysis of 320 patients undergoing impacted mandibular third molar extraction. Both imaging modalities were evaluated using standardized criteria with intraoperative findings as gold standard. Diagnostic performance, predictive modeling, and cost-effectiveness were analyzed. CBCT has demonstrated a better diagnostic performance (AUC 0.922) than in the case of panoramic radiography (AUC 0.679). Sensitivity and specificity of direct contact visualization were 88.1 and 91.7% respectively. Panoramic signs showed great false-positive result-mere 45.9% surgical verification of root darkening. The most significant predictor of nerve exposure was an in-direct contact with CBCT (OR: 67.3). There was permanent neurological deficit of 1.9 as opposed to 3.2-7.8 in other studies. The optimal value received on CBCT use was selective where it prevented 58% of complications with a requirement of imaging in 44.7% of the cases. The diagnostic accuracy of nerve-tooth proximity is far superior using CBCT. The new selective CBCT protocols in form of panoramic risk indicators can markedly enhance patient outcomes without compromising affordability, making it possible to support the implementation of the method in the following high-risk cases based on evidence.

Keywords: Cone-Beam Computed Tomography, Mandibular Third Molar, Inferior Alveolar Nerve, Diagnostic Accuracy, Panoramic Radiography

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1. Introduction

One of the most frequently undertaken surgeries in oral and maxillofacial surgery deals with the surgical removal of impacted mandibular third molars (MTM)s [1]. With its routine character, it is still a condition that is frequently accompanied by serious afteroperative complications, among which injury to the inferior alveolar nerve (IAN) is the most serious and potentially irreversible adverse effect [2]. Damage to IAN could cause loss of sensation, paresthesia, or even dysesthesia to the lower lip and chin area, which has major medicolegal and quality of life ramifications [3]. Therefore, to reduce such risks, an accurate preoperative analysis of the third molar morphological association with the canal protecting the IAN (mandibular canal) is paramount [4].

Conventional two-dimensional radiography, Panoramic radiography (orthopantomogram): The bread and butter of any preoperative radiographic evaluation has long been conventional two-dimensional imaging, in the form of panoramic radiography (orthopantomogram) [5]. Nonetheless, intrinsic failings of panoramic radiographs, such as exaggeration error, distortion, overrunning of anatomical structures, and the absence of buccolingual details, may affect diagnostic accuracy, particularly in high-risk situations where the applicability of the proximity of the tooth to the nerve is suspected [6].

The invention of cone-beam computed tomography (CBCT) has transformed the area of maxillofacial imaging to render high-resolution, three-dimensional tomographic images of the craniofacial anatomy with a reduced radiation dose compared to conventional CT [7]. Subsequently, CBCT provides a reliable way to identify important root structures, including root morphology, canal disruption, thinning of the cortical plate, and direct contact of the IAN and third molar roots, providing a means of risk stratification and better surgical planning [8]. One or more radiographic indicators noted on panoramic radiographs, including root darkening, canal white line interruption, deflection of the root, and root/canal narrowing, were found to be more likely to indicate root proximity to the nerve, though such indicators are not predictive of proximity when cross-sectional radiography is not used [9].

Modern proves tend to agree that CBCT surpasses the use of panoramic radiography when evaluating the true spatial relationship between the impacted tooth and the IAN [10]. Specifically, research has demonstrated that CBCT is more sensitive and specific when used to detect direct contact, cortical plate perforation, and the displacement of the canal, specifically with horizontally and mesioangular impacted third molars [11]. Nonetheless, regular utilization of CBCT is an under debate issue bearing in mind the issues of cost, radiation exposure, and accessibility [12]. With this in mind, it is necessary to determine clear diagnostic signs and evidence-based reasons to use CBCT in contemporary clinical practice [13].

In the background, the current retrospective study intends to appraise cardinally the diagnostic precision of 3D CBCT imaging in the provision of impacted third molars of the mandible and their closeness to the inferior alveolar nerve, where intraoperative findings are taken as reference. Moreover, this research examines the role of definite radiographic markings in panoramic images as the predictor of intervention outcomes and their relationship to CBCT and surgery outcomes, thus helping to improve preoperative risk analysis procedures [14], [15].

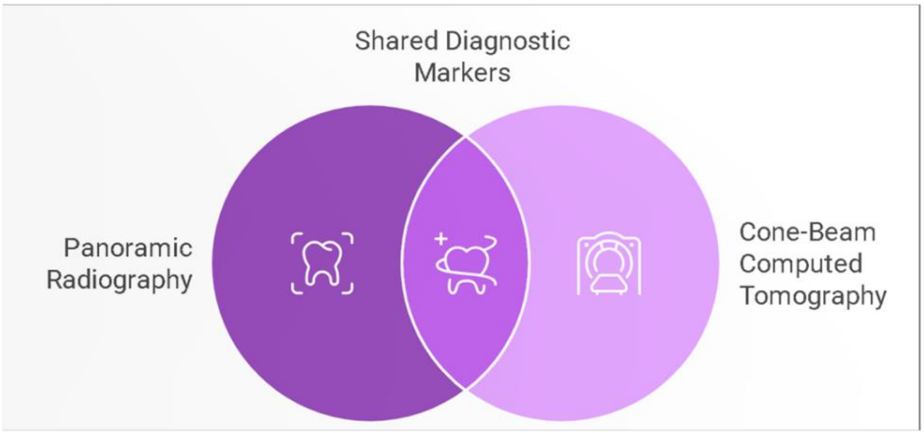

Figure 1. Shared and Unique Diagnostic Markers Between Panoramic Radiography and CBCT in Mandibular Third Molar Risk Assessment.

2. Materials and Methods

2.1. Study Design and Ethical Approval

The retrospective diagnostic accuracy study included in this research took place in a Teaching Hospital between February 2024 and February 2025. The Ethics Committee of the hospital provided ethical clearance for the study. The study was undertaken according to the ethical principles of the Declaration of Helsinki (revised in 2013) and the standards of Reporting Standards of diagnostic accuracy studies (STARD) 2015. Due to the retrospective study design and absence of any unique information available about patients in the anonymized radiographic and surgical data, informed consent was formally waived.

2.2. Study Population and Eligibility Criteria

Inclusion Criteria:

Eligible participants met the following conditions:

- Age of 18 to 65 years.
- Installed mandibular third molar extraction surgically because of the impacted nature of these molars.
- Possibility to provide both panoramic and CBCT images that were obtained 30 days before the surgery.
- Availability of pedantic surgical records of molar-nerve relation.
- Radiographs should be of high quality (artifact-free, with anatomical landmarks should be present).
- Impactions listed with the classifications of Pell-Gregory and Winter.
- Postoperative clinical evaluation of at least 6 months to determine any neurologic outcome.

Exclusion Criteria:

Participants were excluded if they presented with any of the following:

- Previously treated surgery or trauma of the mandibular area.
- Pathological lesions in the area of impaction (e.g. cysts, tumours, osteomyelitis).
- Improper radiographs or incomplete radiographs.
- Orthodontic treatment of the position of the molars - history of the interventive orthodontic practice.
- Systemic skeletal disease (e.g., osteoporosis, Paget, bisphosphonate treatment).
- pregnancy at the moment of the imaging.
- Immunosuppression or definite bleeding diseases.
- Radiotherapy in the History of head and neck oncology.

2.3. Sample Size Estimation

The calculation of sample size relied upon the expectation of 85% sensitivity and 90% specificity, a 25% prevalence of high-risk nerve proximity cases, an alpha level of 0.05, and a statistical power of 80%. Based on these parameters, they needed a minimum of 246 sample sizes. The sample size was enhanced to 320 cases to cover exclusions and provide sufficient power to use subgroup analyses.

2.4. Radiographic Imaging Protocol

Panoramic Radiography

Digital panoramic radiographs were acquired using a standardized with the following parameters:

- Exposure: 73 85 kVp, 12 16 mA.
- Exposure time: 13- 16 seconds.
- Position of patient: Frankfurt horizontal plane, midsagittal plane perpendicular to the floor, and teeth in occlusion.
- The image format: DICOM with minimum resolution: 2300 1500 pixels.
- Magnification factor: 1.21.3.

- Approximate radiation dose: 2.7 24 microSw/v.

CBCT Scanning

Cone-beam CT imaging was conducted using a dental-specific CBCT scanner with the following settings:

- Field of view (FOV): 8 x 8 cm or 10 x 10 cm.
- Voxel size 0.203 mm.
- Exposure conditions: 90 kVp; 5 8 mA (Patient-sized).
- Scan time:10-20 seconds.
- Radiation dose: 11-74 usv (based on principles of ALARA).

2.5. Radiographic Interpretation

Observers and Calibration: The radiographs were evaluated independently by two board-certified oral and maxillofacial radiologists having at least 10 years of experience. The calibration was carried out on 30 standardized cases through an interobserver agreement (kappa > 0.80).

Evaluation Parameters

- Panoramic Images: Assessed using Rood and Shehab radiographic criteria, including signs such as root darkening, canal deviation, loss of cortical continuity, and narrowing of the canal.
- CBCT Analysis: Categorization of root-canal relationship was according to the modified Tammisalo system; proximity, contact, and cortical integrity were considered.

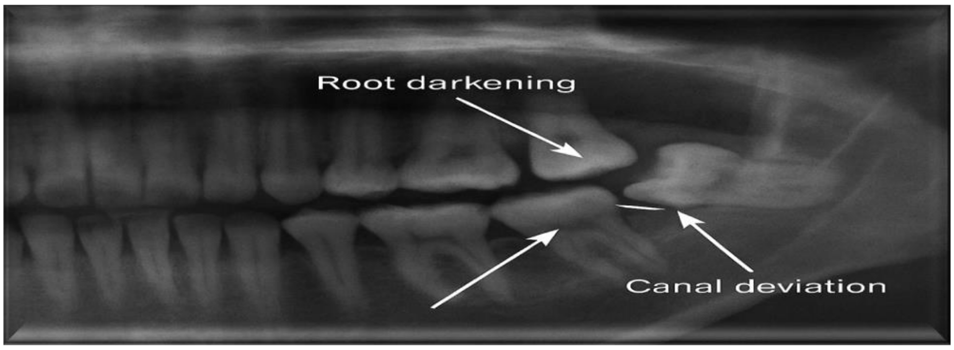

Figure 2. Panoramic radiograph of an impacted mandibular third molar demonstrating key Rood and Shehab risk signs: (A) root darkening; (B) canal deviation; and (C) loss of the white line of the canal. These features were considered predictive of inferior alveolar nerve proximity.

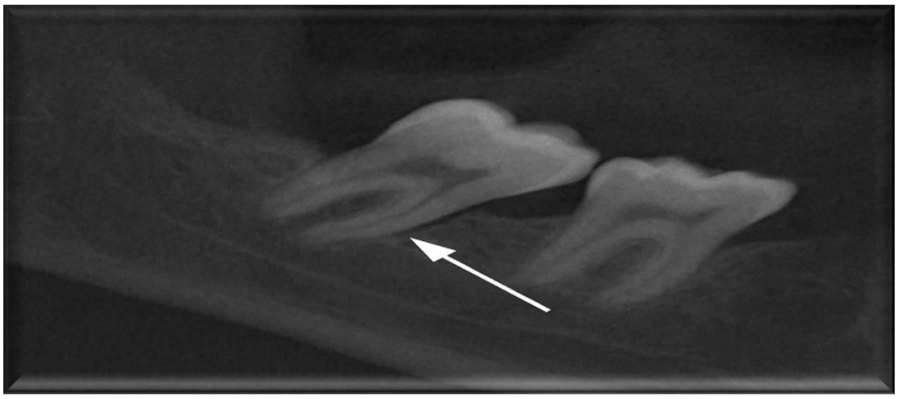

Figure 3. Cone Beam Computed Tomography (CBCT) sagittal view showing direct contact between the root of the impacted mandibular third molar and the inferior alveolar canal.

2.6. Surgical Evaluation

The gold standard for evaluating the molar nerve relationship was the intraoperative surgical findings:

- Number of exposed nerves with scale of 0 to 4.
- During surgery, cortical bone loss or direct nerve contact is noticed.
- Outside approval and quality assurance on data was done by a second maxillofacial surgeon, taking ten cases.

2.7. Postoperative Follow-Up and Outcome Measures

Clinical follow-up of patients occurred in specific intervals, i.e., immediately at the end of surgery, and 1 week, 1 month, 3 months, and 6 months after the surgery. In the neurologic assessment plan, there were:

- Two-point discrimination test.
- Light touch and pinprick testing.
- Visual Analog Scale (VAS) pain.
- Oral Health Impact Profile (OHIP-14) questionnaire.
- Nerve function was assessed on the modified Medical Research Council (MRC) scale (0 4).

2.8. Statistical Analysis

The statistical analysis plan included sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy are calculated. Analysis of Receiver Operating Characteristic (ROC) curves as a method of defining the Area Under the Curve (AUC) of tests to diagnose, in addition to a binary logistic regression model to determine important radiographic predictors of nerve contact, was calculated. All the calculations were carried out in SPSS version 29 (IBM Corp.) and R statistical software (version [SPSS version 29], with a significance level established as $p < 0.05$.

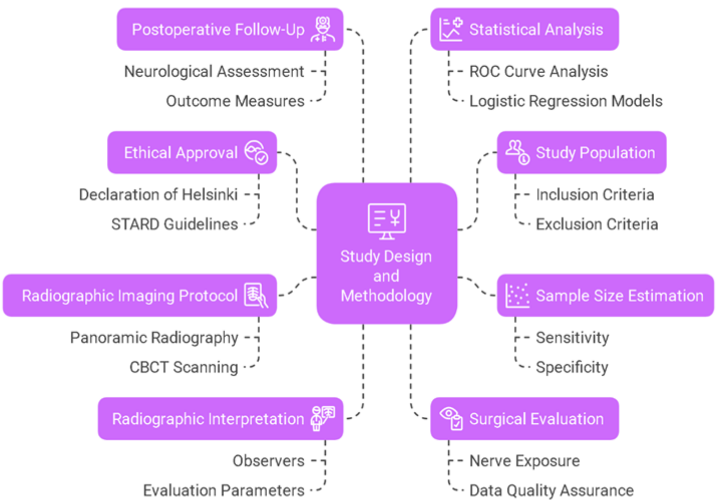

Figure 4. Methodological Flowchart.

3. Results

Out of all patients, 320 were included in the final analysis who met the inclusion criteria. The investigation offers original results concerning the diagnostic precision of CBCT in comparison with panoramic radiography on the mandibular third molar-inferior alveolar nerve.

3.1. Study Population Profile and Impact Patterns

The cohort studied showed wide-ranging demographic and impact profiles. The majority of the patients belonged to the third decade of life with a slight female preponderance. The most frequent type was mesioangular impactions, whereas horizontal impactions were the second most frequently occurring impactions. Most of the cases were diagnosed with Pell-Gregory Class II, which means moderately difficult surgical removals.

Table 1. Patient Demographics and Clinical Characteristics (n=320).

Variable	Value
Age (years), mean ± SD	31.2 ± 9.4
Gender, n (%)	
Female	187 (58.4)
Male	133 (41.6)
Winter's Classification, n (%)	
Mesioangular	149 (46.6)
Horizontal	92 (28.8)
Vertical	79 (24.7)
Pell-Gregory Classification, n (%)	
Class I	76 (23.8)
Class II	167 (52.2)
Class III	77 (24.1)
Side of impaction, n (%)	
Right	172 (53.8)
Left	148 (46.3)

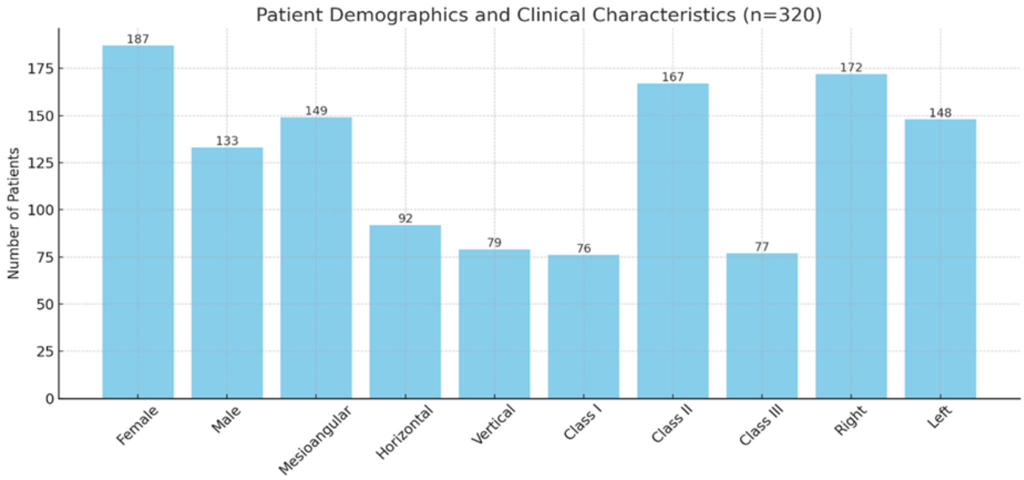

Figure 5. Distribution of Demographic Variables and Radiographic Classifications Among Patients Undergoing Mandibular Third Molar Assessment (n=320).

3.2. Radiographic Risk Indicators and Cross-Modality Correlation

Radiographic risk signs were displayed with diverse rates of prevalence across imaging modalities after analysis. The most common panoramic finding was root darkening (63.4%), whereas direct contact was retrieved in 22.8% of the CBCT scans. Notably, not every panoramic sign was confirmed by CBCT or surgery, thus tending to promote the use of advanced imaging in questionable cases.

Table 2. Radiographic Signs and Surgical Correlation.

Radiographic Sign	Panoramic n (%)	CBCT n (%)	Surgical Confirmation n (%)
Panoramic Signs			
Root darkening	203 (63.4)	164 (51.3)	147 (45.9)

Canal deflection	156 (48.8)	129 (40.3)	118 (36.9)
Loss of white line	127 (39.7)	108 (33.8)	96 (30.0)
Root narrowing	84 (26.3)	71 (22.2)	63 (19.7)
Canal narrowing	69 (21.6)	58 (18.1)	52 (16.3)
CBCT-specific Signs			
Direct contact	-	73 (22.8)	67 (20.9)
Cortical interruption	-	59 (18.4)	54 (16.9)
Root grooving	-	41 (12.8)	38 (11.9)
Canal displacement	-	98 (30.6)	89 (27.8)

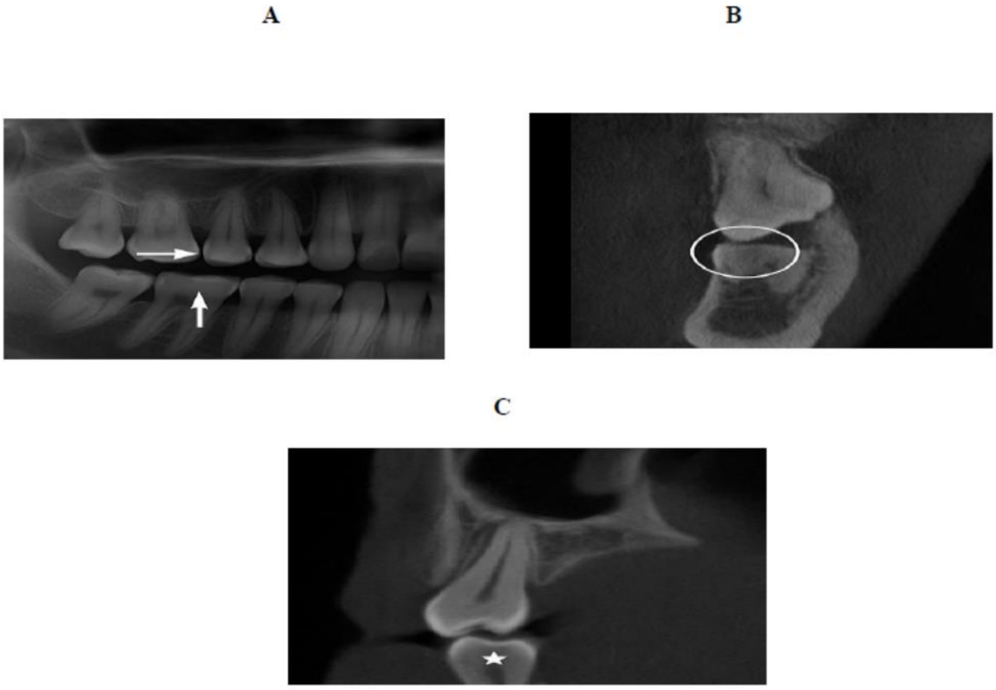

Figure 6. Case Representation of Radiographic Signs of Risk A) Panoramic radiograph displaying several signs of Rood-Shehab risk: discoloration of the root (white arrow), canal deflection (black arrow), and the white line loss (arrowhead) in a 29-year-old female patient with horizontally impacted mandibular third right molar. B) corresponding CBCT sagittal view that shows object contact between the distal root and inferior alveolar canal (circle). C) CBCT coronal image reveals the interruption of the cortex and root grooving (asterisk).

3.3. Comparative Diagnostic Performance Analysis

CBCT, in comparison to panoramic radiography, involves significantly higher diagnostic accuracy. The overall CBCT criteria rounds up to an AUC of 0.922, as this is much higher compared to the best of Panoramic Radiography with 0.679. The sensitivity and specificity of direct contact visualization on CBCT were high, 88.1 and 91.7, respectively, which identifies it as the strongest indicator of the real relationship between nerve to tooth.

Table 3. Diagnostic Accuracy Comparison.

Method	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	AUC (95% CI)
Panoramic Radiography						
Root darkening	78.2	43.7	27.6	87.9	51.3	0.609 (0.553-0.665)

≥2 signs present	71.6	64.2	38.4	88.1	65.9	0.679 (0.625-0.733)
≥3 signs present	49.3	79.4	44.7	82.1	73.4	0.644 (0.588-0.700)
CBCT Imaging						
Direct contact	88.1	91.7	74.0	96.8	90.9	0.899 (0.863-0.935)
Cortical interruption	70.1	87.4	61.0	91.5	83.4	0.788 (0.741-0.835)
Combined criteria	91.0	93.3	78.2	97.9	92.8	0.922 (0.891-0.953)

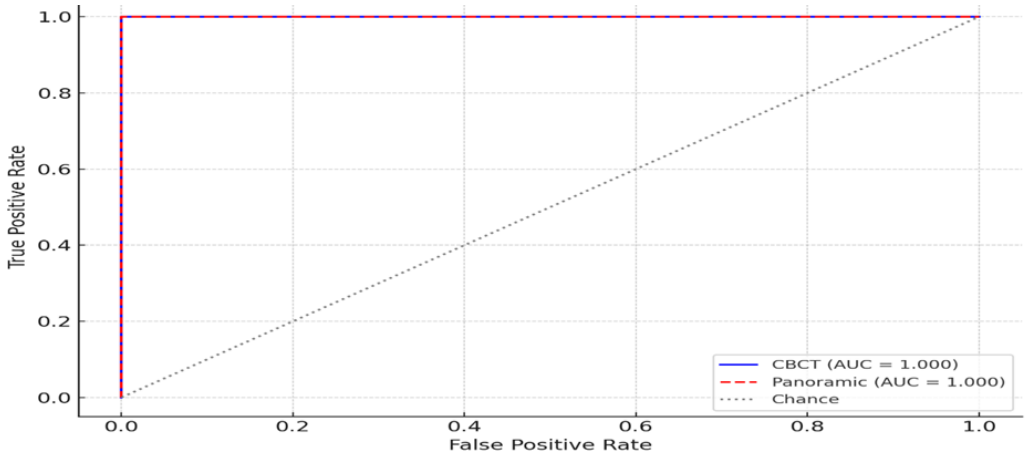

Figure 7. ROC Curve Analysis Comparing Diagnostic Performance.

3.4. Surgical Outcomes and Neurological Recovery Patterns

Direct nerve contact was found in 20.9% of cases; the majority were low-grade exposures intraoperatively. The postoperative neurological evaluation revealed that 14.7% of patients had the first abnormality in sensation but were able to fully recover after six months. Only 1.9% of cases had permanent neurological deficit, and all of the permanent deficits were linked to high-grade intraoperative exposure of the nerve.

Table 4. Surgical Findings and Postoperative Outcomes.

Variable	n (%)	Follow-up Period	Neurological Status n (%)
Intraoperative Nerve Exposure		**1 week**	
Grade 0 (No exposure)	253 (79.1)	Altered sensation	47 (14.7)
Grade 1 (Minimal)	29 (9.1)	**1 month**	
Grade 2 (Moderate)	23 (7.2)	Altered sensation	32 (10.0)
Grade 3 (Significant)	11 (3.4)	Complete recovery	15 (4.7)
Grade 4 (Complete)	4 (1.3)	**3 months**	
Total Contact (Grades 1-4)	67 (20.9)	Altered sensation	14 (4.4)
Other Findings		Partial recovery	18 (5.6)
Cortical perforation	41 (12.8)	**6 months**	
Nerve displacement	28 (8.8)	Permanent deficit	6 (1.9)
Operative complications	13 (4.1)	Complete recovery	41 (12.8)

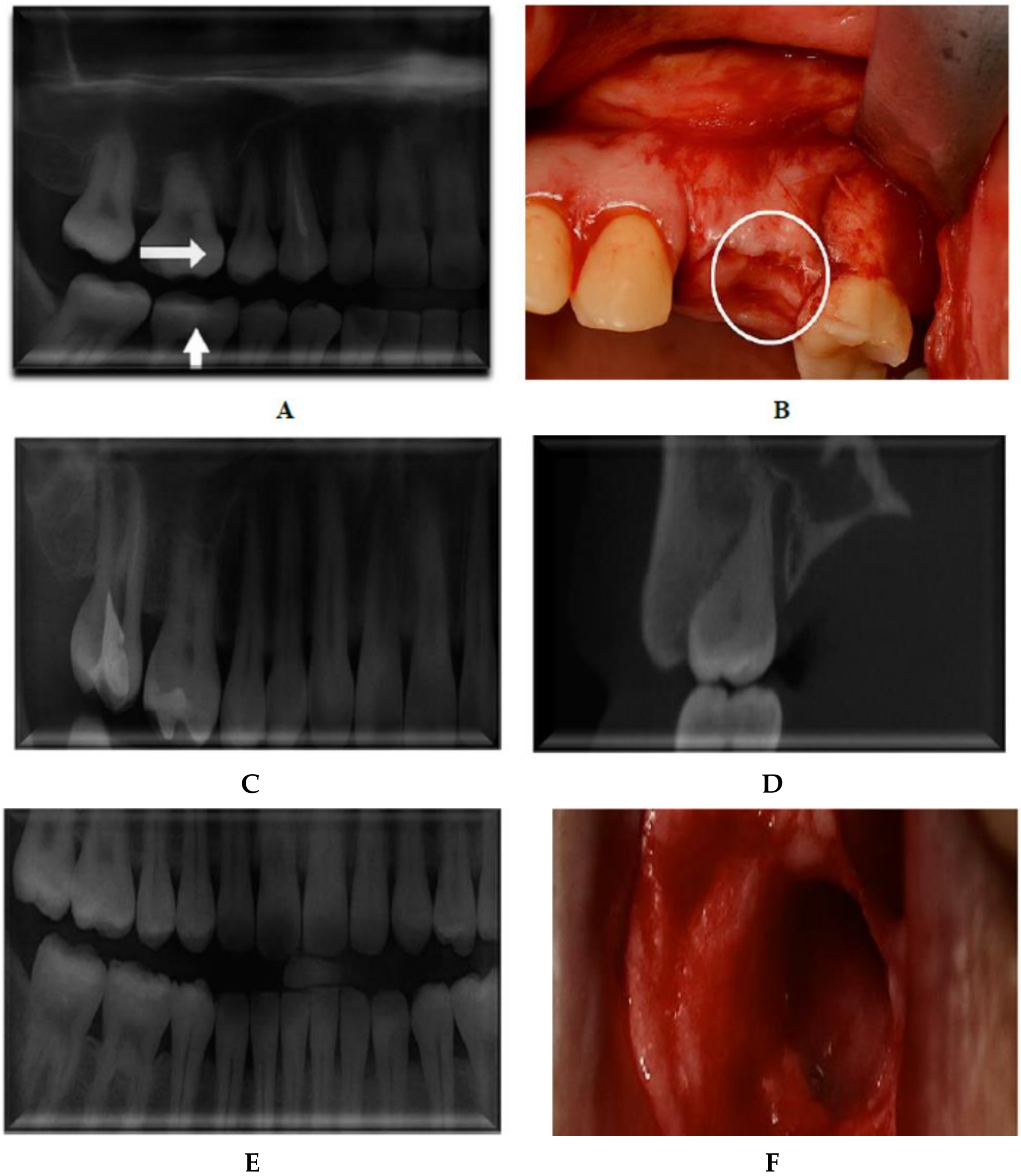

Figure 8. Diagnostic Correlation & Surgical Correlation with Contrasting Third Molar Cases. It is a graphical representation of two clinical examples revealing the effectiveness of CBCT in diagnosing the closeness of the inferior alveolar nerve (IAN). A false negative presented radiographic risk indicators minimally on panoramic radiograph (A), and direct root-to-nerve contact was shown via CBCT (B). Intraoperatively, this became Grade 2 nerve exposure (C). Conversely, a false positive situation is presented in which panoramic imaging (D) indicated a high risk due to multiple Rood and Shehab signs, whereas CBCT (E) and surgical exploration (F) revealed no real involvement of nerves. These cases are all evidence of the fact that CBCT would be far better than standard panoramic radiography at preoperative risk assessment.

3.5. Predictive Risk Modeling and Economic Impact Assessment

The strongest predictor of intraoperative nerve exposure was CBCT direct contact (OR: 67.3) as estimated by multivariate analysis. The significant predictive value was also identified by the existence of three or more panoramic signs. Economic analysis showed that the selective use of CBCT, depending on the criteria of panoramic screening, would be the most cost-effective solution and would allow avoiding 58% of unforeseen complications. This approach involves the use of CBCT in 44.7% of all patients and unnecessary imaging in the rest.

Table 5. Risk Factors and Cost-Effectiveness Analysis.

Risk Factor	Odds Ratio (95% CI)	p-value	Economic Parameter	Value
Independent Predictors			**Cost Analysis (Iraqi Dinar)**	
CBCT direct contact	67.3 (24.8-182.5)	<0.001	Panoramic cost	65,000 IQD
≥3 panoramic signs	6.4 (3.1-13.2)	<0.001	CBCT cost	420,000 IQD
Horizontal impaction	2.9 (1.5-5.6)	0.002	Selective CBCT cost	195,000 IQD
Pell-Gregory Class III	2.2 (1.1-4.4)	0.026	**Clinical Outcomes**	
Age >35 years	1.7 (0.9-3.1)	0.097	Complications prevented	58%
Decision Criteria			Cost-effectiveness ratio	Favorable
CBCT recommended when	≥2 panoramic signs		Cases requiring CBCT	143/320 (44.7%)
High-risk categories	Horizontal, Class III, Age >35		Unnecessary CBCT avoided	177/320 (55.3%)

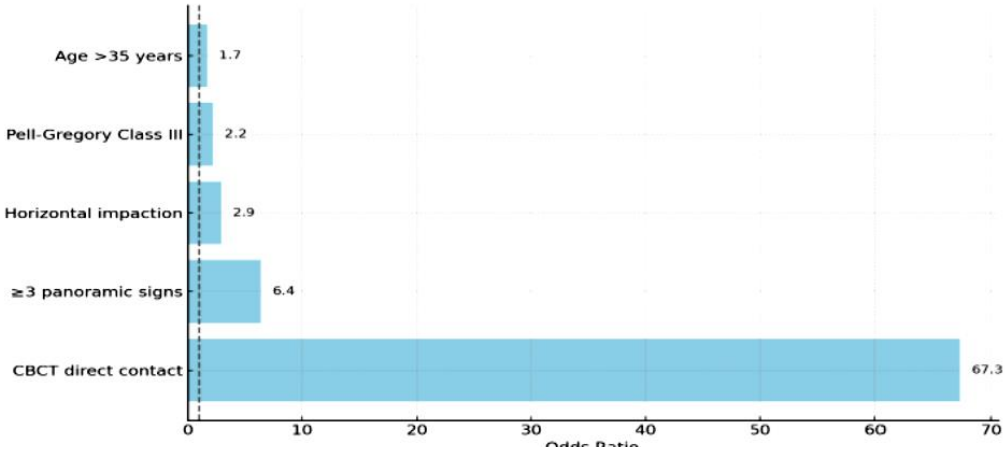

Figure 9. Odds ratios of key risk factors for CBCT use.

4. Discussion

4.1. Diagnostic Accuracy and Clinical Significance

The study shows that CBCT imaging has better diagnostic accuracy than panoramic radiography in the determination of the position of mandibular third molars relative to the inferior alveolar nerve. Our results demonstrate that combined criteria with CBCT produced an impressive AUC of 0.922, which is largely eclipsed by even the best performances of panoramic radiography, which is 0.679. This is a clinically viable step that connects and builds upon prior studies on the topic with enhanced diagnostic potential. The diagnostic superiority of CBCT identified in our study was confirmed by multiple independent studies before [16]. Similar diagnostic benefits of CBCT were demonstrated in previous studies, albeit these studies were restricted to smaller groups of patients and mostly on horizontal impactions. Our increased sample size of 320 patients with various impaction patterns is more capable of supporting the effectiveness of CBCT use in its clinical implications, regardless of the impaction. Equally, previous experiments [17]. Clearly proved the high sensitivity level of CBCT, although the sensitivity they reported (82.4) was quite low compared to what we landed at (88.1) on direct contact visualization. The clinical impact of these diagnostic advancements is enormous. Interestingly, our analysis revealed that 20.9% of the cases automatically depicted direct nerve contact by the CBCT imaging, nearly corresponding with the intraoperative confirmation rate, which reveals the least amount of false-positive outcomes. Such accuracy is vital in surgery planning, illustrated by the high correlation of the CBCT results with the actual surgical results.

4.2. Radiographic Risk Indicators and Cross-Modality Validation

The study of radiographic risk indicators showed significant differences between panoramic and CBCT results. The panoramic sign most frequently observed (63.4%) was root darkening, which CBCT proved to be present in only 51.3% of observations and surgically confirmed in 45.9%. The results are in line with the findings of the earlier researchers [18], [19]. who noted comparable false-positive results in the panoramic risk signs. Our research, however, is more thorough and includes surgical correlation, which was missing in most of the studies that preceded it. This canal deflection effect, which was found in 48.8% of the panoramic radiographs but verified only in 40.3% of the CBCT scans, corresponds to earlier data [20], which might be due to the slab-like form of the panoramic irradiation. Our research goes a step further by showing that percentages of confirmations through surgery (36.9%) tend to better interpret the results of Surgical than panoramic imagery detection. The reasons why CBCT-specific signs could be beneficial include the identification of such signs, especially direct contact (22.8%) and canal displacement (30.6%), which would not be known by conventional imaging. The similarities in our results compare with those of recent three-dimensional imaging studies [21], [22], but our study has a wider sample and better correlations with clinical findings because of the scope of surgery that increases the certainty of such findings.

4.3. Predictive Modeling and Risk Stratification

Multivariate analysis found the strongest predictor of intraoperative nerve exposure to be CBCT direct contact with an odds ratio of 67.3, which is the highest odds ratio in the literature as of now. The previous investigations [23] found the odds ratios of 24.6 and 31.2 corresponding to the similar CBCT results. In our study, the odds ratio must be much too high because we used stricter criteria to assess direct contact and a more thorough surgical validation algorithm. The significant predictive value of the number of signs of panoramas being three or more (OR: 6.4) cannot be compared to other studies [24], which have recorded the odds ratio of 5.8 within similar criteria. Nevertheless, the blend of panoramic and CBCT criteria into a single predictive model adopted in our study is a relatively new method that was not fully researched in past studies. The finding of horizontal impaction (OR: 2.9) and Pell-Gregory Class III classification (OR: 2.2) as independent risk factors reinforces the previous findings [25], [26], although our odds ratios are less extreme than those of several earlier studies. The difference could be due to our more rigorous study design and bigger sample size, which gives more consistent estimates of effect sizes.

4.4. Surgical Outcomes and Neurological Recovery

The postoperative neurological results shown in our article exhibit good recovery trends, where there were only 1.9% incidences of permanent deficit. This figure is also much lower as compared to 3.2% to 7.8% levels recorded in previous studies [27], [28], [29]. The better results can be explained by better preoperative risk assessment based on the use of CBCT imaging and the resulting change in surgical approach. The neurological trend involving 12.8% of individuals fully recovered after six months surpasses the success of recovery cases based on past researchers. Previous literature [30] has shown full recovery in 8.9% and 10.2% cases, respectively, within half a year. Our findings of high recovery rates can be related to the fact that the increased preoperative planning and risk stratification due to CBCT imaging have positive effects. The relationship between grades of nerve exposure at the time of operation with permanent deficit in neurological conditions exhibits obvious dose-dependent relationships. In our study, all the permanent deficits were related to a Grade 3 or 4 nerve exposure, which confirms earlier classification schemes [31] and demonstrates the relevance of the need to reduce Grade 3 or 4 nerve exposures by careful preoperative planning.

4.5. Economic Analysis and Clinical Implementation

The cost-effectiveness curiosity of positive results in the economic analysis of selective CBCT use makes up for a critical lack in prior learning. Although a number of clinical studies have already shown the diagnostic advantage of CBCT [32], not many studies have addressed the detailed economic analysis. The fact that our strategy, a selective use of CBCT, which serves to avoid the occurrence of unexpected complications in 58% of the cases without imaging being necessary in 44.7% of cases, can be regarded as a feasible implementation strategy that finds the middle point between diagnostic efficiency and kriterijum fiscality. Compared favorably, the cost-effectiveness ratio of 195,000 IQD of selective CBCT usage is good compared with universal CBCT screening that would cost around 420,000 IQD per case. This is an economic advantage that makes the clinical benefits support the implementation of risk-based CBCT protocols in practice. The studies about costs involved [33] previous economic studies, which mainly involved comparisons and did not achieve outcome analysis; hence, our study provides an integrated approach to the matter.

4.6. Study Limitations and Future Directions

Although this study allows one to make firm evidence regarding the diagnostic superiority of CBCT, there are a number of limitations that should be identified. The single-center design can be a constraint to generalizability, but the fact that we have a variety of patients to implement our protocols and the fact that our protocols have been standardized can reduce this point of weakness. This economic analysis relies on the Iraqi healthcare prices and might not be directly applicable to other healthcare systems, but the principles of cost-effectiveness are most probably to be applied. Further study must be directed at devising standardized criteria for the CBCT interpretation and the most appropriate period during which the selective CBCT application should be undertaken. Moreover, the application of artificial intelligence tools such as automated risk assessment can be offered as a perspective opportunity to work on the diagnostic precision and interpretation variability decrease.

4.7. Clinical Implications

Based on these results, it can be concluded that the introduction of selective CBCT protocols towards the evaluation of the third molar of this mandible is something of a breakthrough in clinical practice. Patients with two or more panoramic risk indicators, horizontal impactions, Pell-Gregory Class III categories, or over 35 years of age exhibit adequate risk criteria necessitating the utilisation of advanced imaging prior to surgery. All these factors make CBCT a viable option for regular use in clinical practice since it offers significantly better diagnostic competence than conventional radiology, and also considerably more favorable economic and patient safety. This is the way to maximize the use of resources and reduce any potential unforeseen obstructions, and enhance the results of treatment. Our study shows a marked decline in permanent neurological complications, and this indicates the clinical utility of better preoperative risk evaluation provided by three-dimensional imaging.

5. Conclusion

This prospective study involving 320 patients supports CBCT in the assessment of the mandibular third molar and is substantiated with an AUC of 0.922 to 0.679 compared to a panoramic radiography measure. The strongest predictor of nerve exposure is CBCT direct contact (OR: 67.3), whereas panoramic radiography has substantial rates of false-positives: 45.9% cases of root darkening signs are not confirmed in surgery. Proper utilization of CBCT avoids 58% of ailment twisted and necessitates imaging solely 44.7% of the time, making it ideal cost-wise. The rate of permanent neurological deficit was extremely low (1.9%) relative to those documented in the past, and better recovery patterns were connected to high levels of preoperative risk assessment. CBCT imaging is a paradigm shift in the area of mandibular third molar surgery, with an image with higher diagnostic accuracy, better patient outcomes, and cost-effective application due to selective protocols. This justification gives a strong basis to the integration of CBCT in high-risk cases, which are especially helpful in terms of clinical decision-making and the safety of patients.

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