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Imaginology

Can CBCT change the level of confidence of oral maxillofacial surgeons in mandibular third molar management?

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Abstract: This study analyzed the impact of CBCT on the level of confidence in diagnostic and treatment thinking in mandibular lower molar (M3M) clinical management. Thirty cases for which panoramic radiographs and CBTC images were available were selected and classified according to radiologic signs indicating the proximity of the M3M to the mandibular canal (interruption of the radiopaque borders of the canal of the mandibular canal wall, darkening of the roots, and diversion or narrowing of the canal, n = 10 for each classification). Twelve oral and maxillofacial surgeons (OMS) contributed to this study by answering two questionnaires. The first questionnaire contained a clinical description of the case and a panoramic radiograph. After 30 days, a second questionnaire with the same clinical illustrations and tomographic multiplanar reconstruction images was administered. Both questionnaires asked specialists to rate diagnostic confidence, the surgical complexity, chosen treatment, and surgical confidence. In approximately 40% of answers, CBCT images had a positive impact on ratings of diagnostic confidence and treatment thinking confidence, and in 24.4%, they increased the surgical complexity score. There was no change in the treatment plan following the use of CBCT, but the CBCT examination was a determining factor for diagnosis and treatment planning in 72.8% of the answers CBCT improved the confidence level in diagnostic and treatment thinking of the M3M management while also increasing the perceived level of surgical complexity. The findings of this study support the need to consider using CBCT in diagnosis and treatment planning for M3Ms with radiographic signs such as darkening of the roots, interruption of the radiopaque borders of the mandibular canal, or deviation of the mandibular canal and narrowing of the roots.

Keywords: Cone-Beam Computed Tomography; Diagnosis, Oral; Molar, Third; Oral and Maxillofacial Surgeons.

Introduction

Extraction of the mandibular lower molar (M3M) can damage the inferior alveolar nerve (IAN), with an incidence ranging from 0.35% to 8.4%.[1] Therefore, the knowledge of this incidence is essential to

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assess the anatomy of the tooth roots and their proximity to the mandibular canal (MC) when planning surgery.[2,3] Traditionally, seven radiologic signs suggest a relationship between the M3M and the mandibular canal (MC).[4] Two systematic reviews found that interruption of the canal radiopaque borders, darkening of the roots, and diversion or narrowing of the canal were most predictive of the relationship between M3M roots and MC.[5,6] The choice of the image acquisition method should be based on the patient's cost-benefit relationship and the risk associated with each imaging exam, following the ALADA principle (as low as diagnostically acceptable).[7] In panoramic radiography subjects the patients are subjected to a low dose of radiation for a broader view of the dentomaxillofacial complex.[8] The limitations are related to the low definition of specific structures and superimposition of images.[9] Despite its limitations, this method is still the most widely used imaging exam.[10-12] However, when two-dimensional exam is inconclusive, the CBCT could be indicated, with protocols that reduce patient radiation dose as restricted field of view (FOV), mA adjustment, and shorter exposure time[13] The SEDENTEXCT project highlights the need for scientific evidence regarding changes in diagnoses and results of clinical planning with the use of CBCT.[14] Fryback and Thornbury developed a hierarchical model of diagnostic efficacy comprising six levels: technical efficacy, diagnostic accuracy efficacy, diagnostic thinking efficacy, therapeutic efficacy, patient outcome efficacy, and societal efficacy.[15] The current literature on most diagnostic methods is mainly circumscribed to the first two levels.[16-18] Moreover, these data are mostly based on in vitro studies. As a result, it is still unknown how the information affects the clinician's thinking, *i.e.*, in this case, how CBCT examinations influence the diagnostic and therapeutic decision.[11] This study assessed the impact of CBCT on diagnostic and treatment thinking in M3M clinical management among oral and maxillofacial surgeons (OMSs) and indicated the level of professional confidence for the judgments of the clinical cases.

Methodology

A single-center, "before and after" study was conducted. The Institutional Research Board and the Research Ethics Committee at the Federal University of Rio Grande do Sul, Brazil, approved the study (CAAE 80080817.6.0000.5347).

Selection of cases

Thirty digital folders containing panoramic radiographs and CBCT images were selected from the image database of a private dental radiology clinic image database. All images were acquired with the Vatech Pax-Duo3D Cloth / CBCT system (Vatech, Seoul, Republic of Korea), with 5x5 cm FOV and a 0.08 mm voxel (CBCT), running at 89 kVp and 5 mA (CBCT) or 4 mA (Panoramic). Two dentomaxillofacial radiologists and one OMS conducted this classification together, reaching a consensus. Inclusion criteria were as follows: the M3M with total root formation, free from pathologies, and in proximity to the MC. The radiographs were classified according to radiologic signs suggestive of close contact between the M3M and MC: interruption of the radiopaque borders (IRB) of the canal of the mandibular canal wall (IRB), darkening of the narrowing (DN), and diversion or narrowing of the canal, n=10 for each classification. The exams were anonymized before being sent out for evaluation.

Questionnaire's design and evaluation

Two questionnaires were prepared using Google Forms, web 2.0 (Google Inc., Mountain View, USA). The first questionnaire (Q1) presented the clinical cases with a fictitious medical history, including age, sex, and clinical signs and symptoms, followed by a panoramic image (Figure and Table 1), followed by questions about diagnosis and treatment planning. The second questionnaire (Q2) was provided 30 days later. It contained the same clinical description as Q1, providing the multiplanar tomographic reconstruction (static pre-selected images) rather than the panoramic image, followed by similar questions to those in Q1. Codes identified cases and examiners in both questionnaires. The evaluators assessed the images in a dark room on a Dell Precision ® Display (1,920×1,200 pixels) (Dell Inc.,

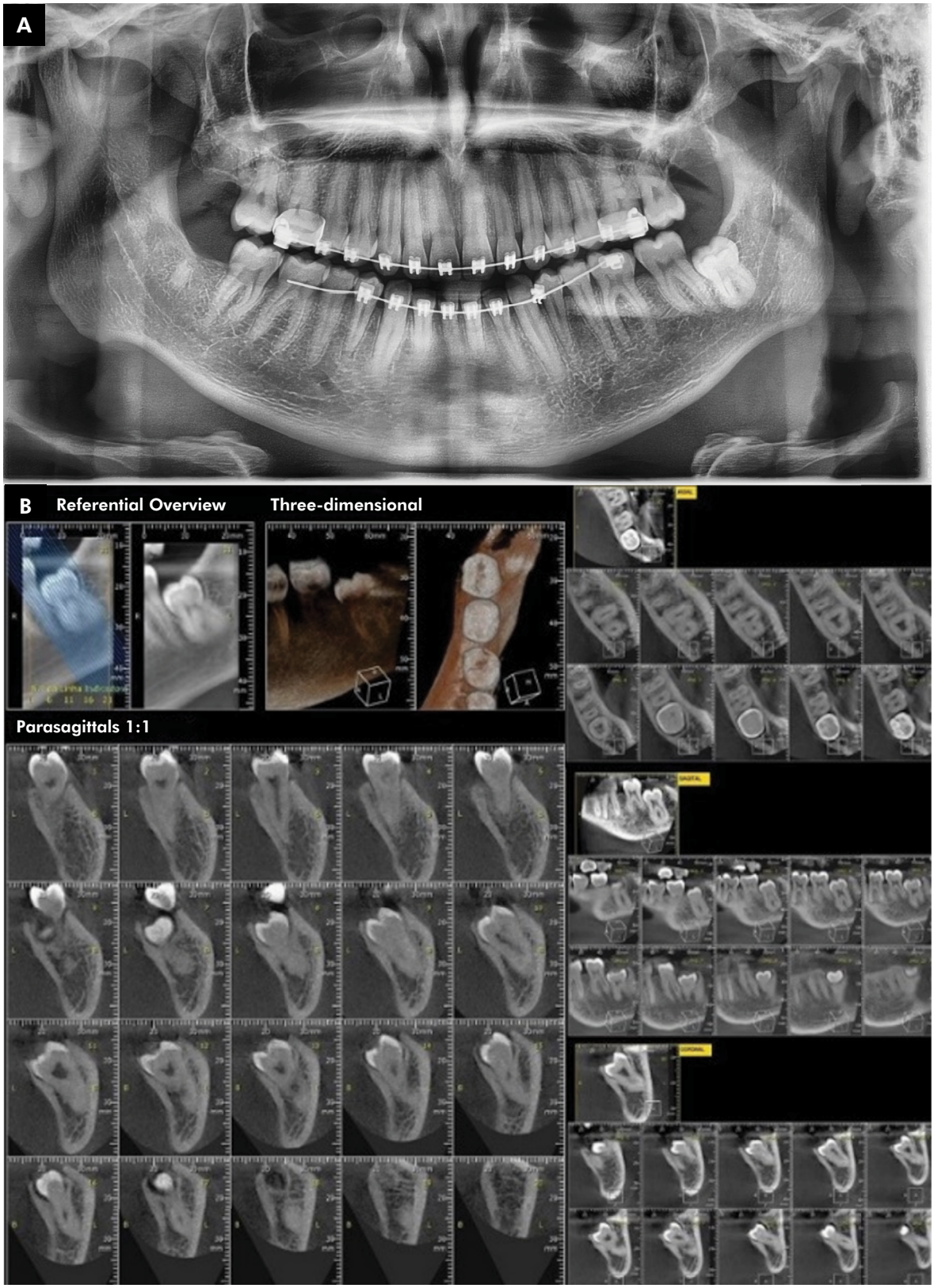

Figure. (A) panoramic radiograph from the first questionnaire and (B) multiplanar tomographic sections from the second questionnaire.

Table 1. A report of the questionnaire's questions.

Questions	Answers
1. How confident would you be in the diagnosis of this clinical case?	1) unconfident, (2) slightly unconfident, (3) uncertain, (4) slightly confident and (5) very confident
2. At what level of difficulty would you classify the surgery required?	(1) very easy, (2) easy, (3) uncertain, (4) moderate, or (5) complex
3. How confident would you be to conduct surgery using this imaging exam?	1) unconfident, (2) slightly unconfident, (3) uncertain, (4) slightly confident and (5) very confident
4. What would your treatment decision be?	tooth extraction or clinical and radiographic follow-up
5. Would you request an additional imaging exam?	yes or no
6. * Do you think that CBCT was decisive for diagnosis and/or treatment choice in this case?	yes or no

*This question only appears in the 2nd questionnaire.

Round Rock, USA) using OnDemand3D ® software (Cybermed Co., Seoul, Korea).

Study participants

Thirty-four OMSs and graduate oral and maxillofacial surgery students - in the last year of program - were invited; 12 completed both phases of the study.

Statistical analysis

The analyses were performed using SPSS version 18.0 (SPSS, Chicago, USA). The significance level was set at 5%. The answers to the PAN and CBCT questionnaires were matched, and nonparametric tests were conducted. A total of 360 answers (total pairs for each case) were included in the data analysis. Items on observers' confidence in their diagnosis and treatment planning and their opinions on surgical complexity had 5-point Likert scales. The Wilcoxon test was used to analyze the answers before and after CBCT.

Results

A total of 30 M3M cases, classified by radiologic signs suggestive of proximity to the MC, were analyzed using panoramic radiographs and CBCT. The Wilcoxon test (Tables 2, 3, and 4) identified significant differences between the scores chosen in PAN and CBCT questionnaires for all comparisons except the question about the level of surgical complexity for DN cases. Overall, the scores attributed were significantly higher when using CBCT, revealing a greater level of confidence in diagnosis and surgical planning and a higher level of surgical complexity perception.

Table 2 presents the results for the question: "How confident would you be in the diagnosis of this clinical case?" The returns pointed that 64 and 57 answers remained unchanged for IRB and DR, respectively. Forty answers had higher scores when CBCT was used for diagnosis of IRB cases, and 47 were higher for DR cases (*i.e.*, confidence was greater with CBCT). For the DN, the results showed confidence increased (55) instead of remaining unchanged (45) or decreasing (20). Analyzing the overall ranking, the mean Likert score was higher for CBCT, 3.99 compared to 3.39, showing greater diagnostic confidence in 39.4% of the answers.

The answers to the question "At what level of difficulty would you classify the surgery required?" (Table 3) revealed all variable had higher numbers of unchanged scores (IRB = 60, DR = 79, and DN = 64) than changed answers. Among answers that had changed, positive ratings invariably prevailed, i.e., observers classified the surgery as more complex after the CBCT images. Analyzing the overall rankings, the mean Likert score was higher for Q2 (3.84 as compared to 3.68). CBCT influenced the perceived complexity of surgery in 24.4% of the answers.

When respondents were asked, "How confident would you be to conduct surgery using this imaging exam?" (Table 4), most of them did not change their answers between Q1 and Q2. However, among those who changed their answers, higher scores for Q2 prevailed, and this difference was statistically significant. Analyzing the overall rankings, the mean

Likert score was higher for CBCT (4.04 as compared to 3.24), improving confidence in performing surgery in 43.6% of the answers.

When asked, "What would be your clinical treatment planning?" It was revealed that, regardless of the imaging exam, there was no significant difference in the recommend treatment recommended, with "tooth extraction" chosen in the vast majority of the answers (Table 5). Observing answers to the question, "Would you request an additional imaging exam," it is clear that there is a considerable difference between Q1 and Q2. There was a higher proportion of "yes" answers in Q1 when compared to Q2 (after CBCT). The evaluators stated that they would request an additional examination for cases with the DN sign (Table 6). Assessing only the answers to Q1, evaluators would not request a supplementary exam in 204 (56.7%) answers. Still, when asked in Q2 whether CBCT was decisive for diagnosis and treatment choice, 72.8% replied, "yes."

Discussion

The SEDENTEXCT project published guidelines for the use of CBCT images.[14] Currently, the guidelines do not suggest the regular use of CBCT as routine for diagnosis and treatment planning of M3M.[19] Levels 1 and 2 from the Fryback and Thornbury six-level hierarchical model demonstrate the accuracy of CBCT compared with panoramic radiography in identifying

Table 2. Score ranking for the question "How confident are you in the diagnosis of this clinical case?" A negative rank indicates the confidence score was higher when the panoramic exam was available, while a positive rank means higher diagnostic confidence after CBCT.

Classification	Rank	p-value	PAN Mean (SD)	CBCT Mean (SD)
IRB	16 negatives 40 positives 64 no change Total 120	0.000*	3.62 (1.15)	4.11 (0.41)
DR	16 negatives 47 positives 57 no change Total 120	0.000*	3.48 (1.14)	4.03 (0.54)
DN	20 negatives 55 positives 45 no change Total 120	0.000*	3.39 (1.31)	3.84 (0.77)
TOTAL	52 negatives 142 positives 166 no change Total 360	0.000*	3.39 (1.21)	3.99 (0.59)

Thirty cases and 15 observers, comprising 360 answers on a 5-point Likert scale (from 1 – not confident to 5 – very confident). Significant difference according to the Wilcoxon test: *significant to $p \leq 0.001$. SD: standard deviation; IRB: interruption of the radiopaque borders of the canal. DR: darkening of the roots DN: diversion or narrowing of the canal; PAN: panoramic; CBCT: cone beam computed tomography.

Table 3. Scores' ranking for the question "At what level of difficulty would you classify the M3M extraction surgery?" A negative rank indicates greater difficulty when the panoramic exam was available, while a positive rank indicates greater difficulty after CBCT.

Classification	Rank	p-value	PAN Mean (SD)	CBCT Mean (SD)
IRB	22 negatives 38 positives 60 no change Total 120	0.031*	3.32 (1.24)	3.61 (1.04)
DR	16 negatives 25 positives 79 no change Total 120	0.028*	3.63 (1.08)	3.81 (0.93)
DN	31 negatives 25 positives 64 no change Total 120	0.888^{NS}	4.12 (1.01)	4.11 (0.82)
TOTAL	69 negatives 88 positives 203 no change Total 360	0.003*	3.68 (1.15)	3.84 (0.95)

Thirty cases and 12 observers, comprising 360 answers on a 5-point Likert scale (from 1 – very simple to 5 – complex). Significant difference according to the Wilcoxon test: **significant to $p \leq 0.05$. SD: standard deviation; IRB: interruption of the radiopaque borders of the canal. DR: darkening of the roots DN: diversion or narrowing of the canal; PAN: panoramic; CBCT: cone beam computed tomography.

Table 4. Score ranking for the question "How confident are you to conduct surgery using this imaging exam?" A negative rank indicates the confidence score was higher when the panoramic exam was available, while a positive rank indicates higher diagnostic confidence scores after CBCT.

Classification	Rank	p-value	Mean PAN (SD)	Mean CBCT (SD)
IRB	11 negatives 42 positives 67 no change Total 120 answers	0.000*	3.50 (1.18)	4.13 (0.40)
DR	5 negatives 49 positives 66 no change Total 120 answers	0.000*	3.36 (1.08)	4.05 (0.56)
DN	5 negatives 49 positives 66 no change Total 120 answers	0.000*	2.88 (1.22)	3.96 (0.60)
TOTAL (n=30)	21 negatives 157 positives 182 no change Total 360 answers	0.000*	3.24 (1.18)	4.04 (0.53)

Thirty cases and 15 observers, comprising 360 answers on a 5-point Likert scale (from 1 – not confident to 5 – very confident). Significant difference according to the Wilcoxon test: *significant to $p \leq 0.001$. SD: standard deviation; IRB: interruption of the radiopaque borders of the canal. DR: darkening of the roots DN: diversion or narrowing of the canal; PAN: panoramic; CBCT: cone beam computed tomography.

anatomical details in M3M surgery cases.[16] Some analyses report that CBCT has a specificity of 93% and sensitivity of 77% for third molar intervention, while the specificity and sensitivity of panoramic radiography is 70% and 63%, respectively.[20,21] However, there is a lack of studies at levels 3 and 4, and the present study aimed to fill this gap. In this study, the answers were paired, allowing assessment of the impact of CBCT images. We observed that CBCT changed the diagnostic confidence in approximately 40% of the answers. The knowledge that CBCT can be more precise than 2D techniques for confirming the relationship between the tooth and the MC is essential to determine how this information provided by the 3D exam alters the surgeon's diagnostic thinking and treatment planning.[22-25] A study at level 3 assessed the differences between treatment planning made using panoramic radiography and CBCT and showed CBCT contributed to a more comprehensive surgical plan and risk assessment, minimizing the risk of injury to the IAN.[26] Likewise, Mendonça et al.[27] concluded that changes in the diagnosis after CBCT examination can lead to alterations in the treatment plan of impacted M3M.

Our results showed that the perception of surgical complexity changed before and after CBCT analysis. OMS changed their opinions about complexity in a higher numbers of M3M cases, particularly in the IRB and DR radiographic signs, classifying them as more complex. Considering the changes in answers that changed, 24.4% responded surgery was more complex after CBCT analysis. This result corroborates the data reported in a study in which 43.3% of cases interpreted with panoramic radiographs were classified as complicated extractions, compared to 77.8% when assessed by CBCT.[28]

Particular radiological signs seem to increase the risk of IAN injury: DR, IRB of the mandibular canal, and DN of the mandibular canal.[29-33] Canal narrowing seems to increase the risk of postoperative IAN damage (adjusted OR, 3.69).[34] Confidence comprises an individual perception about the diagnosis, clinical history, and treatment planning. In this study, we suppose that when OMS evaluated CBCT images, the relationship between M3M and MC was more explicit, increasing the confidence in performing diagnosis and planning the surgery, even though they also classified the surgery as more complex. On the other hand, some studies have shown that CBCT before M3M extraction was not superior to panoramic radiography for predicting postoperative complications and did not decrease the frequency of sensory disorders.[9,17,35,36]

The use of CBCT appears to encourage OMS while maintaining the pre-established patient treatment plan.[26] Given that surgical philosophies or the variability related to the OMS's time of practice were not within the scope of this study the questions about the type of surgery were not considered. Tooth extration and clinical and radiographic follow-up were the treatment choices offered. According to our results, the imaging exam was not associated with an

Table 5. Scores chosen in response to the question "Which treatment option would you choose?" before (PAN) and after CBCT.

Third molar signs	CBCT		CBCT		p-value
	Tooth extraction		Following-up the case		
	n	%	n	%	
IRB					
PAN – Tooth extraction	105	87.5%	6	5.0%	1.000[NS]
PAN – Following-up of the case	7	5.8%	2	1.7%	
DR					
PAN – Tooth extraction	97	80.8%	8	6.7%	0.815[NS]
PAN – Following-up of the case	10	8.3%	5	4.2%	
DN					
PAN – Tooth extraction	102	85.0%	9	7.5%	1.000[NS]
PAN – Following-up of the case	8	6.7%	1	0.8%	
Total[a]					
PAN – Tooth extraction	304	84.5%	23	6.4%	0.885 [NS]
PAN – Following-up of the case	25	6.9%	8	2.2%	

Thirty cases and 15 observers, comprising 360 answers. Values in bold indicate the proportion of agreement between answers to the PAN and CBCT questionnaires for each type of case (IRB, DR, DN). Significant difference: NS - not significant; IRB: interruption of the radiopaque borders of the canal. DR: darkening of the roots DN: diversion or narrowing of the canal; PAN: panoramic radiograph; CBCT: cone beam computed tomography.

Table 6. Answers to the question "Would you request an additional imaging exam?" before (PAN) and after CBCT.

Classification	CBCT - No		CBCT - Yes		p-value
	n	%	n	%	
IRB					
PAN - No	76	63.3%	4	3.3%	0.000*
PAN - Yes	39	32.5%	1	0.8%	
DR					
PAN - No	72	60.0%	4	3.3%	0.000*
PAN - Yes	43	35.8%	1	0.8%	
DN					
PAN - No	47	39.2%	1	0.8%	0.000*
PAN - Yes	70	58.3%	2	1.7%	
Totala					
PAN - No	195	54.2%	9	2.5%	0.000*
PAN - Yes	152	42.2%	4	1.1%	

Thirty cases and 15 observers, comprising 360 answers. Values in bold indicate the proportion of agreement between answers to the PAN and CBCT questionnaires for each type of case (IRB, DR, DN). *significant to $p \leq 0.001$; IRB: interruption of the radiopaque borders of the canal. DR: darkening of the roots DN: diversion or narrowing of the canal; PAN: panoramic radiograph; CBCT: cone beam computed tomography.

essential difference in choice of treatment, and in both cases, the most frequent answer was tooth extraction. Some researchers have pointed out it is essential to control other individualities such as patients' age, oral health (associated pathologies and diseases), and systemic factors for surgical treatment [31]. Some authors also consider that the decision to request CBCT before surgical removal of a M3M is based on legal concerns.[37] This trend may be intensified if recommendations are based on low evidence levels.[19,38]

Lastly, we found that in 56.6% of Q1 answers, the experts chose not to request an additional examination. In most cases, the OMSs would make the same treatment choice without additional information as they did when provided with CBCT but decided with a lower level of confidence (3.24 and 4.04 for PAN and CBCT, respectively). After CBCT, 72.8%, of the evaluators stated that the imaging exam was a determining factor for diagnosis and treatment judgments. This study was based on a retrospective model with some limitations such as the number of evaluators, but we should consider we have examiners enthused to carefully analyze each case. Still, understanding that the principles of justification, which inspired this study, were kept in mind, we expect more reviews to reinforce our results. Systematic reviews have concluded that there is still limited evidence on the diagnostic efficacy of CBCT for impacted M3M, so further studies with standardized parameters are necessary for a better comparability between the variables in the studies.[17,18,36] Our findings show a change in diagnostic and treatment confidence levels in approximately 40%, in which CBCT examination had a beneficial effect on both factors.

Conclusion

CBCT improved the level of confidence in diagnostic and treatment thinking of the M3M management while also increasing the perceived level of surgical complexity. The findings of this study support the need to consider using CBCT in diagnosis and treatment planning for M3M's with radiologic signs such as DR, IRB of mandibular canal, or DN of the mandibular canal.

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