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Systematic Review
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Influence of cone beam computed tomography versus panoramic radiography on the surgical technique of third molar removal: a systematic review

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Abstract. Panoramic radiography is the standard imaging method for preoperative assessment before lower third molar removal. However, oral surgeons have been using cone beam computed tomography (CBCT) as an additional tool to assess detailed preoperative data, as it provides cross-sectional images. The aim of this systematic review was to determine whether the use of CBCT and the additional information provided modifies the preoperative assessment of lower third molar removal when compared to panoramic radiography and consequently results in a different surgical approach. A search of the PubMed, Embase, Web of Science, Science Direct, and Scopus electronic databases was performed on 30 June 2018, which retrieved 196 records without duplicates. The grey literature was also searched to include any other paper that might meet the eligibility criteria, which resulted in an additional five records. Among these papers, five met all of the eligibility criteria. These five studies included a total of 289 individuals and a total sample of 311 teeth. The findings showed that three-dimensional imaging does not change the surgical approach when compared to panoramic radiography; however it is considered a useful imaging method to understand the relationship between the lower third molars and the mandibular canal.

Key words: third molar; panoramic radiography; cone beam computed tomography; oral surgery; review; systematic.

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Success rates for the surgical removal of lower third molars have increased over the last decades due to advances in imaging modalities. Conventional panoramic radiography remains the standard imaging method during the preoperative assessment. However, as a surgical procedure, the extraction of lower third molars is subject to risks and can lead to iatrogenic

injury and postoperative complications. Among these, inferior alveolar nerve (IAN) injury is the most serious complication and can result in neurosensory impairment of the lower lip and chin[1].

The incidence of transient neurosensory disturbance related to the IAN ranges from 0.4% to 9.4%[2–4]. In contrast, permanent sensory loss of the IAN occurs in about 1% of cases[5]. Studies have been conducted to evaluate the risk factors for IAN injury following the removal of lower third molars[4,6], which can be associated with direct or indirect trauma to the nerve by surgical instruments[1,4,6]. The incidence of this complication is influenced by the surgeon's expertise, anatomical and radiographic factors, bone density, and the age of the patient[7].

The preoperative assessment of the risk of an IAN deficit is commonly performed using two-dimensional (2D) radiographs, which are evaluated by the clinician to determine the degree and orientation of impaction and the vertical relationship between the apices of the lower third molar and the mandibular canal (MC). Radiographic risk predictor signs include darkening of the root, discontinuity of the superior radio-opaque line that constitutes the superior border of the inferior alveolar canal, diversion of the mandibular canal, deflection of the root, narrowing of the root, narrowing of the mandibular canal and bifid root apex[7,8].

The significant correlation between sensory loss of the IAN and the close vertical proximity of the lower third molar roots and the MC has been addressed in studies using different imaging modalities[4,8,9]. When panoramic radiography is insufficient to access the intimate relationship of these anatomical structures, three-dimensional (3D) imaging is required[10–12], since the proximity of the structures can influence the surgical preoperative planning[1].

Cone beam computed tomography (CBCT) allows the relationship of the bone structures and the third molars to be visualized in cross-sectional images with better spatial resolution[13]. Additionally, it permits the type of impaction, the size of the follicle, the inclination of the long axis of the tooth, the 3D position of the tooth and its relationship with the MC, and the amount of bone around the tooth to be classified[7].

Detailed preoperative data is important to determine the risk of IAN injury according to the relationship of the MC with the lower third molar[1]. Thus, CBCT provides precise information for the clinician to evaluate and determine the preoperative surgical risk of neurosensory injury and may allow them to modify their surgical technique in order to decrease postoperative complications[7,8].

This systematic review was performed to determine whether the use of CBCT and the additional information provided modifies the preoperative assessment of lower third molar removal when compared to panoramic radiography and consequently results in a different surgical approach.

Methods

This systematic review was conducted in accordance with the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)[14].

All studies met the criteria established by the PICO strategy: participants (P) were individuals with a lower third molar requiring removal; the intervention (I) was CBCT; the control (C) was panoramic radiography; the outcome (O) was a description of the difference in preoperative planning for the extraction of lower third molars using CBCT as compared to panoramic radiography through the use of questionnaires.

The protocol of this systematic review was registered in the PROSPERO database (CRD42018096701) and is available at http://www.crd.york.ac.uk/PROSPERO/.

Sources of information

A thorough literature review was conducted to identify studies comparing the preoperative assessment of lower third molar removal using two imaging methods (CBCT and panoramic radiography) through questionnaires. The identification of studies was based on a search strategy for each of the following electronic databases: PubMed, Embase, Web of Science, Science Direct, and Scopus.

Search strategy

A detailed search strategy was performed, structured with Boolean operators (AND/OR) and designed to identify all relevant studies on the assessment of lower third molar removal through panoramic radiography and CBCT published up to 30 June 2018. The following descriptors were used: (Molar, Third OR Tooth, Wisdom) AND (Cone Beam Computed Tomography OR Tomography, Cone Beam Computed OR Tomography, Volume Computed OR CAT Scan, Cone Beam OR Cone Beam CT) AND (Canal mandibular) NOT (Review). Also, the grey literature was searched in order to include any additional paper that might meet the eligibility criteria.

The reference management software EndNote Web (http://www.myendnoteweb.com) was used to collect and save the records. The records were also checked for duplicate references.

Process of data collection

The study selection was analyzed independently by two calibrated reviewers (MPM and GTTA) to avoid bias and ensure that they met the eligibility criteria for the review. The identification of studies for inclusion was divided into two stages: in the first stage, the title and abstract of each paper were read; in the second stage, the full-text articles were read. Any discrepancies during the identification of studies at each stage were resolved in consensus meetings. Details of the study selection process are given in Fig. 1.

Selection criteria

To be included in the study sample, the publications had to meet the selection criteria listed in Table 1. Descriptive literature reviews, clinical reports, and series of clinical reports were excluded, as well studies that evaluated the anatomical structures and the relationship of the lower third molar roots with the MC, studies that only assessed the risk of IAN injury, studies addressing the use of panoramic radiography and CBCT for other types of surgery, and studies on teeth other than lower third molars.

Data extraction

Data extracted from each study were analyzed and sorted by two independent examiners, and the following characteristics were obtained: author, year of publication, study country of origin, number of patients, sex and age of the patients, sample (number of teeth), risk assessment for IAN injury, any change in surgical technique. Data were collected using a standardized form, considering only information available in the papers. The details of each study are presented in Table 2.

Analysis of the quality of included studies

The studies were analyzed to identify the risk of bias in the aims, methods, sampling, data analysis, ethics and bias, and reporting of results. The checklist of Hawker et al.[15] and modified by McEvoy

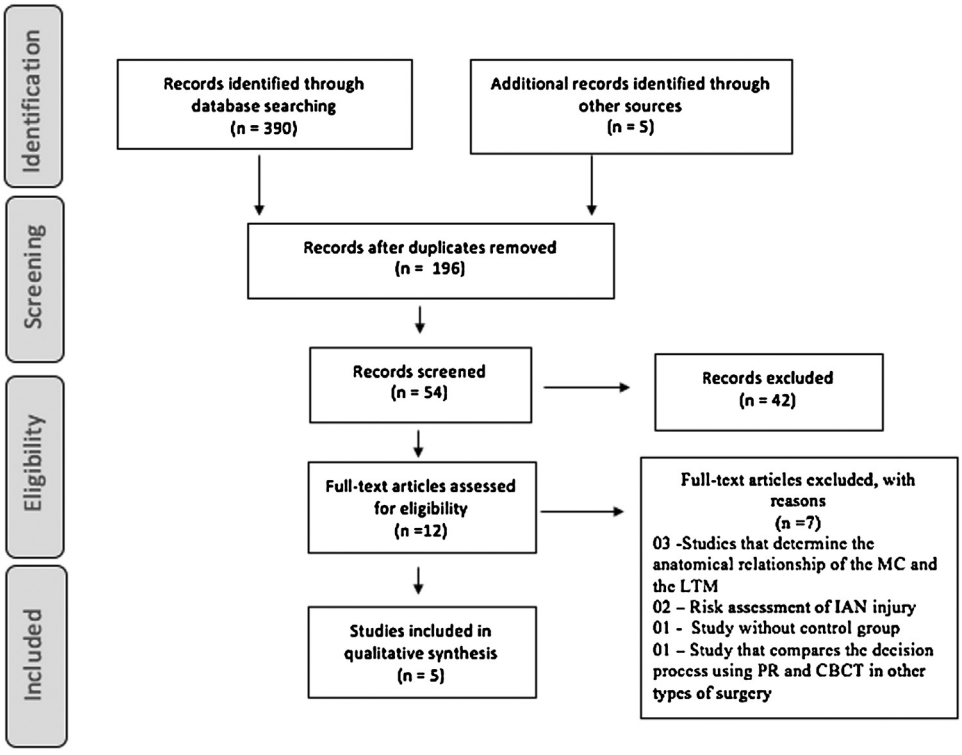

Fig. 1. Diagram showing the selection of articles for the systematic review (MC, mandibular canal; LTM, lower third molar; IAN, inferior alveolar nerve; PR, panoramic radiography; CBCT, cone beam computed tomography).

Table 1. Selection criteria for final inclusion.

Control group: panoramic radiography
Experimental group: CBCT
Studies with assessment prior to the extraction of the lower third molar
Studies comparing the planning of the surgical technique through questionnaires, using panoramic radiography only and with CBCT after

et al.[16], was used to determine the quality of the studies according to the following scoring system: good = 4, fair = 3, poor = 2, very poor = 1; a lower score indicates poor quality. Using this quality scale, a study can receive a maximum of 36 points, corresponding to the highest quality and therefore a low risk of bias. The scores for each question clearly indicate the strengths and weaknesses of each study.

Results

Research and selection of studies

Overall, 395 records were identified during the database search. These were saved in EndNote Web for the removal of duplicate records, after which 196 papers remained; 54 were retained after reading the title and abstract and 42 of these were excluded because they did not meet the eligibility criteria. Seven further articles were then excluded, three because they focused on studying the relationship between the MC and the lower third molar[8,17,18], two because they evaluated the risk assessment of IAN injury[19,20], one for not meeting the inclusion criteria of having a control group (panoramic radiography) and an experimental group[21], and one for focusing on types of surgery other than the removal of lower third molars[22]. Finally, this review included five studies that met all eligibility criteria (Fig. 1)[1,12,23–25]. These studies were published between 2011 and 2017 and were conducted in the Netherlands[1], Denmark[24], Israel[12], Brazil[25], and the USA[23].

Types of studies

Three of the five studies were prospective[1,23,24] and two were cross-sectional studies[12,25]. This systematic review included studies that evaluated whether there were differences in the preoperative planning for lower third molar removal when using CBCT imaging in addition to panoramic radiography, through questionnaires answered by oral and maxillofacial surgeons.

Sample sizes and characteristics

A total of 289 patients were evaluated in the five studies. The average age of the patients was 25.9 years, with a range of 18.2 to 68.3 years[1,23,24]; two studies did not report the mean age or age range of the patients[12,25]. All of the studies reported the inclusion of subjects with an increased risk of IAN injury, as diagnosed on panoramic radiographs, with the exception of the study by Manor et al., which did not specifically report this factor[1,23–25]. The overall sample size of the studies was 311 impacted lower third molars[1,23–25]; one study did not report the sample of teeth analyzed, only the number of patients evaluated, and did not specify whether one or more teeth per patient were included in the sample[12].

Types of intervention

The review included studies comparing the preoperative assessment of lower third molar removal using additional information provided by CBCT and how this affected the treatment decision regarding the surgical technique, through questionnaires answered by oral and maxillofacial surgeons. The control was the surgical technique based on panoramic radiography. The intervention was the change in surgical technique after the patient had undergone CBCT imaging.

Evaluation of the images

All studies included reported a professional evaluation of the images by oral and

Table 2. Characteristics of the studies included in the review.

Authors and year	Country	Study design	Number of patients	Sex Average age (years)	Sample of molars	Questions regarding the surgical technique answered by the surgeon	Risk of IAN injury after CBCT	Change in surgical technique after CBCT	Benefits of using CBCT
Ghaeminia et al.[1], 2011	Netherlands	Prospective	40	M 20, F 20 27.6	53 Impacted	Removal of buccal bone; elevator placement; tooth sectioning; direction of tooth removal	Lower	Yes	Buccolingual relationship of the MC with roots of the lower third molar
Matzen et al.[24], 2013	Denmark	Prospective	135	M 68, F 67 25.5	186 NA	Full extraction and coronectomy	NA	No	Buccolingual relationship of the roots/position of the MC
Aravindaksha et al.[23], 2015	USA	Prospective	36	M 16, F 20 24.6	52 Impacted	Removal of buccal bone; elevator placement; coronectomy; direction of tooth removal	Same	No	NA
Sampieri[25], 2015	Brazil	Cross-sectional	16	M 10, F 6 NA	20 Impacted	Coronectomy and removal of buccal bone	NA	No	Buccolingual relationship of the MC with the lower third molar roots
Manor et al.[12], 2017	Israel	Cross-sectional	62	NA NA	NA NA	Full extraction and coronectomy	NA	No	Buccolingual relationship of the roots/number and morphology of roots

CBCT, cone beam computed tomography; F, female; IAN, inferior alveolar nerve; M, male; MC, mandibular canal; NA, information not available.

maxillofacial surgeons[1,12,23–25]. Overall, 19 dental professionals were responsible for assessing the images ($n = 2$[1], $n = 9$[12], $n = 3$[23], $n = 3$[24], $n = 2$[25]).

Equipment

Only two out of the five studies reported the type of panoramic radiography used. Both used digital panoramic radiography (Soredex, Helsinki, Finland; 81 kV and 10 mA)[1,24].

CBCT scans were acquired using the i-CAT 3D imaging system (Imaging Sciences International Inc., Hatfield, PA, USA) in two studies[1,25]. However, images were acquired using two different protocols. Ghaeminia et al. used 120 kVp, 3–8 mA, focal spot 0.5 mm, field of view (FOV) 6 cm, voxel size 0.25 mm, scan time 20 s, and slice thickness 1 mm. Sampieri used 120 kVp, 18,45 mAs, focal spot 0.5 mm, voxel size 0.3 mm, and scan time 20 s. Matzen et al. used two different CBCT units during their study: NewTom 3 G (QR srl, Verona, Italy) to scan 83 third molars and Scanora 3D (Soredex, Helsinki, Finland) to scan 103 third molars[24]; however, the scan protocols were not reported. Two studies did not report the CBCT equipment used to acquire the 3D images[12,23].

Outcomes

The primary outcome was to describe through questionnaires the difference in the preoperative assessment of lower third molar removal using the additional information provided by CBCT compared to panoramic radiography. The secondary outcomes were to determine when to indicate CBCT and the risk assessment of IAN injury comparing the two imaging methods.

Changes in preoperative surgical assessment through CBCT and panoramic radiography according to the questionnaires

The data were collected using questionnaires in all five studies[1,12,23–25]. Oral and maxillofacial surgeons were asked to answer questions regarding the removal of buccal bone, elevator placement, need for coronectomy, and direction of tooth removal based on the two imaging methods in two studies[1,23]. In contrast, Manor et al. and Matzen et al. asked the surgeons whether they would perform a full extraction or a coronectomy (full extraction yes/no, coronectomy yes/no) after assessing the CBCT scans and panoramic radio-

graphs[12,24]. Differently from the other studies, the surgeons in the study by Sampieri were asked whether they would perform a coronectomy or remove buccal bone during surgery[25].

Surgical technique

Four studies reported that the surgical technique for removing the lower third molar did not change with the additional information from CBCT[12,23–25]. Only one study found that the surgical technique changed after the evaluation of CBCT images compared to panoramic radiography[1].

Ghaeminia et al. reported that the analysis of the additional information provided in the cross-sectional CBCT images led to a different surgical approach[1]. It was possible for the surgeons to determine whether it was necessary to remove buccal bone, to place elevators safely without crushing the IAN, and to remove extra bone after the coronectomy. According to that study, the assessment of panoramic radiographs alone was not sufficient to decide which direction the lower third molar should be luxated in 87% of cases. On the other hand, the impact of CBCT during the assessment resulted in surgeon confidence regarding the surgically planned direction of tooth removal in all cases. In 88% of cases where the MC was positioned buccal to the lower third molar, the surgeon planned to luxate the tooth in a buccal direction, thereby rotating the apex into a lingual direction[1].

According to Manor et al., despite several cases (eight cases) in which the treatment decision following CBCT image analysis changed from full extraction to coronectomy, the treatment decision could be based on the information provided solely by panoramic radiography[12]. Although the conduct did not change, there was consensus regarding the need for CBCT scans to plan the method of tooth removal in order to avoid intraoperative complications.

Matzen et al. reported that the treatment plan based on panoramic radiography alone or combined with a stereo-scanogram was the same in 88% of the cases[24]. A change happened in only 12% of the cases, which consisted of a change from full extraction to coronectomy. The decision regarding tooth sectioning was also made on the basis of direct contact (no bony separation) between the lower third molar and the MC assessed on CBCT; however this was not considered a major factor for deciding on coronectomy (37 coronectomies for 91 teeth with direct contact)[24].

Although Aravindaksha et al. found some inconsistencies across the surgeons, the results of their study showed that additional 3D imaging did not change the surgical planning and technique when compared with panoramic radiography. There was full agreement between the professionals for parameters such as coronectomy and elevator placement during the evaluation with both imaging methods[23].

Sampieri concluded that CBCT imaging was not superior to panoramic radiography in determining the need for buccal bone removal. Regarding coronectomy, panoramic radiography showed a better agreement with surgery than CBCT. Nevertheless, the evaluation of cross-sectional images revealed slightly fewer indications for coronectomy in these cases[25].

Indications for CBCT imaging

Manor et al. stated that oral surgeons do not need CBCT for the treatment decision, but that most oral surgeons preferred to examine 3D images in cases with signs indicating root proximity to the IAN for extraction planning. The authors also added that the proximity of the roots to the thin lingual plate and its width can only be assessed in 3D images, and that this can contribute to minimizing some intraoperative complications such as the risk of lingual plate fracture during an extraction and a displaced residual root in the submandibular space[12].

For Sampieri, the best indication for CBCT would be those cases in which a high vertical position of the MC superimposed onto the cervical part of the roots of the lower third molar is observed in the panoramic radiograph[25].

Other authors reported that the use of CBCT is only indicated in cases where there is an intimate relationship between the lower third molar and the MC or direct contact (no bony separation) of the structures[1,24].

Risk assessment of IAN injury—comparison of the two imaging methods

Based on CBCT images, a significant number of lower third molars were reclassified as having a lower risk for IAN injury than was determined on panoramic radiography in the study by Ghaeminia et al.[1]. Aravindaksha et al. showed no significant difference between the two imaging methods in the prediction of nerve injury[23]. Manor et al. concluded that the assessment of risk could be made solely according to panoramic radiography, but that referral for CBCT is necessary when the patient has a lot of questions regarding the risks[12]. Sampieri addressed the assessment of the risk of IAN injury according to the position of the MC in relation to the roots of the lower third molar, but did not have a conclusive result due to the small sample size of the study[25]. Matzen et al. did not evaluate the injury risk scale of the two imaging modalities[24].

Analysis of the quality of studies

This review applied the checklist of Hawker et al.[15], as modified by McEvoy et al.[16], in which each study may achieve a maximum of 36 points. The study by Ghaeminia et al.[1] had a total score of 36 points, Manor et al.[12] and Matzen et al.[24] received 35 points. Sampieri et al.[25] had a score of 31 points and Aravindaksha et al.[23] had a score of 30 points. Thus, all five studies included in this review presented good methodological quality, reaching scores close to 36, which represents optimal methodological quality. These studies are therefore reliable and may serve as a basis for future studies in this field (Table 3).

Discussion

Regarding the surgical technique, most of the studies stated that there was no statistically significant difference in the treatment decision when panoramic radiography was compared to CBCT[12,23–25]. However, Ghaeminia et al. reported that 3D information contributed to a dramatic surgical change in the direction of tooth removal, which was associated with the buccolingual relationship between the lower third molar and the MC as determined on CBCT images, and that surgeons were able to safely determine whether to remove buccal bone, place elevators, and remove extra bone after coronectomy[1].

Ghaeminia et al.[1] and Aravindaksha et al.[23] were able to assess the impact of CBCT by dividing the surgical planning into subgroups: removal of buccal bone, elevator placement, tooth sectioning, and direction of tooth removal. However, the results differed. Although the study of Aravindaksha et al.[23] showed some inconsistency in the results, they concluded that CBCT imaging does not change the surgical planning and technique when compared with panoramic radiography.

Studies that were in agreement with that of Aravindaksha et al.[23], concluding that CBCT provided negligible information

Table 3. Methodological quality score of Hawker et al. (2002)[15], modified in the study of McEvoy et al. (2014)[16], for the internal validity of the included studies.

Checklist	Article				
	Ghaeminia et al.[1], 2011	Aravindaksha et al.[23], 2015	Matzen et al.[24], 2013	Manor et al.[12], 2017	Sampieri[25], 2015
1. Abstract and title: Did they provide a clear description of the study?	Good = 4	Good = 4	Good = 4	Good = 4	Good = 4
2. Introduction and aims: Was there a good background and clear statement of the aims of the research?	Good = 4	Good = 4	Good = 4	Good = 4	Good = 4
3. Method and data: Is the method appropriate and clearly explained?	Good = 4	Good = 4	Good = 4	Good = 4	Good = 4
4. Sampling: Was the sampling strategy appropriate to address the aims?	Good = 4	Fair = 3	Good = 4	Good = 4	Poor = 2
5. Data analysis: Was the description of the data analysis sufficiently rigorous?	Good = 4	Fair = 3	Good = 4	Good = 4	Good = 4
6. Ethics and bias: Have ethical issues addressed, and what has necessary ethical approval gained? Has the relationship between researchers and participants been adequately considered?	Good = 4	Good = 4	Good = 4	Good = 4	Good = 4
7. Results: Is there a clear statement of the findings?	Good = 4	Poor = 2	Good = 4	Good = 4	Poor = 2
8. Transferability or generalizability: Are the findings of this study transferable (generalizable) to a wider population?	Good = 4	Poor = 2	Fair = 3	Fair = 3	Fair = 3
9. Implications and usefulness: How important are these findings to policy and practice?	Good = 4	Good = 4	Good = 4	Good = 4	Good = 4
Total	36	30	35	35	31

regarding the treatment decision, only evaluated whether to perform a full extraction or to perform a coronectomy[12,24]. In addition to coronectomy, Sampieri also evaluated whether to remove buccal bone during tooth extraction[25]. However, the author concluded that the anatomical variation in the study sample was not sufficient to determine changes in surgical technique, which explained why no significant differences in the results were found[25].

When establishing the treatment plan, whether to perform a full extraction or to do a coronectomy, the assessment of panoramic radiographs is sufficient to determine this[12,23–25]. However, in cases where there are signs indicating root proximity to the IAN, the additional information from CBCT might provide security for the surgeon by allowing an understanding of the relationship between the MC and the lower third molar, such as direct contact (no bony separation) between these anatomical structures[24], the number of roots, root morphology, and the vertical position of the MC[8,13]. Consequently, these data may influence a surgical change, such as the direction of tooth extraction and the removal of extra bone, preventing harmful movements of the roots in relation to the IAN or the incorrect use of burs or elevators.

Determining whether to perform a full extraction or a coronectomy is an important part of surgery planning. According to systematic reviews, coronectomy is associated with significantly less loss of sensitivity of the IAN and prevents the occurrence of dry socket[26,27]. Coronectomy is indicated in cases where the lower third molar is in intimate contact with the MC, and where full extraction may cause injury to the nerve, as was seen in the study of Matzen et al.[24] in which 12% of surgeons changed from full extraction to coronectomy due to the proximity of these structures.

Although Manor et al. stated that 3D imaging may provide a backup for the inexperienced surgeon[12], the authors agreed with others that the use of CBCT should be indicated only in cases of high-risk tooth removal as suggested by signs on panoramic radiography and/or for coping with intraoperative complications[1,11,12,25,28]. The decision to perform a preoperative radiograph should be based on the 'as low as reasonably achievable' (ALARA) principle[29]. CBCT results in a higher radiation dose than conventional panoramic radiography[30], thus dental surgeons should evaluate the real necessity of additional CBCT imaging carefully.

The prediction of IAN injury as assessed by panoramic radiography is determined on the basis of seven signs of a close relationship between the MC and lower third molar: the interruption of the white line of the mandibular canal wall; darkening of the root; diversion of the mandibular canal; narrowing of the mandibular canal; narrowing of the roots; and deflection of the roots[1,7,31,32]. However, some studies have concluded that three signs are significantly more related to IAN injury: diversion of the inferior alveolar canal, darkening of the root, bifid root apex, and interruption of the white line[33,34].

The results of the study by Ghaeminia et al. showed that the risk of IAN injury was minimized after analyzing 3D images[1]. In order to prove the usefulness of CBCT in reducing the prevalence of IAN injury, large randomized clinical trials as performed by Petersen et al. are needed[35]. In that study, it was found that CBCT was not superior to panoramic radiography for avoiding IAN injury and it was concluded that the use of CBCT before removal of a lower third molar does not seem to reduce the number of neurosensory disturbances[35].

The identification of appropriate indications for CBCT prior to lower third molar removal is important, due to the prevalence of IAN neurosensory disturbances associated with the proximity of the structures (MC and lower third molar). The results of the present study are relevant because this is a common procedure in the daily practice of the dental surgeon and the use of additional 3D information could improve the surgical planning and minimize the risk of IAN injury. Moreover, this review provides information on the possible qualitative evaluations that may be used for the analysis of outcomes.

The systematic literature review identified five studies that met all eligibility criteria according to the PICO strategy parameters. Overall, these papers gathered a sample of 311 impacted lower third molars among 289 patients evaluated. Based on the results, evidence was found that preoperative CBCT assessment of the lower third molar resulted in no difference in treatment planning or surgical technique when compared to panoramic radiography. However, this systematic review is limited by the relatively small sample sizes[25], and each study evaluated different surgical technical parameters. These parameters should be standardized in future prospective studies with larger sample sizes.

With the exception of two studies[1,23], the surgical planning evaluated was limited to coronectomy, full extraction, or/and removal of buccal bone[12,24,25]. However, the extraction of impacted lower third molars is a complex procedure subject to postoperative complications that demands in-depth knowledge of the professionals[1]. In order to better address the subject of this systematic review and add more information to the article, it will be necessary to explore the surgical technique in greater detail in further studies, as was done in the studies by Ghaeminia et al. and Aravindaksha et al., with the inclusion of the direction of tooth removal, the need for additional bone removal after coronectomy, and the correct positioning of the extractors.

In conclusion, the results of this systematic review show that CBCT imaging does not change the surgical approach for third molar removal when compared with panoramic radiography. However, CBCT is indicated when signs suspicious for root proximity to the MC are revealed on panoramic radiography. 3D imaging can be useful as a backup, providing additional information on the relationship between the lower third molar and the MC, thereby giving confidence to the surgeon and consequently preventing harmful movements during surgery that might cause neurosensory disturbances of the IAN.

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Competing interests

The authors declare that there is no conflict of interest.

Ethical approval

Not required.

Patient consent

Not required.

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