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Accuracy of cone-beam computed tomography in detecting MB2 canals in maxillary molars

Precisão da tomografia computadorizada de feixe cônico na detecção dos canais MB2 em molares superiores

Precisión de la tomografía computarizada de haz cónico en la detección de los canales MB2 en molares superiores

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ABSTRACT

Objective: To evaluate the accuracy of cone-beam computed tomography (CBCT) in detecting second mesiobuccal (MB2) canals in maxillary first molars. **Methods:** A systematic review was conducted in accordance with PRISMA 2020 and registered in PROSPERO (CRD420251067699). Searches were performed in MEDLINE (via PubMed), BVS, LILACS, Cochrane Library, and Google Scholar for studies published between 2013 and 2025. Eligible studies included clinical trials, observational studies, systematic reviews, and meta-analyses evaluating CBCT for MB2 detection in maxillary first molars. Exclusion criteria were case reports, animal studies, and experimental models. Data extraction covered study design, population characteristics, imaging protocols, and MB2 prevalence. The certainty of evidence was assessed with the GRADE approach. **Results:** From 2,502 records, seven studies met the inclusion criteria. CBCT showed higher diagnostic accuracy than conventional radiographs, with MB2 prevalence ranging from 69.6% to 92%. No significant differences were found between right and left maxillary molars. Findings regarding sex and age were inconsistent, while ethnicity, Vertucci classifications, and inter-orifice distances were reported as influencing factors. Certainty of Evidence ranged from moderate to high. **Final considerations:** CBCT is a reliable and accurate tool for detecting MB2 canals in maxillary first molars, improving diagnostic capacity, treatment planning, and endodontic outcomes.

Keywords: Endodontics, Cone-beam computed tomography, Root canal therapy.

RESUMO

Objetivo: Avaliar a acurácia da tomografia computadorizada de feixe cônico (TCFC) na detecção do segundo canal mesiobucal (MB2) em primeiros molares superiores. **Métodos:** Foi realizada uma revisão sistemática de acordo com o PRISMA 2020 e registrada no PROSPERO (CRD420251067699). As buscas foram realizadas no MEDLINE (via PubMed), BVS, LILACS, Cochrane Library e Google Scholar para estudos publicados entre 2013 e 2025. Os estudos elegíveis incluíram ensaios clínicos, estudos observacionais, revisões sistemáticas e meta-análises que avaliaram a TCFC para a detecção do MB2 em primeiros molares superiores. Os critérios de exclusão foram relatos de caso, estudos com animais e modelos experimentais. A extração de dados abrangeu o desenho do estudo, as características da população, os protocolos de imagem

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e a prevalência do MB2. A certeza da evidência foi avaliada com a abordagem GRADE. **Resultados:** De 2.502 registros, sete estudos atenderam aos critérios de inclusão. A tomografia computadorizada de feixe cônico (CBCT) demonstrou maior precisão diagnóstica do que as radiografias convencionais, com prevalência de MB2 variando de 69,6% a 92%. Não foram encontradas diferenças significativas entre os molares superiores direito e esquerdo. Os achados referentes a sexo e idade foram inconsistentes, enquanto etnia, classificação de Vertucci e distância interorifícios foram relatados como fatores de influência. A certeza da evidência variou de moderada a alta. **Considerações finais:** A CBCT é uma ferramenta confiável e precisa para detectar canais MB2 em primeiros molares superiores, aprimorando a capacidade diagnóstica, o planejamento do tratamento e os resultados endodônticos.

Palavras-chave: Endodontia, Tomografia computadorizada de feixe cônico, Terapia endodôntica.

RESUMEN

Objetivo: Evaluar la precisión de la tomografía computarizada de haz cónico (CBCT) en la detección de segundos conductos mesiobucales (MB2) en primeros molares maxilares. **Métodos:** Se realizó una revisión sistemática de acuerdo con PRISMA 2020 y se registró en PROSPERO (CRD420251067699). Se realizaron búsquedas en MEDLINE (a través de PubMed), BVS, LILACS, Cochrane Library y Google Scholar para estudios publicados entre 2013 y 2025. Los estudios elegibles incluyeron ensayos clínicos, estudios observacionales, revisiones sistemáticas y metaanálisis que evaluaron CBCT para la detección de MB2 en primeros molares maxilares. Los criterios de exclusión fueron informes de casos, estudios en animales y modelos experimentales. La extracción de datos abarcó el diseño del estudio, las características de la población, los protocolos de imágenes y la prevalencia de MB2. La certeza de la evidencia se evaluó con el enfoque GRADE. **Resultados:** De 2502 registros, siete estudios cumplieron los criterios de inclusión. La CBCT mostró una mayor precisión diagnóstica que las radiografías convencionales, con una prevalencia de MB2 que osciló entre el 69,6 % y el 92 %. No se encontraron diferencias significativas entre los molares maxilares derechos e izquierdos. Los hallazgos relativos al sexo y la edad fueron inconsistentes, mientras que la etnia, las clasificaciones de Vertucci y las distancias entre orificios se reportaron como factores influyentes. La certeza de la evidencia varió de moderada a alta. **Consideraciones finales:** La CBCT es una herramienta fiable y precisa para detectar conductos MB2 en los primeros molares maxilares, lo que mejora la capacidad diagnóstica, la planificación del tratamiento y los resultados endodóncicos.

Palabras clave: Endodoncia, Tomografía computarizada de haz cónico, Terapia del conducto radicular.

INTRODUCTION

In the endodontics field, the evaluation of the anatomy and morphology of root canals is of utmost importance for a successful endodontic treatment (MARTINS JNR, et al., 2019; PATEL S, et al., 2019; CHOGLE S, et al., 2020). Nevertheless, in some cases, the endodontist is unable to identify the location of additional canals using only conventional radiography, making the use of cone-beam computed tomography (CBCT) necessary (MARTINS JNR, et al., 2019; PATEL S, et al., 2019; CHOGLE S, et al., 2020). Most of these cases occur in permanent molars, which have a very complex canal system (MARTINS JNR, et al., 2019; PATEL S, et al., 2019; CHOGLE S, et al., 2020; NASSEH I e AL-RAWI W, 2018; MARTINS JNR, et al., 2020). In maxillary permanent molars, especially the mesiobuccal (MB) root, there are two main root canals, known as MB1 and MB2 (MARTINS JNR, et al., 2019; PATEL S, et al., 2019), and the high incidence of fine anatomical structures such as intercanal communications, loops, accessory canals, and apical ramifications results in a very complex canal system (MARTINS JNR, et al., 2019; PATEL S, et al., 2019; CHOGLE S, et al., 2020; NASSEH I e AL-RAWI W, 2018; MARTINS JNR, et al., 2020).

In this context, the use of CBCT in dentistry allows for three-dimensional visualization of anatomical structures in axial, sagittal, and coronal planes (NASSEH I e AL-RAWI W, 2018). This advanced imaging technique helps overcome the limitations of conventional 2D radiographs, which compress complex anatomical

details into flat images; CBCT provides a much clearer and more detailed view and thus enhances diagnostic precision and treatment planning (NASSEH I e AL-RAWI W, 2018).

Because of this challenging morphology, the incidence of missed canal anatomy in the maxillary first molar is between 41.3% and 46.5% (CHOGLE S, et al., 2020; MARTINS JNR, et al., 2020), the highest of all other treated teeth (MARTINS JNR, et al., 2020; ZHUK R, et al., 2020). This high failure rate is related to the difficulty in locating and instrumenting the second mesiobuccal canal (MB2) in the mesiobuccal root, mainly due to its variable location (PATEL S, et al., 2019; MARTINS JNR, et al., 2020; ZHUK R, et al., 2020). Moreover, ethnicity is a predisposing factor in these anatomical variations, including the number of roots (CAPUTO BV, et al., 2016). In the Brazilian population, it has been difficult to correlate internal configuration and the number of canals in roots due to the diversity and heterogeneity of the population (CAPUTO BV, et al., 2016; SILVA EJNL, et al., 2021). Therefore, the aim of this study was to verify, through a systematic review, the effectiveness of cone-beam computed tomography in identifying the second canal (MB2) in the mesiobuccal root of the maxillary first molar.

METHODS

This systematic review was conducted to evaluate the accuracy of cone-beam computed tomography (CBCT) in detecting the second mesiobuccal canal (MB2) in maxillary first molars. Furthermore, the research question was formulated according to the PICO framework: In patients undergoing endodontic evaluation of maxillary first molars, how effective is CBCT compared with conventional diagnostic methods such as two-dimensional radiography, microscopy, or ultrasonics in detecting the MB2 canal? The review was conducted in accordance with PRISMA 2020 guidelines (Figure 1), and the protocol was prospectively registered in PROSPERO (CRD420251067699).

Search strategy and information sources

A comprehensive electronic search was conducted in MEDLINE (via PubMed), BVS, LILACS, Cochrane Library, and Google Scholar to identify relevant studies published between January 2013 and March 2025. The final search was performed in March 2025.

The search strategy combined Medical Subject Headings (MeSH) and free-text terms, including “Endodontics”, “Root Canal Therapy”, “Cone-Beam Computed Tomography”, “Maxillary First Molar”, and “MB2 canal”, combined using Boolean operators (AND/OR). To reduce the risk of publication bias, grey literature was also searched using Google Scholar, applying the same search strategy and eligibility criteria used for the electronic databases. Reference lists of all included studies were manually screened to identify additional eligible articles.

All records retrieved from the searches were imported into Rayyan, a web-based systematic review management tool, where duplicates were removed and title and abstract screening were performed independently by the reviewers.

Eligible studies included randomized clinical trials, clinical studies, systematic reviews, or meta-analyses that investigated the detection of MB2 canals in maxillary first molars using CBCT. Only human studies published in English within the defined timeframe were considered. Exclusion criteria included animal studies, experimental models, case reports, monographs, and cohort studies (**Tables 1** and **2**). The language restriction was applied due to feasibility constraints and to ensure accurate data interpretation.

Study selection and reviewer calibration

Four reviewers independently screened titles and abstracts for eligibility. Prior to screening, a calibration exercise was performed to ensure consistent application of the inclusion and exclusion criteria. During this process, a subset of records was independently evaluated by all reviewers, and discrepancies were discussed to clarify eligibility definitions and harmonize decision-making.

Following calibration, all records were screened independently. Studies deemed potentially eligible by consensus were retrieved for full-text assessment. Disagreements at any stage of the selection process were resolved through discussion, and when consensus could not be reached, a fifth reviewer adjudicated the final decision.

Risk of bias assessment and data synthesis

The methodological quality of the included studies was evaluated using the QUADAS-2 tool, which assesses potential sources of bias across four domains: patient selection, index test, reference standard, and flow and timing. For each study, these domains were judged for risk of bias, and applicability concerns were considered for patient selection, index test, and reference standard. The overall certainty of the evidence was further appraised using the GRADE framework, considering methodological limitations, inconsistency of results, indirectness of evidence, imprecision, and the likelihood of publication bias.

Substantial heterogeneity was observed among the included studies regarding study design, population characteristics, CBCT acquisition protocols, reference standards, and outcome reporting, which prevented the performance of quantitative synthesis. The available evidence included systematic reviews and meta-analyses, as well as mainly retrospective cross-sectional observational studies based on CBCT image analysis, conducted in populations that varied in age, sex distribution, and geographic origin. These clinical and methodological differences made a meta-analysis inappropriate. Therefore, a narrative synthesis was adopted, and the findings were organized to focus on MB2 detection rates, the diagnostic performance of CBCT, and anatomical or demographic factors influencing canal prevalence.

RESULTS

The study selection process is presented in the PRISMA flow diagram (**Figure 1**). The electronic database search yielded a total of 2,502 records, including 627 from MEDLINE, 21 from LILACS, 56 from BIREME, 28 from the Cochrane Library, and 1,770 from Google Scholar. After applying the predefined eligibility filters (human studies, full-text availability, systematic reviews, meta-analyses, controlled or randomized clinical trials, and publications between 2013 and 2025) a total of 2,454 records were excluded.

The remaining 48 records were screened by title to determine their relevance to the review question, leading to the exclusion of 9 studies. Subsequently, 39 articles were retrieved and assessed in full text according to the established inclusion and exclusion criteria. Following this evaluation, 32 studies were excluded, and 7 studies were ultimately included in the qualitative synthesis.

The included studies comprised systematic reviews, cross-sectional CBCT-based investigations, and diagnostic accuracy studies. These investigations were conducted in Brazil (Martins et al., 2020; Candeiro et al., 2019; Blank-Gonçalves et al., 2025), Egypt (Ghobashy et al., 2017), Portugal (Fernandes et al., 2019), Thailand (Ratanajirasut et al., 2018), and the United States (Azim et al., 2017), representing research from South America, Europe, Asia, Africa, and North America. This broad geographic distribution reflects the global interest in evaluating the prevalence of the second mesiobuccal (MB2) canal in maxillary molars.

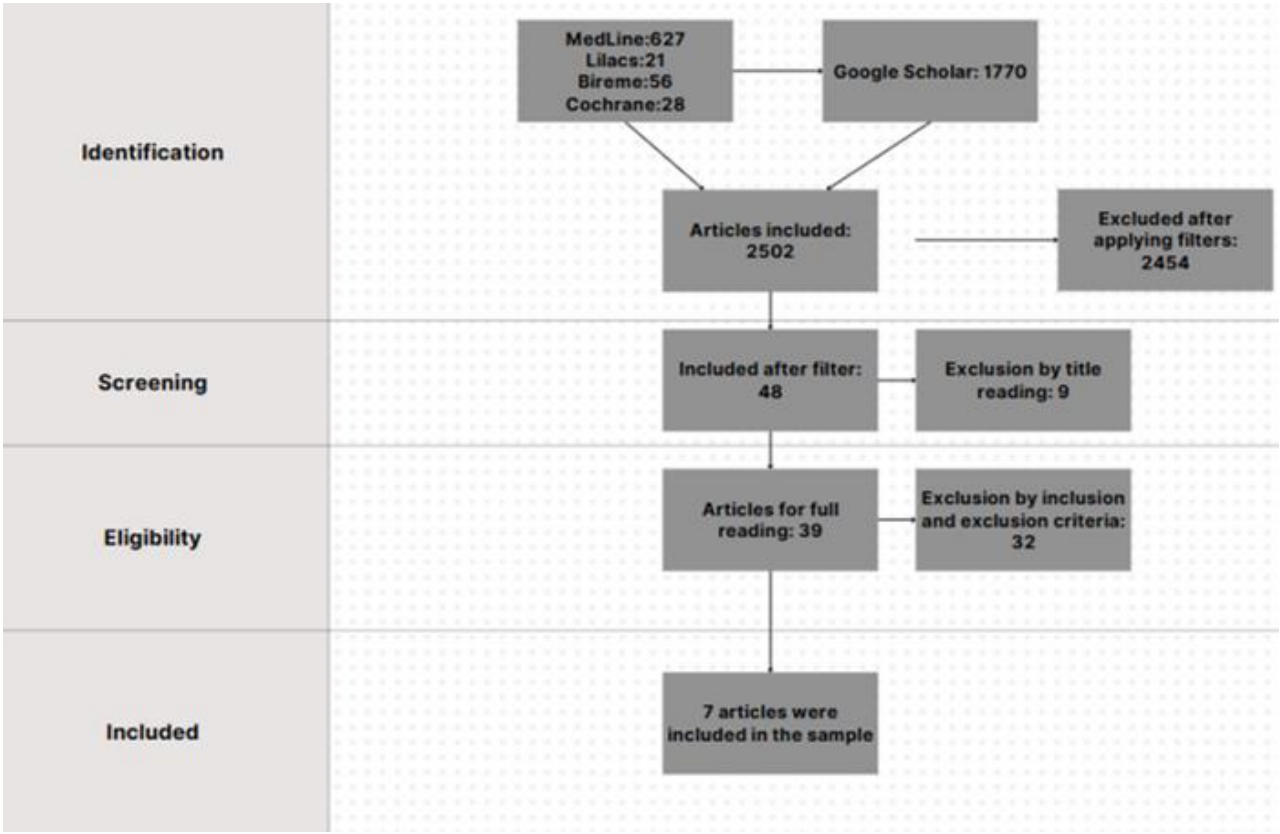
Most of the primary studies were in vivo, cross-sectional investigations using cone-beam computed tomography, with sample sizes ranging from several hundred to more than 15,000 maxillary molars. The study populations were predominantly adult, with reported age ranges approximately between 16 and 75 years. CBCT acquisition protocols varied among studies, particularly with respect to voxel size and field of view, reflecting differences in image resolution and diagnostic thresholds. Despite this methodological heterogeneity, all included studies consistently demonstrated superior detection of the MB2 canal using CBCT compared with conventional radiographic methods.

To assess the scientific quality of the included studies, a search was conducted on the Sucupira Platform, analyzing each journal in which the studies were published. A summary table was created to characterize and describe each publication found (**Table 3**). GRADE was also used to analyze the quality of the studies (**Table 4**).

The authors of the studies evaluated suggested that MB and multiple canals were more frequent in 1MS, and the canals had significant anatomy variability and bilateral presentation of MB were also detected in some patients. The prevalence in certain sex was debatable between the authors; some found a higher prevalence of MB in men whilst other did not find any distinction between sexes.

This systematic review provides a comprehensive synthesis integrating anatomical predictors, diagnostic accuracy, and certainty of evidence. Our findings suggest that CBCT is a reliable tool for detecting MB canals, and it should definitely be considered when diagnosing complex cases.

Figure 1 - Prisma flow chart.



Source: Dantas MCFR, et al., 2026.

Table 1 - Inclusion and Exclusion Criteria.

Category	Inclusion Criteria	Exclusion Criteria
Sample	Patients of both sexes	Studies on animal or experimental models
Diagnosis	CBCT for identification of MB2 canal in the mesiobuccal root (MBR) of first maxillary molars (1MS)	–
Type of Publication	Full-text articles: systematic reviews, meta-analyses, clinical trials (controlled or randomized)	Case reports, dissertations, cohort studies, abstracts, conference proceedings
Period	Published between 2013 and 2025	Articles published before 2013

Source: Dantas MCFR, et al., 2026.

Table 2 - Main Variables Analyzed.

Variable	Description	Objective

1	Effectiveness of CBCT in identifying MB2 canal in MBR of 1MS	Evaluate diagnostic capacity of CBCT
2	Comparison between CBCT and conventional methods in identifying MB2 canal in MBR of 1MS	Verify whether CBCT is superior, equivalent, or inferior to conventional methods

Source: Dantas MCFR, et al., 2026.

Table 3 - Summary of included studies.

Nº	Study (Author, Year)	Sample Size	Results	Outcome
1	Martins et al., 2020	26 studies; 15,285 1MS, 8,641 2MS; 12,456 patients (5,541 men, 6,915 women); Mean age: 40.9 years	MB2 more prevalent in 1MS (69.6%) than 2MS (39%); Higher in males; Significant geographic variation	Higher MB2 prevalence in 1MS; sex and geographic differences influence prevalence
2	Ghobashy et al., 2017	657 patients (CBCT scans); Age 16–75 years	No significant association of MB2 with sex, age, or tooth position	CBCT improves diagnosis of root canal morphology
3	Fernandes et al., 2019	800 teeth (200 patients: 100 males, 100 females)	MB2 in 1MS: 92% (tooth 16), 87% (tooth 26); 2MS: 69% (tooth 17), 65% (tooth 27); No age/sex difference	MB2 more common in 1MS; significant variability in anatomy
4	Candeiro et al., 2019	1,501 teeth (700 1MS, 801 2MS); 512 patients (184 men, 328 women); Mean age: 44.5 years	MB2 in 1MS: 48.2%; 2MS: 22.7%; 3–4 canals found in both	MB2 and multiple canals more frequent in 1MS
5	Ratanajirasut et al., 2018	476 1MS, 457 2MS	MB2 in 1MS: 63.6%; 2MS: 29.4%; Bilateral MB2: ~81–83%	Bilateral MB2 canals frequently observed; higher in 1MS
6	Azim et al., 2017	1,200 CBCT scans (600 males, 600 females); adults 18+	MB2 detected in 88% of 1MS; no sex differences	Very high MB2 prevalence in 1MS; CBCT recommended
7	Blank-Gonçalves et al., 2025	820 maxillary molars; adult patients	MB2 observed in 61.4% of 1MS and 32.1% of 2MS; Bilateral MB2 in 78% of cases	MB2 is more common in 1MS; bilateral presentation frequent; CBCT enhances visualization
Legend	MB2 = Second mesiobuccal canal	1MS = First maxillary molar	2MS = Second maxillary molar	CBCT = Cone Beam Computed Tomography

Source: Dantas MCFR, et al., 2026.

Table 4 - Risk of Bias and Certainty of Evidence.

Study (Author, Year)	Risk of Bias (QUADAS-2)	Applicability Concerns	GRADE Certainty of Evidence
Martins et al., 2020	Moderate: Meta-analysis includes heterogeneous studies	Low: Based on Brazilian journals with regional focus	Moderate: Heterogeneity affects consistency
Ghobashy et al., 2017	Low: Clear inclusion/exclusion; CBCT applied consistently	Low: Good generalizability across sexes and ages	High: Robust design and low bias
Fernandes et al., 2019	Low: Balanced sample by sex; appropriate CBCT use	Low: Clear patient selection and imaging protocol	High: Well-controlled study with strong methodology
Candeiro et al., 2019	Moderate: Gender imbalance, possible selection bias	Low: Sample from broad population; CBCT use supports accuracy	Moderate: Risk of bias limits confidence

Ratanajirasut et al., 2018	Moderate: Limited demographic data; unclear blinding	Low: CBCT application appropriate	Moderate: Some bias, findings consistent
Azim et al., 2017	Low: Large sample, good demographics, clear protocol	Low: High-quality CBCT used consistently	High: Strong methodological clarity
Blank-Gonçalves et al., 2025	Low: Rigorous imaging, large sample, accurate anatomical interpretation	Low: High-resolution CBCT enhances reliability	High: Well-conducted diagnostic accuracy study

Source: Dantas MCFR, et al., 2026.

DISCUSSION

It is still not possible to affirm which sex shows a higher prevalence of having the MB2 (PATEL S, et al., 2019; SILVA EJNL, et al., 2021; CANDEIRO GT, et al., 2019; ZHENG Q, et al., 2010; BETANCOURT P, et al., 2016; ZAND V, et al., 2017).According to Silva EJNL, et al. (2021), Candeiro GT, et al. (2019) e Zheng Q, et al. (2010), the prevalence of the second mesiobuccal canal in maxillary molars is higher in men than in women. On the other hand, Betancourt P, et al. (2016) e Zand V, et al. (2017) argue that this prevalence is only true for second molars, while MB2 is more commonly found in women in first molars. Moreover, Betancourt P, et al. (2016) proposes the theory that the lower detection rate of MB2 in women, as found by Zheng Q, et al. (2010), could be explained by demineralization and bone mass loss, which is more pronounced in women over time, causing difficult visualization of the canal on CBCT due to lack of contrast (BETANCOURT P, et al., 2016). However, this theory has not yet been proven (BETANCOURT P, et al., 2016). In contrast, Ghobashy AM, et al. (2017) e Fernandes NA, et al. (2019) concluded that there were no significant differences between sex and second mesiobuccal canal prevalence.

Dental morphology is typically evaluated using conventional radiographs (FERNANDES NA, et al., 2019). Thus, these are inadequate for detecting additional canals such as MB2, as they provide a 2D representation of 3D structure (FERNANDES NA, et al., 2019). In contrast, CBCT provides three-dimensional imaging, enhancing visualization of these structures (FERNANDES NA, et al., 2019). The difficulty in visually detecting this canal with the naked eye is due to several factors, including variation in position, small diameter, calcification, and presence of pulp stones (IMURA N, et al., 1998). Therefore, the 3D imaging provided by CBCT increases the success rate of endodontic treatment, since precise anatomical knowledge of the treated tooth is crucial (RATANAJIRASUT R, et al., 2018).

Other studies have shown that the frequency of detecting the second mesiobuccal canal in maxillary first molars without the aid of instruments ranged from 17.2% to 56.7% (BUHRLEY LJ, et al., 2002; PATEL S, et al., 2019; CAPUTO BV, et al., 2016). When magnification tools like loupes were used, the frequency increased to around 62.7% (CAPUTO BV, et al., 2016; BUHRLEY LJ, et al., 2002; SMADI L e KHRAISAT A, 2007). The detection rate of these canals can increase by up to threefold when visual enhancement methods are used (WOLCOTT J, et al., 2005). When scanning electron microscopy was used, MB2 detection rates were 73.2% and 67%, respectively, in maxillary first molars (STROPKO JJ, 1999; ALAÇAM T, et al., 2008). Alaçam T, et al. (2008) also noted that when microscopy was combined with ultrasound, MB2 detection rose to 74%.

In contrast, CBCT-based studies reported MB2 prevalence in maxillary first molars ranging from 69.6% to 92% (ZHUK R, et al., 2020; CANDEIRO GT, et al., 2019; ZHENG Q, et al., 2010; FERNANDES NA, et al., 2019; IMURA N, et al., 1998; RATANAJIRASUT R, et al., 2018; BUHRLEY LJ, et al., 2002). This suggests that CBCT offers greater precision in locating the MB2 canal. Maxillary first molars exhibit a higher frequency of second mesiobuccal canal compared to second molars (CANDEIRO GT, et al., 2019; ZHENG Q, et al., 2010; FERNANDES NA, et al., 2019; IMURA N, et al., 1998; RATANAJIRASUT R, et al., 2018; BUHRLEY LJ, et al., 2002). Additionally, Ratanajirasut R, et al. (2018) observed bilateral MB2 canals in 80.93% and 82.59% of first and second maxillary molars, respectively. Regarding tooth anatomy, Candeiro GT, et al. (2019) found that first molars have a higher prevalence of four canals compared to second molars. As stated by the author, age is another factor affecting MB2 prevalence (CANDEIRO GT, et al., 2019). Several authors state that patients under 50 are more likely to present a second mesiobuccal canal (MARTINS JNR, et al., 2018; LEE

JH, et al., 2011; ALRAHABI M e ZAFAR MS, 2015). Nevertheless, Fernandes NA, et al. (2019) did not find a significant association between age and MB2 prevalence.

In relation to root quantity for maxillary first molars, a three-root configuration was observed in 100% of patients (FERNANDES NA, et al., 2019). For second maxillary molars, the most common configuration was also three roots (87.7%), followed by two roots (10.66%) and single-rooted (1.64%) (ZHENG Q, et al., 2010; MARTINS JNR, et al., 2019; FERNANDES NA, et al., 2019). Similarly, Candeiro GT, et al. (2019) reported higher prevalence of three roots in first molars (99.1%) compared to second molars. Still, Alrahabi M e Zafar MS (2015) found that 94% of first molars had three roots, while 6% had four roots (ALRAHABI M e ZAFAR MS, 2015; ZHUK R, et al., 2020).

Ghobashy AM, et al. (2017) e Zhang Y, et al. (2017) state that the tooth's position (right or left) did not affect the statistical prevalence of MB2. In addition, the inter-orifice distance ratio can help in predicting the presence of MB2 (ZHANG Y, et al., 2017; KESKIN C, et al., 2021). This ratio is calculated between the mesiobuccal and palatal canal orifices and the distobuccal and palatal orifices. A ratio greater than 1.26 was strongly indicative of the presence of MB2 (MARTINS JNR, et al., 2019; KESKIN C, et al., 2021). Keskin C, et al. (2021) supported this by stating that, in second maxillary molars with fused roots, the mesiobuccal-palatal distance measured by CBCT yielded an acceptable prediction for MB2 diagnosis. Therefore, CBCT is a precise tool, not only for detecting but also for locating the MB2 canal in vivo in maxillary molars (BETANCOURT P, et al., 2016).

The Vertucci's Type I configuration is more frequent in second molars than in first molars and becomes more common with increasing age in the mesiobuccal root (CANDEIRO GT, et al., 2019). In agreement, Ratanajirasut R, et al. (2018) reported that in maxillary first molars, Vertucci Type I occurred in 36.4% of cases, followed by Type II (28.8%) and Type IV (25.3%). Ghobashy AM, et al. (2017), however, found in the Egyptian population that Types II, I, and IV occurred in 45.62%, 25.45%, and 27.27% of cases, respectively. Likewise, Pérez-Heredia M, et al. (2017) reported Vertucci Type II (2–1) in 56.5% of cases and Type IV (2–2) in 23.2%. Conversely, Guo J, et al. (2014) found that Vertucci Type IV was the most common configuration in the North American population.

Other studies reported Vertucci Types I and II in mesiobuccal roots and that the likelihood of MB2 presence could exceed 70% (ALRAHABI M e ZAFAR MS, 2015). However, the exact percentage cannot be confirmed, as it varies depending on patient nationality (GHOBASHY AM, et al., 2017; RATANAJIRASUT R, et al., 2018; PÉREZ-HEREDIA M, et al., 2017; GUO J, et al., 2014; COELHO MS, et al., 2018; ZHANG X, et al., 2019; SILVA EJ, et al., 2014). The mesiobuccal roots of maxillary molars show greater anatomical variation in canal systems than distobuccal and palatal roots (ALRAHABI M e ZAFAR MS, 2015; SILVA EJ, et al., 2014). This is likely due to the higher frequency of two canals in mesiobuccal roots compared to distobuccal and palatal roots (ALRAHABI M e ZAFAR MS, 2015; PÉREZ-HEREDIA M, et al., 2017).

Cone-beam computed tomography (CBCT) has emerged as a pivotal imaging modality in endodontics, offering three-dimensional visualization that significantly enhances diagnostic accuracy and treatment evaluation (AZIM AA e ALAUGAILY I, 2017; BLANK-GONÇALVES LM, et al., 2025). Nascimento EHL, et al. (2018) demonstrated a substantial prevalence of technical deficiencies and associated periapical pathology in endodontically treated teeth, findings made possible through CBCT analysis, which surpasses the limitations of conventional two-dimensional imaging. Kumar R (2014) documented an exceptional case of a maxillary first molar exhibiting seven canals, a morphological complexity that was unequivocally confirmed using CBCT. These studies emphasize the critical role of CBCT in detecting anatomical variations and procedural shortcomings, thereby reinforcing its value in optimizing endodontic outcomes and supporting evidence-based clinical decision-making (NASCIMENTO EHL, et al., 2018; KUMAR R, 2014).

In this context, the detection of second mesiobuccal (MB2) canals in maxillary molars remains a critical aspect of successful endodontic treatment, and recent studies have emphasized the enhanced diagnostic accuracy afforded by CBCT (AZIM AA e ALAUGAILY I, 2017; BLANK-GONÇALVES LM, et al., 2025). Azim AA e Alaugaily I (2017) demonstrated that the use of CBCT significantly increases the clinical detection rate of MB2 canals when compared to traditional methods, reinforcing its value as a diagnostic adjunct.

Complementing this, Blank-Gonçalves LM, et al. (2025) utilized high-resolution CBCT to provide detailed anatomical insights into the MB2 canal configuration, highlighting the complex and variable nature of these canals. Together, these findings show the importance of incorporating CBCT into routine endodontic diagnostics, particularly for maxillary molars, to improve treatment planning and outcomes through more accurate canal identification.

Although the studies demonstrate high accuracy of CBCT in detecting MB2 canals, its indication should follow a rational, case-specific approach rather than routine use. Therefore, conventional radiographs should remain the first imaging choice due to their lower radiation dose and cost-effectiveness. CBCT becomes particularly relevant when there is strong clinical suspicion of an MB2 canal based on access cavity findings or anatomical hints, when attempts to locate the canal have failed despite the use of magnification and ultrasonics, or in cases of persistent endodontic failure such as retreatment scenarios. Additional factors, including patient age (with higher MB2 prevalence observed in individuals under 50 years), the presence of pulp calcifications or unusual anatomical configurations, and suspected iatrogenic complications, further justify its use. These recommendations should be considered to balance the diagnostic benefits of CBCT with patient safety, cost considerations, and adherence to the ALARA principle, ensuring that CBCT is reserved for situations in which accurate MB2 detection significantly impacts treatment outcomes.

Clinical implications and evidence appraisal

The findings of this systematic review suggest that CBCT may influence clinical management in selected cases by improving the identification of the MB2 canal in maxillary first molars, particularly when conventional periapical radiographs and clinical magnification are inconclusive. Its main clinical value lies in teeth with complex anatomy, unclear canal configurations, or persistent signs and symptoms after initial treatment, where CBCT information may lead to modifications in access preparation, canal negotiation, or retreatment decisions. CBCT should not be used routinely and must be justified on a case-by-case basis, in accordance with the ALARA principle, being most appropriately indicated when the additional anatomical information is expected to influence diagnosis, treatment planning, or prognosis.

Strengths and limitations

This review followed the PRISMA 2020 guidelines and was prospectively registered in PROSPERO, with methodological quality and certainty of evidence assessed using QUADAS-2 and GRADE, supporting a transparent and structured appraisal of the findings. However, substantial heterogeneity among study designs, CBCT protocols, and outcome definitions precluded meta-analysis and limited the synthesis to a qualitative approach. In addition, restriction to English-language publications and variability in risk of bias, particularly related to patient selection and reference standards, reduced the overall certainty of the evidence and should be considered when interpreting the results.

FINAL CONSIDERATIONS

CBCT is a highly accurate diagnostic tool for detecting MB2 canals in maxillary molars and offers clear advantages over conventional methods. However, its use should be selective rather than routine. Indications are strongest in anatomically complex cases, suspected MB2 presence after unsuccessful conventional attempts, and retreatments where detection impacts prognosis. A judicious, evidence-based approach ensures the clinical benefits of CBCT are realized without compromising patient safety or increasing costs unnecessarily.

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REFERENCES

1. AZIM AA, ALAUGAILY I. Prevalence of MB2 canals in maxillary molars and its subsequent clinical detection using CBCT: a comparative clinical study. J Endod, 2017; 43: 608–12.
2. ALRAHABI M, ZAFAR MS. Evaluation of root canal morphology of maxillary molars using cone-beam computed tomography. Pak J Med Sci, 2015; 31: 426–30.
3. ALAÇAM T, et al. Second mesiobuccal canal detection in maxillary first molars using microscopy and ultrasonics. Aust Endod J, 2008; 34: 106–9.
4. BLANK-GONÇALVES LM, et al. Anatomical configuration of the MB2 canal using high-resolution cone-beam computed tomography. J Endod, 2025; 51: 609–15.
5. BUHRLEY LJ, et al. Effect of magnification on locating the MB2 canal in maxillary molars. J Endod, 2002; 28: 324–7.
6. BETANCOURT P, et al. Prevalence and location of the secondary mesiobuccal canal in 1,100 maxillary molars using cone-beam computed tomography. BMC Med Imaging, 2016; 16: 66.
7. CHOGLE S, et al. The recommendation of cone-beam computed tomography and its effect on endodontic diagnosis and treatment planning. J Endod, 2020; 46: 162–8.
8. CAPUTO BV, et al. Evaluation of the root canal morphology of molars by using cone-beam computed tomography in a Brazilian population: Part I. J Endod, 2016; 42: 1604–7.
9. CANDEIRO GT, et al. Internal configuration of maxillary molars in a subpopulation of Brazil's Northeast region: a CBCT analysis. Braz Oral Res, 2019; 33: e082.
10. COELHO MS, et al. Locating the second mesiobuccal canal in maxillary molars: challenges and solutions. Clin Cosmet Investig Dent, 2018; 10: 195–202.
11. FERNANDES NA, et al. The prevalence of second canals in the mesiobuccal root of maxillary molars: a cone-beam computed tomography study. Aust Endod J, 2019; 45: 46–50.
12. GUO J, et al. Evaluation of root and canal morphology of maxillary permanent first molars in a North American population by cone-beam computed tomography. J Endod, 2014; 40: 635–9.
13. GHOBASHY AM, et al. Evaluation of root and canal morphology of maxillary permanent molars in an Egyptian population by cone-beam computed tomography. J Endod, 2017; 43: 1089–92.
14. IMURA N, et al. Two canals in mesiobuccal roots of maxillary molars. Int Endod J, 1998; 31: 410–4.
15. KESKIN C, et al. Mesiobuccal and palatal interorifice distance may predict the presence of the second mesiobuccal canal in maxillary second molars with fused roots. J Endod, 2021; 47: 585–91.
16. KUMAR R. Report of a rare case: a maxillary first molar with seven canals confirmed with cone-beam computed tomography. Iran Endod J, 2014; 9:153–7.
17. LEE JH, et al. Mesiobuccal root canal anatomy of Korean maxillary first and second molars by cone-beam computed tomography. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2011; 111: 785–91.
18. MARTINS JNR, et al. Prevalence studies on root canal anatomy using cone-beam computed tomographic imaging: a systematic review. J Endod, 2019; 1: 1–15.
19. MARTINS JNR, et al. Second mesiobuccal root canal in maxillary molars: a systematic review and meta-analysis of prevalence studies using cone-beam computed tomography. Arch Oral Biol, 2020; 113: 104589.
20. MARTINS JNR, et al. Worldwide analyses of maxillary first molar second mesiobuccal prevalence: a multicenter cone-beam computed tomographic study. J Endod, 2018; 44: 1641–9.
21. NASSEH I, AL-RAWI W. Cone beam computed tomography. Dent Clin North Am, 2018; 62: 361–91.
22. NASCIMENTO EHL, et al. Prevalence of technical errors and periapical lesions in a sample of endodontically treated teeth: a CBCT analysis. Clin Oral Investig, 2018; 22: 2495–503.
23. PATEL S, et al. Cone-beam computed tomography in endodontics: a review of the literature. Int Endod J, 2019; 52: 1138–52.
24. PÉREZ-HEREDIA M, et al. Cone-beam computed tomographic study of root anatomy and canal configuration of molars in a Spanish population. J Endod, 2017; 43: 1511–6.
25. RATANAJIRASUT R, et al. A cone-beam computed tomographic study of root and canal morphology of maxillary first and second permanent molars in a Thai population. J Endod, 2018; 44: 56–61.
26. SILVA EJ, et al. Evaluation of root canal configuration of maxillary molars in a Brazilian population using cone beam computed tomographic imaging: an in vivo study. J Endod, 2014; 40:173–6.
27. SMADI L, KHRAISAT A. Detection of a second mesiobuccal canal in the mesiobuccal roots of maxillary first molar teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 2007; 103: e77–81.
28. SILVA EJNL, et al. Prevalence of root canal system configurations in the Brazilian population analyzed by cone-beam computed tomography: a systematic review. Rev Port Estomatol Med Dent Cir Maxilofac, 2021; 62:69–80.
29. STROPKO JJ. Canal morphology of maxillary molars: clinical observations of canal configurations. J Endod, 1999; 25:446–50.

30. WOLCOTT J, et al. A 5-yr clinical investigation of second mesiobuccal canals in endodontically treated and retreated maxillary molars. J Endod, 2005; 31: 262–4.
31. ZHUK R, et al. Locating the MB2 canal in relation to MB1 in maxillary first molars using CBCT imaging. Aust Endod J, 2020; 46: 184–90.
32. ZHENG Q, et al. A cone-beam computed tomography study of maxillary first permanent molar root and canal morphology in a Chinese population. J Endod, 2010; 36: 1480–4.
33. ZAND V, et al. Root canal morphologies of mesiobuccal roots of maxillary molars using cone-beam computed tomography and periapical radiographic techniques in an Iranian population. J Contemp Dent Pract, 2017; 18: 745–9.
34. ZHANG Y, et al. Assessment of the second mesiobuccal root canal in maxillary first molars: a cone-beam computed tomographic study. J Endod, 2017; 43: 1990–6.
35. ZHANG X, et al. Investigating the anatomical relationship between the maxillary molars and the sinus floor in a Chinese population using cone-beam computed tomography. BMC Oral Health, 2019; 19:282.