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REVIEW ARTICLE

Prevalence of middle mesial canal using cone beam computed tomography: A systematic review and meta-analysis

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KEYWORDS

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Mesial root;
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Mandibular molar;
Cone-beam computed tomography

Abstract *Background:* The presence of middle mesial canals in mandibular molars are not commonly encountered in daily practice. However, locating and debriding such anatomical variation during the endodontic therapy is essential to avoid endodontic failure. The aim of this systematic review was to identify the overall prevalence of middle mesial canals (MMC) in mandibular molars using cone-beam computed tomography (CBCT), to assess the influence of different gender on the prevalence of MMCs in mandibular molars and to describe the MMC configurations.

Methods: The review protocol was registered in the PROSPERO database (CRD42021238523). The main electronic databases were searched until February 2022 for prevalence studies on root/canal anatomy in mandibular molars using CBCT imaging, in addition to hand-searched scientific articles in peer-reviewed journals and grey literature. The quality of the included studies was assessed using the Joanna Briggs Institute Critical Appraisal tool. Egger's and Begg's tests and Pearson's chi-square test were used for statistical analysis.

Results: From 523 records, 488 studies were excluded after screening the title and abstract. 35 relevant studies were included for full-text assessment and 28 studies were included in the meta-analysis. The overall prevalence of MMC out of the 19,256 teeth was 5.09% (95% CI: 2.894 to 7.784). The prevalence of MMC was 9.79% (95% CI: 4.296 to 17.224) in males and 13.96% (95% CI: 0.541 to 40.737) in females with a statistically significant difference of 4.16% (95% CI: 2.29 to 6.01). The most MMC configuration found in this review to be confluent with the mesiobuccal canal.

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Conclusion: The results showed an overall 5.09% prevalence of MMC in mandibular molars, with a significantly high prevalence in female subjects. Additionally, this canal was found to be confluent with the mesiobuccal canal.

Contents

1. Introduction

Endodontic treatment is essential to eradicate microorganisms and biofilms by proper chemomechanical debridement and to provide a watertight seal along the root canal system using an inert obturating material (Vertucci, 1984). The complexity of the root canal system usually poses a challenge in achieving this goal (Vertucci, 2005). One of the main reasons for endodontic failure is the presence of an unidentified canal that has not been debrided (Karabucak et al., 2016). Therefore, extensive knowledge of the internal tooth morphology and proper radiographic interpretation must be performed prior to initiating endodontic therapy.

Mandibular molar teeth usually have a mesial root containing two canals, a mesiobuccal (MB) and a mesiolingual (ML) canal, and a distal root with a single canal (Barker et al., 1969). Nevertheless, anatomical variation within the root canal system of mandibular molars is present, and an isthmus, which is a narrow pulp tissue connection between adjacent canals, could lead to rare morphologic variations, such as additional canals (Barker et al., 1969). In 1974, the presence of an additional canal in the mesial root of mandibular molars was reported and described as the middle mesial canal (MMC) (Barker et al., 1974; Vertucci and Williams, 1974).

The middle mesial canal has three possible canal configurations, as classified by Pomeranz et al. (Pomeranz et al., 1981): independent canals, fin type, and confluent canals between the MB and ML canal. The independent type originates and terminates as an individual canal, and the fin type allows the instrument to pass freely between the MB or ML and MMC and does not have a separate orifice. However, the confluent type originates as a separate orifice but joins the MB or ML canals apically. Several studies have reported that the most common type of MMC is confluent, followed by the fin type, and the independent type is rarely identified (Aldosimani et al., 2021; Rehman et al., 2020; Srivastava et al., 2018).

The prevalence of MMC has been documented in different populations to vary from 0.26% to 53.8% (Arayasantiparb, R et al., 2017; Kantilieraki, 2019; Senthil, K and Solete, P, 2021; Tahmasbi et al., 2017). The first mandibular molar was associated with a higher prevalence of MMC than the second molar (Bansal et al., 2018; Palottil, A et al., 2021). The large discrepancy in MMC prevalence reported in the literature could be due to differences in the study methodologies, sample sizes, and sample ethnicities.

To date, no systematic review or meta-analysis reporting the overall prevalence of middle mesial canals in mandibular molars using reliable diagnostic tools such as cone-beam computed tomographic imaging (CBCT) has been published. Thus, this systematic review aimed to identify the overall prevalence of middle mesial canals in mandibular molars using CBCT, to assess the influence of different gender on the prevalence of middle mesial canals in mandibular molars and to describe the MMC configurations.

2. Materials and methods

2.1. Search strategy and sources

The protocol of this systematic review and meta-analysis was registered in the International Prospective Register of Systematic Reviews database (CRD42021238523) and conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009).

The main electronic databases were accessed (PubMed, Science Direct, Google scholar, Cochrane Library, Cochrane Collaboration, Scopus preview, Lilacs and Web of Science), and a search was undertaken between August 2021 and February 2022 for prevalence studies on root/canal anatomy using CBCT imaging. Additionally, the search was expanded by including the gray literature and hand-searched scientific articles in five relevant peer-reviewed scientific journals (International Endodontic Journal, Journal of Endodontics, Australian Endodontic Journal, Evidence-Based Dentistry and Journal of Evidence-Based Dental Practice) (Supplemental Table S1).

Study selection, data extraction, and risk of bias assessment were performed independently by 2 reviewers (SB and SA). Any disagreement between reviewers was resolved by discussing their search results or a third reviewer (AB).

2.2. Inclusion and exclusion criteria

The inclusion criteria included prevalence studies of the middle mesial canal of permanent mandibular first and/or second molars that were given or could be calculated. Sample size (teeth) was given. Evaluation occurred under CBCT using a

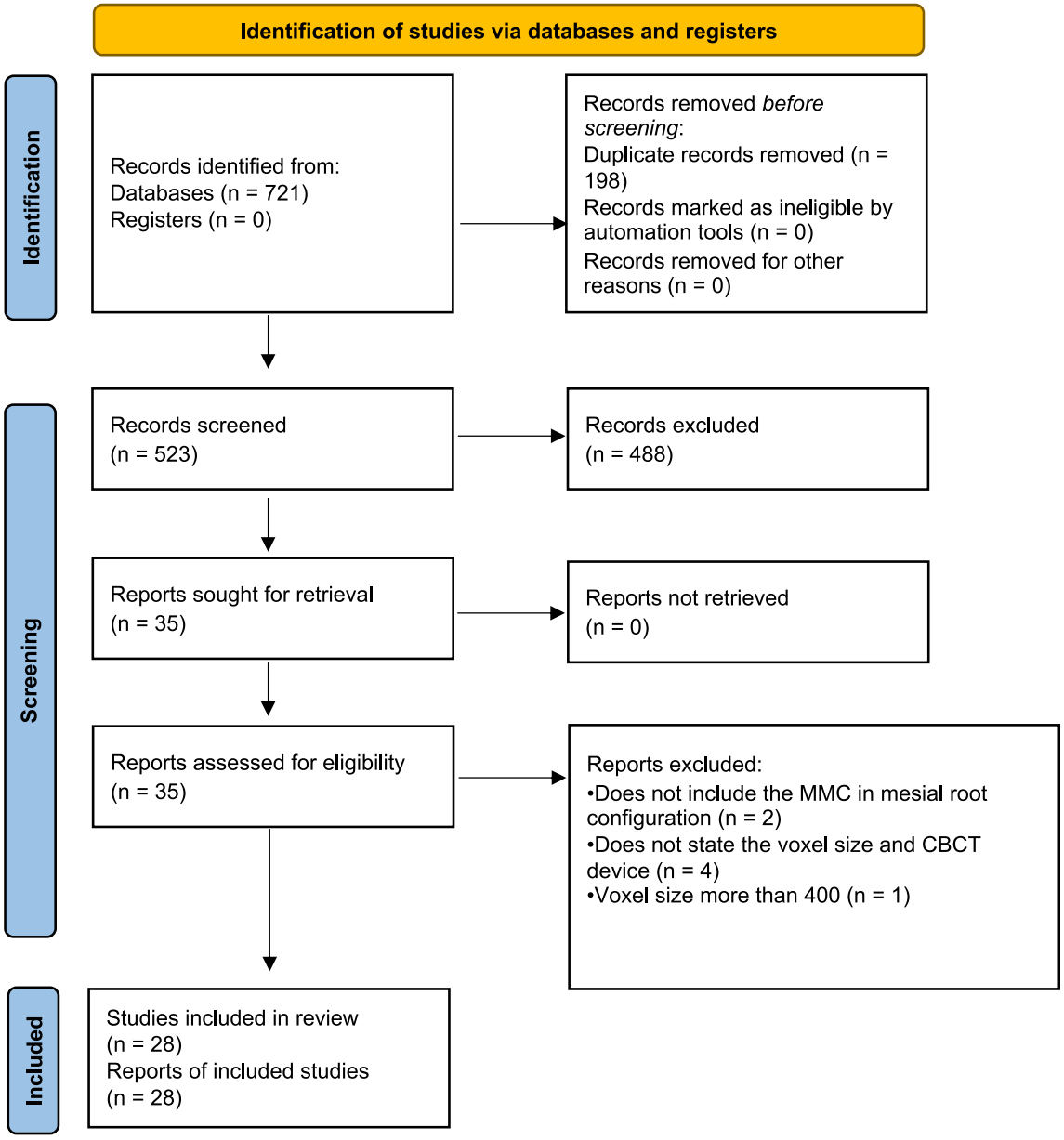

Fig. 1 PRISMA 2020 flow diagram for the systematic reviews and meta-analysis.

Table 1 Summery of the included studies.

Study ID (Author & year)	*Country*	*CBCT device*	*Voxel size (μm)*	*Number of subjects*	*Males/ Females*	*Number of teeth*	*Number of first mandibular teeth*	*Number of second mandibular teeth*	*Overall Prevalence of MMC*	*Prevalence of MMC in first molar*	*Prevalence of MMC in second molar*	*Number of Teeth in males*	*MMC prevalence in males*	*Number of teeth in females*	*MMC prevalence in females*
Rehman et al., 2020	Pakistan	Planmeca	200	51	23/28	189	94	95	4.80%	6.40%	3.20%	NA	2.10%	NA	2.60%
Aldosimani et al., 2021	Saudi Arabia	Planmeca	100–400	395	181/214	1377	687	690	0.90%	1.30%	0.40%	NA	NA	NA	NA
Srivastava et al., 2018	Saudi Arabia	Galileos Comfort	150–300	82	43/39	143	143	NA	18.20%	18.20%	NA	NA	NA	NA	NA
Kuzekanani et al., 2020	Kerman, Iran	Planmeca	120	62	32/30	100	100	NA	8.10%	8.10%	NA	NA	6.30%	NA	10%
Tahmasbi et al., 2017	USA	Carestream	76	90	31/59	122	NA	NA	16.40%	26%	8%	NA	NA	NA	NA
Arayasantiparb et al., 2017	Thailand	Accuitomo	125	595	220/375	903	518	385	0.22%	0.40%	0%	NA	NA	NA	NA
Yang et al., 2020	China	Planmeca	200	875	NA	1750	1750	NA	9.03%	9.03%	NA	NA	51.27%	NA	48.73%
Qiao et al., 2020	China	Accuitomo	125	587	237/350	1174	1174	NA	1.79%	1.79%	NA	474	NA	700	NA
Shah, SA and Khan, A, 2019	Pakistan	Planmeca	70–400	120	NA	120	120	NA	0.80%	0.80%	NA	NA	NA	NA	NA
Shakeri et al., 2019	Iran	Cranex 3D	130	441	176/266	442	207	235	3.20%	3.40%	2.90%	176	0.90%	266	2.20%
Xu et al., 2020	China	NewTom	125	334	NA	357	357	NA	3.10%	3.10%	NA	NA	NA	NA	NA
Hu et al., 2019	China	Vatech	160	496	249/247	823	823	NA	10.80%	10.80%	NA	413	12.30%	410	9.3
Inaty et al., 2020	Lebanon	Carestream	200	200	102/98	505	242	263	14.65%	13.20%	16%	NA	18.40%	NA	11.20%
Akbarzadeh et al., 2017	USA	Carestream	300	210	134/76	210	210	NA	14.70%	14.70%	NA	134	NA	76	NA
Kantilieraki, 2019	Greek	NewTom	100	1002	410/592	1002	478	524	0.20%	0.20%	0%	NA	NA	NA	NA
Pan et al., 2019	Malaysia	KaVo 3D	250	208	90/118	746	370	376	1.90%	1.90%	0%	314	14.30%	432	85.70%
Roshdy and El Khodary, 2018	Egypt	Scanora 3D	300	800	NA	800	800	NA	25.60%	25.60%	NA	374	22.70%	426	28.20%
Hosseini et al., 2020	Iran	NewTom	75	200	NA	200	200	NA	9%	9%	NA	NA	NA	NA	NA
Senthil, K and Solete, P, 2021	India	Galileos Comfort	150–300	50	NA	200	100	100	44.50%	59%	30%	NA	NA	NA	NA
Ni et al., 2018	China	Morita	125	646	302/344	900	900	NA	1.90%	1.90%	NA	431	2.10%	469	1.70%
Abarca et al., 2020	Chile	Gendex	200	289	516/506	1022	510	512	0.30%	NA	NA	516	NA	506	NA
Demirbuga et al., 2013	Tureky	NewTom	125	605	268/337	1748	823	925	0%	0%	0%	NA	NA	NA	NA
Nur et al., 2014	Tureky	i-CAT	300	850	429/421	2131	966	1165	0.20%	0.20%	0%	NA	NA	NA	NA
Torres et al.,	Belgium	Morita	250	100	52/48	257	145	112	1.20%	0.70%	2.10%	NA	NA	NA	NA

(*continued on next page*)

Table 1 (*continued*)

Study ID (Author & year)	*Country*	*CBCT device*	*Voxel size (μm)*	*Number of subjects*	*Males/ Females*	*Number of teeth*	*Number of first mandibular teeth*	*Number of second mandibular teeth*	*Overall Prevalence of MMC*	*Prevalence of MMC in first molar*	*Prevalence of MMC in second molar*	*Number of Teeth in males*	*MMC prevalence in males*	*Number of teeth in females*	*MMC prevalence in females*
2015															
Torres et al., 2015	Chile	Morita	250	170	75/95	258	146	112	2.80%	3.60%	2%	NA	NA	NA	NA
Sajjan et al., 2021	India	Cranex 3D	200	89	55/34	89	NA	NA	4.50%	4.50%	0%	55	NA	34	NA
Palottil, A et al., 2021	India	Planmeca	150–200	103	53/50	324	156	168	9%	6.50%	2.50%	NA	NA	NA	NA
Hasheminia et al., 2021	Iran	Sannora 3D	130–200	768	384/384	768	768	NA	3.13%	3.13%	NA	384	2.34%	384	3.90%
Bhatti et al., 2022	Pakistan	Planmeca	200	149	78/71	596	596	NA	14.70%	14.70%	NA	78	9.40%	71	11.20%

NA: not available.

limited field of view (FOV) with the given CBCT machine brand name. The voxel size was provided and is equal to or lower than 400 μm. Studies were excluded if they were review studies, case reports, or studies that included teeth treated endodontically.

2.3. Data extraction

Two reviewers (SB and SA) accessed the titles and abstracts according to the predefined inclusion/exclusion criteria and were labeled 'relevant' or 'irrelevant'. Then, the reviewers read the full text of the relevant articles and extracted the data separately in a standardized extraction form and summarized them as follows: author, country, CBCT device, voxel size, number of subjects, number of first molars, number of second molars, prevalence of MMC in first molars (%), prevalence of MMC in second molars (%), age average, and number of male/female subjects. Any disagreement was resolved by discussion.

2.4. Quality assessment

The Joanna Briggs Institute (JBI) Critical Appraisal tool checklist for prevalence studies was used to assess the risk of bias among the eligible studies (Munn et al., 2015). The included studies were independently assessed by two evaluators (SB and SA) who scored each JBI question as yes, no, unclear, or not applicable. The final score of each study was calculated according to the percentage of JBI questions, and only answers of ('yes') were included. Interrater reliability tests between both evaluators were undertaken with kappa above 0.61, which is considered good agreement. Then, the risk of bias (RoB) of each study was categorized according to the final score as 'high' (score equal to or lower than 49%, which led to article exclusion), 'moderate' (score ranging from 50% to 69%) or 'low' (score higher than 70%) (Saletta et al., 2019). Any discrepancies with quality assessment were discussed until consensus was reached.

2.5. Statistical analysis

The meta-analysis was carried out to estimate the combined (pooled) estimate of a proportion (prevalence) of MMC in male and female subjects in first molar teeth and overall prevalence. Descriptive statistics were used to describe the outcome variable. As the outcome variable is categorical, the proportion and its 95% confidence intervals were used as a summary statistic. Cochran's Q (weighted sum of squares on standardized scale) and I^2 were used to assess the heterogeneity in the pooled data and percentage of total variation across the included studies. A cutoff value of I^2 greater than 50% was used to identify the higher levels of unexplained variability in the proportions. Egger's and Begg's tests were used to assess the presence and significance of publication bias. Pearson's chi-square test was used to compare two proportions. A p value of ≤ 0.05 and 95% confidence intervals were used to report the statistical significance and precision of estimates. Forest plots were used to graphically show the results of the meta-analysis. Additionally, funnel plots were used to identify the presence of publication bias in the studies. The meta-analysis was carried out using

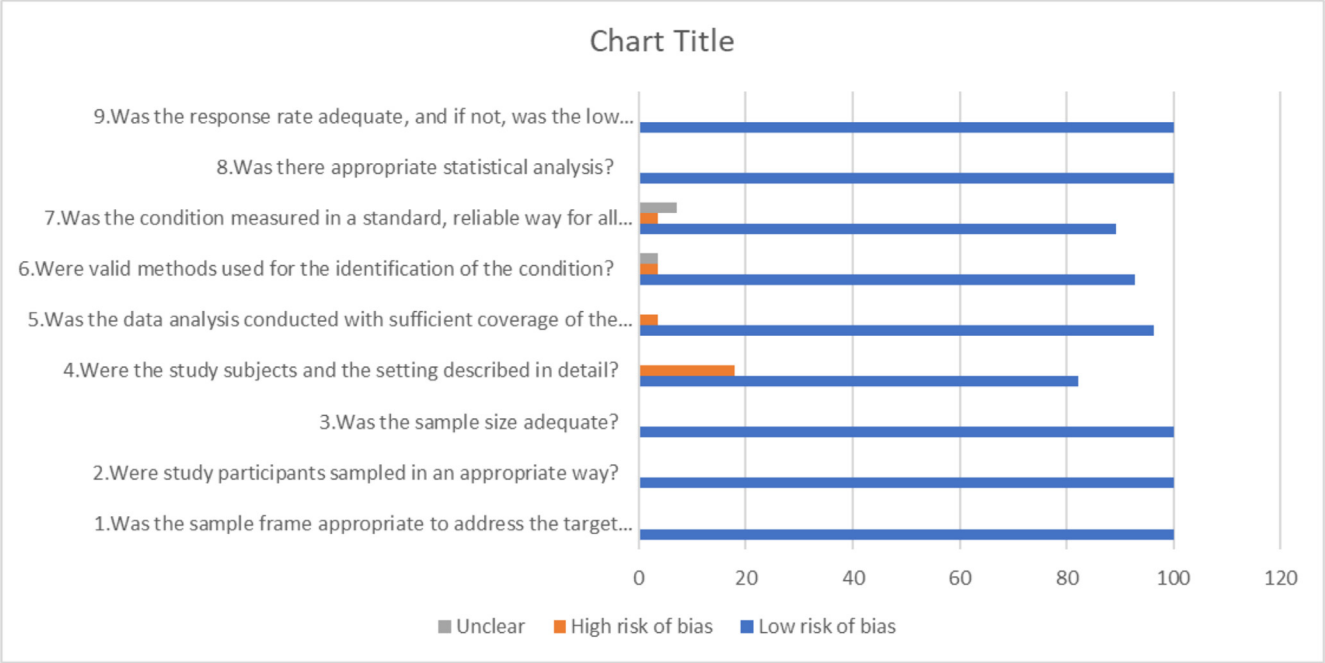

Fig. 2 The risk of bias (RoB) assessment.

MedCalc for Windows version 15.0 (MedCalc Software, Ostend, Belgium).

3. Results

3.1. Study characteristic

After database screening and the removal of duplicates, 523 studies were identified (Fig. 1). A total of 488 studies were excluded after screening the title and abstract, and only 35 relevant studies were included for full-text assessment. Two studies were excluded because the studies did not include the MMC in mesial root configuration (Pawar et al., 2017; Zhang et al., 2015), four studies were excluded because they did not state the voxel size and the CBCT machine (Al Shehadat et al., 2019; Babu, PS and Anjaneyulu, K, 2020; Perlea et al., 2019; Reddy, KH et al., 2021), and one study was excluded because the voxel size used in the study was more than 400 μm (Tredoux et al., 2021). Finally, 28 studies were included in the meta-analysis (Abarca et al., 2020; Akbarzadeh et al., 2017; Aldosimani et al., 2021; Arayasantiparb, R et al., 2017; Bhatti et al., 2022; Demirbuga et al., 2013; Hasheminia et al., 2021; Hosseini et al., 2020; Hu et al., 2019; Inaty et al., 2020; Kantilieraki, 2019; Kuzekanani et al., 2020; Ni et al., 2018; Nur et al., 2014; Palottil, A et al., 2021; Pan et al., 2019; Qiao et al., 2020; Rehman et al., 2020; Roshdy and El Khodary, 2018; Sajjan et al., 2021; Senthil, K and Solete, P, 2021; Shah, SA and Khan, A, 2019; Shakeri et al., 2019; Srivastava et al., 2018; Tahmasbi et al., 2017; Torres et al., 2015; Xu et al., 2020; Yang et al., 2020). The main features of the included studies are summarized in Table 1. Worthy to note that one study (Torres et al., 2015) assessed the prevalence of middle mesial canals in two different populations; the Belgian population and Chilean population, we considered it as two separate studies in the meta-analysis because of the ethnic difference of the two samples.

3.2. Quality assessment

Cohen kappa interrater reliability results between evaluators for the included studies submitted to the JBI critical assessment are summarized in Supplemental Table S2. The kappa statistic could not be calculated, as both evaluators had constant observations (up to 95%) for all 9 items in each of the included studies. The risk of bias (RoB) assessment is presented in Fig. 2. The RoB assessment for the included twenty-eight studies was categorized as low RoB.

3.3. MMC configuration in mandibular molars

The MMC configuration found in this systematic review was mostly confluent either with the mesiobuccal (MB) or mesiolingual (ML) canal followed by the independent type. The study by Rehman et al. (Rehman et al., 2020) found that 5 MMCs were fused with the ML canal, 2 MMCs were fused with the MB canal, and 2 MMCs were independent. Aldosimani et al. (Aldosimani et al., 2021) found that 6 MMC were fused with MB, 4 MMC were fused with ML and 2 MMC showed fin type. Srivastava et al. (Srivastava et al., 2018) found that 24 MMCs were fused with MB and ML and 2 MMCs were independent. Tahmasbi et al. (Tahmasbi et al., 2017) found that 17 MMCs fused with either MB or ML, and 3 MMCs were independent types. Arayasantiparb et al. (Arayasantiparb, R et al., 2017) found only 2 teeth with MMC; one was fused to MB, and the other showed an independent type. Yang et al. (Yang et al., 2020) found that 146 MMCs were fused with either MB or ML, and 12

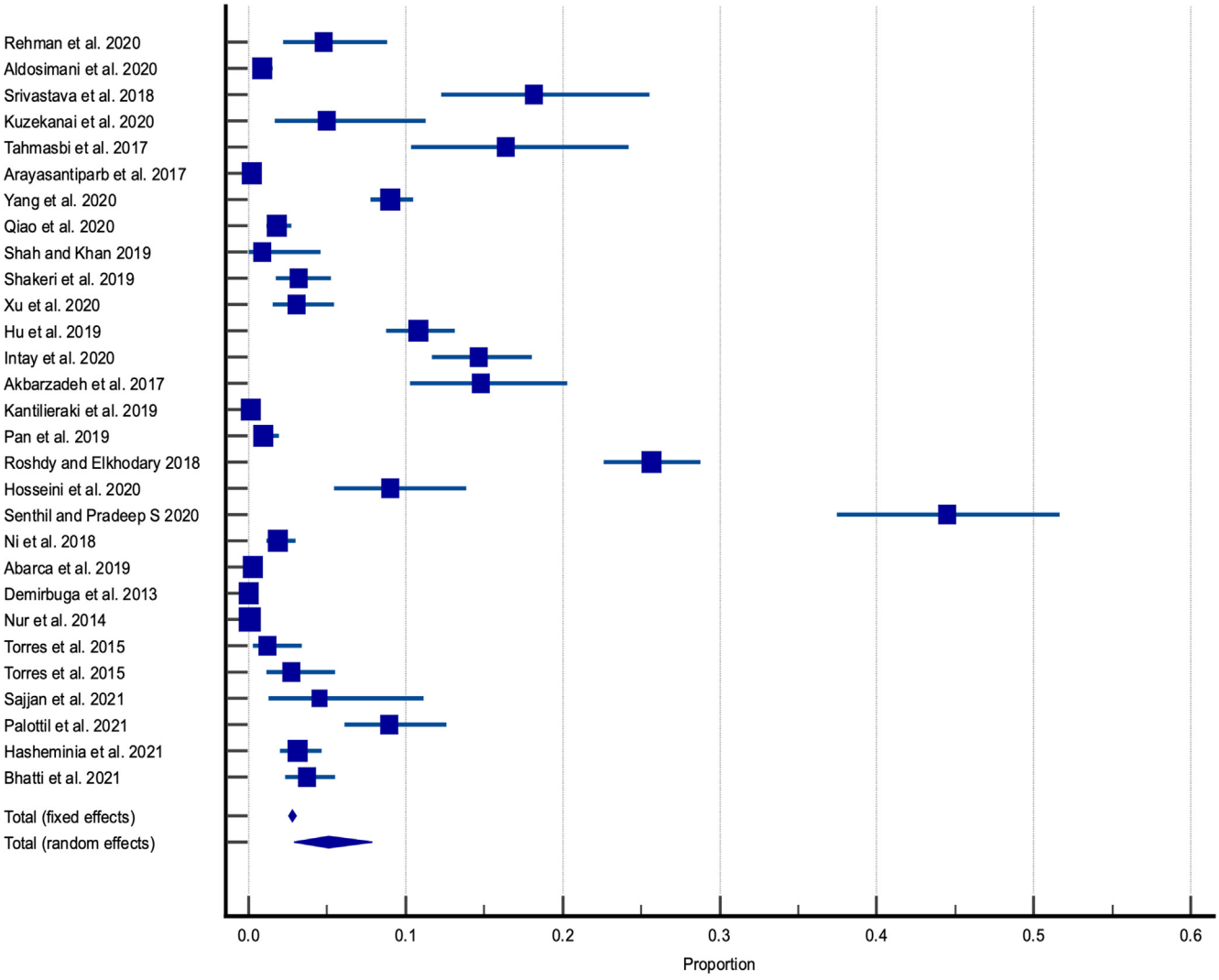

Fig. 3 Forest plot for the overall prevalence of MMC across different studies of systematic review.

were independent types. Xu et al. (Xu et al., 2020) showed that the 11 MMCs found in their study were fused either with MB or ML. Hu et al. (Hu et al., 2019) demonstrated that 86 MMCs were fused with either MB or ML, and 3 MMCs were independent. Intay et al. (Inaty et al., 2020) found that 71 MMCs were fused with either MB or ML, and 3 were independent types. Akbarzadeh et al. (Akbarzadeh et al., 2017) reported that 24 MMCs were fused with MB and ML and 7 were independent. Hosseini et al. (Hosseini et al., 2020) showed that 18 MMCs were fused with either MB or ML. Ni et al. (Ni et al., 2018) indicated that 17 MMCs were fused with ML. Abarca et al. (Abarca et al., 2020) reported that 3 MMCs were fused with either ML or MB. Bhatti et al. (Bhatti et al., 2022) found that 10 MMCs were confluent type, 8 were independent and 5 were fin type. However, a higher prevalence of the independent type was reported by Senthil and Pradeep (Senthil, K and Solete, P, 2021), who showed that 23 MMCs were independent, 51 MMCs were fused with ML, and 15 MMCs were fused with MB. Shah and Khan (Shah, SA and Khan, A, 2019) and Nur et al. (Nur et al., 2014) found in a total of one MMC that was an independent type.

3.4. Prevalence of MMC in mandibular molars

The overall results on the prevalence of MMC are presented in Supplemental Table S3. The total number of teeth for this analysis was 19,256 teeth. A meta-analysis revealed that the overall prevalence of MMC out of the 19,256 teeth as per the random effects model was 5.09% (95% CI: 2.894 to 7.784). The Cochran's Q value was statistically significant ($Q = 1735.71$, $DF = 28$, $p < 0.0001$), and the I^2 value (98.39%) was higher, which implies heterogeneity among the included studies and is statistically significant. The forest plot and funnel plot for this meta-analysis are presented in Fig. 3 and Supplemental Fig. 1.

3.5. Prevalence of MMC in mandibular first molars

A total of 26 studies that reported the prevalence of MMC in mandibular first molars were submitted to a quantitative analysis (Supplemental Table S4). The total number of mandibular first molars was 12,873 teeth. A meta-analysis revealed that the MMC prevalence in mandibular first molars out of 12,873

teeth per the random effects model was 5.47%. There was no publication bias across the 26 studies, as both the p values obtained by using Egger's and Begg's tests were more than 0.05, indicating nonstatistical significance. The forest plot and funnel plot for this meta-analysis are presented in Fig. 4 and Supplemental Fig. 1.

3.6. Prevalence of MMC in male and female subjects

A total of 7 studies reported the number of males and females in regards to the MMC prevalence and were submitted to a quantitative analysis (Supplemental Table S5). The total number of teeth was 2170 in males and 2458 in females. A

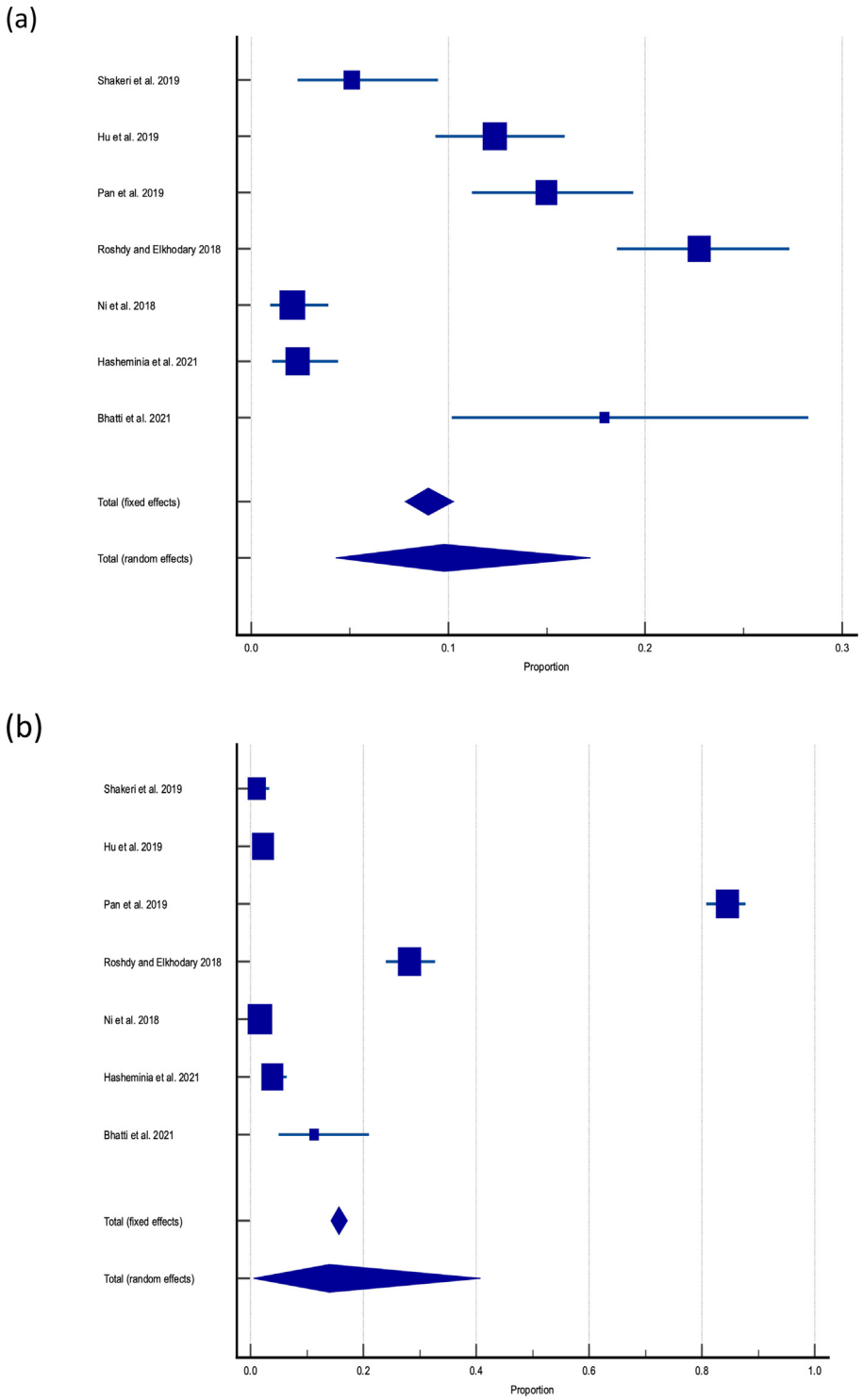

Fig. 4 Forest plots for the prevalence of MMC in (a) male subjects (b) female subjects (c) first mandibular teeth across different studies of systematic review.

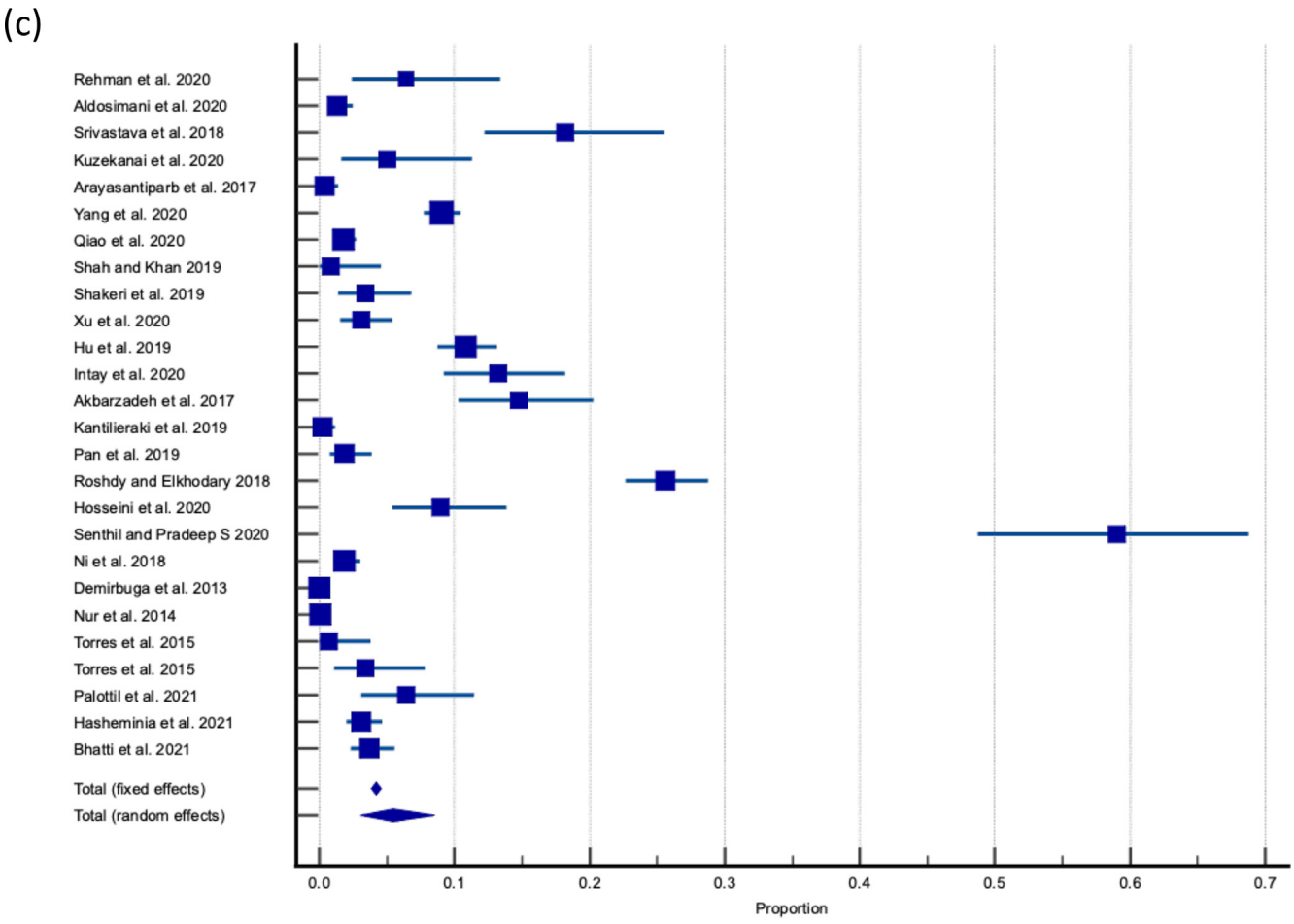

Fig. 4 (*continued*)

meta-analysis indicated that the prevalence of MMC per the random effects model was 9.79% (95% CI: 4.296 to 17.224) in males and 13.96% (95% CI: 0.541 to 40.737) in females. There was no publication bias across the 7 studies, as both the p values obtained by using Egger's and Begg's tests were more than 0.05, indicating nonstatistical significance. The forest plot and funnel plot for this meta-analysis are presented in Fig. 4 and Supplemental Fig. 1.

The comparison of the prevalence of MMC in males and females showed a statistically significant difference of 4.16% (95% CI: 2.29 to 6.01) with a chi-square of 18.90, and the p value (<0.0001) indicated that the prevalence of MMC in females (13.961%) was significantly higher than the prevalence of MMC in males (9.798%).

4. Discussion

The present systematic review and meta-analysis showed that the overall prevalence of MMC in mandibular molars was 5.09%. To the best of our knowledge, this is the first systematic review and meta-analysis that assessed the prevalence of middle mesial canals in mandibular molars across different studies using CBCT. The mandibular first molar teeth showed a prevalence of 5.47% in this review. This result was consistent with a previous study that reported a prevalence of 4.8% of MMC in mandibular first molars (Rehman et al., 2020). Additionally, another study showed a 4.5% MMC prevalence in mandibular first molars (Sajjan et al., 2021). In contrast, a higher prevalence of MMC in mandibular first molars was reported by several studies to vary from 10.8% to 59% (Akbarzadeh et al., 2017; Bhatti et al., 2022; Hu et al., 2019; Inaty et al., 2020; Roshdy and El Khodary, 2018; Senthil, K and Solete, P, 2021; Srivastava et al., 2018). This could be explained by the differences in CBCT evaluators, CBCT devices used, and sample sizes included in their studies. The outcome of mandibular second molars was not sufficient to be pooled in meta-analysis calculations; thus, the prevalence of MMC in mandibular second molars was not performed in this systematic review and meta-analysis.

This review revealed an influence of different gender on the prevalence of MMC in mandibular molars. The meta-analysis showed that the prevalence of MMC in females (13.961%) was significantly higher than that in males (9.798%). This result is in accordance with several studies that reported a higher prevalence of MMC in females than in males (Bhatti et al., 2022; Pan et al., 2019; Roshdy and El Khodary, 2018).

The present review was conducted on studies that identified MMCs using CBCT imaging. CBCT displays anatomical structures without superimposition and blurring of images that is observed in conventional 2D imaging. The American Academy of Oral and Maxillofacial Radiology and the American Association of Endodontics have recommended limited field

of view CBCT as the imaging modality of choice for identifying variation in root canal morphology (Fayad et al., 2015). The voxel size parameter is crucial for the reliability of the methodology in studies using CBCT imaging for the study of root and canal anatomy. CBCT examination using a lower voxel size showed a more reliable outcome (Martins and Versiani, 2019). One study showed that CBCT images were accurate in detecting root canal system configuration when using a voxel size of 125 μm (Zhang et al., 2017). Another report showed that diagnostic CBCT images were obtained when using a voxel size equal to or lower than 300 μm (Maret et al., 2014). Accordingly, the present study included CBCT voxel sizes equal to or lower than 400 μm as an inclusion criterion.

The most MMC configuration found in this systematic review was the confluent canal with MB canal, followed by the confluent canal with ML canal, and last, the independent type. These results are in accordance with the study by Versiani et al., who reported that confluent MMCs with the MB canal were the most common type, and the MMC to be fused with the MB canal more than to be fused with the ML canal (Versiani et al., 2016).

In this systematic review, all the included studies exhibited a low risk of bias, making this study design robust. The most common risk of bias was observed in nonstandardization of the measurement of the MMC, valid method of MMC identification, data analysis, and description of the study and the settings.

This systematic review has a few limitations, including the small number of available studies for mandibular second molars. The difficulty to address the ethnic variable and the age group to the MMC prevalence. Additionally, there is variation in the CBCT imaging devices used and the number of CBCT image evaluators.

The clinical relevance of reporting the prevalence of the anatomical variations that could occur in teeth is important, because these variations can be misdiagnosed or misinterpreted with other pathology. This demonstrates the importance of being knowledgeable with different variations like the additional canals, also to consider their presence during the clinical and radiographic examinations to reduce the possibility of missed canals during the root canal treatment.

5. Conclusion

The current study results showed an overall 5.09% prevalence of MMC in mandibular molars, with a significantly high prevalence in female subjects. Additionally, this canal was found to be confluent with the MB canal more than the ML canal.

Ethical statement

Due to the nature of study being a review of existing literature, no institutional ethical board review was conducted.

CRediT authorship contribution statement

Sundus Bukhary: Conceptualization, Investigation, Methodology, Writing – review & editing. **M Endo:** . **Sarah M. Alkahtani:** Supervision, Investigation, Methodology. **Areej Bukhari:** Data curation, Methodology. **Ahad Aldosari:** Data curation, Methodology. **Rehab Alanazi:** Data curation, Methodology.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sdentj.2023.08.009.

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