Review Article

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Root Canal Morphology of Primary Mandibular First Molar: A Systematic Review

Dentistry Section

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ABSTRACT

Introduction: Pulp therapy procedures especially pulpectomy, aids in retaining the teeth in oral cavity. The complex morphology and pulp-periodontal intricacies insists the need for the understanding of internal pulp canal morphology to treat the primary teeth with dental caries and dental trauma which aids for efficient endodontic therapy.

Aim: To explore the root canal morphology of primary mandibular first molar in different ethnic population based on different diagnostic aids used.

Materials and Methods: Present systematic review was registered in PROSPERO database and was carried out from August 2021 till October 2021 including data from January 1970 to May 2021 by following PRISMA guidelines. Four electronic databases (Web of Science, Pub Med, Scopus, and Cochrane) were searched. In-vivo, in-vitro studies, comparative and evaluative studies have been included and studies mentioning anamolies, accessory canals and case reports all were excluded. Quality assessment was done by using Anatomical Quality Assessment tool (AQUA).

Results: Out of 215 studies, nine studies were retrieved and those investigated root canal morphology of primary mandibular first molar were included. Most predominantly two rooted primary mandibular first molar (99.9%) with four canals (81.25%) of straight morphology (>90% even 100% in few studies) showing root length of 6.4 to 9.4 mm exhibiting Vertuccis type I and IV, were reported to be prevalent.

Conclusion: Inspite of varying ethnicity most predominantly two rooted primary mandibular first molar with four canals of straight anatomy seems to be prevalent in all the included diagnostic techniques.

Keywords: Diagnostic aids, Number of canals, Primary tooth, Root canal anatomy

INTRODUCTION

Dental caries and dental trauma of primary teeth can end up easily into pulpal pathology which needs to be encountered by an endodontic therapy since, the hard tissue covering the pulp is less compared to that of permanent successors. To carry out such endodontic procedure proper understanding and knowledge of internal pulp canal morphology is to be gained which when managed by an expert can provide better treatment outcome [1-3].

Only two-dimensional visualisation was possible with conventional imaging techniques. Advanced techniques such as computed tomographic techniques and Cone Beam Computed Tomography (CBCT) all allows two-dimensional as well as three-dimensional visualisation of root canals to study its morphology. Each of these aided well in fulfilling their purpose and gave an idea of what complex morphologies can be expected while dealing with primary teeth [4-6]. The intricacies of primary teeth root canals is due to the secondary dentin deposition that leads to frequent variations of canals [2]. Further the pulpal periodontal breakdown due to the presence of the accessory canals and root resorptions also depicts that complexity of primary teeth morphology. The primary mandibular first molars in particular shows more complex internal anatomy than its external morphology which is as well unique compared to other primary molars [1,3,7,8].

Few studies proposed high prevalence of caries is found to be in mandibular molars than in maxillary molars [4,5]. Proximal caries being prevalent in mandibular first molars mostly leads to pathology needing pulpectomy. The complications like ramifications, furcation connections, horizontal anastomosis and other features becomes a challenge for a paedodontist to fulfil the endodontic therapy successfully. Thus, the need for understanding the root canal morphology of these teeth is of utmost importance [2,5,7-10].

This systematic review aims to analyse, understand and to present the morphology of root canals of primary mandibular first molar by compiling all the knowledge gained through in-vitro and in-vivo studies done by various researchers by using various diagnostic aids in different population thereby to help with the clinical endodontic therapy.

MATERIALS AND METHODS

Registration of the protocol of the systematic review was done with International prospective register of systematic reviews (PROSPERO) (ID-CRD42021268264, 16 August 2021). The guidelines followed for the systematic review was PRISMA and the study period was from August to October 2021. The structured question for this review was framed as, 'is there a variation in canal morphology in primary mandibular first molar with different diagnostic aids in different ethnic population?'

PICO Strategy

- Population- children
- Intervention- both in-vitro and in-vivo studies
- Comparison- diagnostic aids
- Outcome- morphology of root canals in primary mandibular first molar.

Only papers on root canal configuration was included and rest of studies after removing duplicates were screened by title and abstract in which those did not refer to the topic were discarded and several papers which did not meet criteria after reviewing the full text were also excluded.

Inclusion criteria

- In-vivo studies
- In-vitro studies
- Comparative studies
- Evaluation studies

Exclusion criteria

- Studies that does not involve primary mandibular first molar
- Case reports
- Abnormalities of teeth

Information Sources and Search Strategy

Search for papers done from Web of Science, Pub Med, Scopus, Cochrane along with manual searching in journals namely International Journal of Clinical Paediatric Dentistry, International Journal of Paediatric Dentistry, Indian Society of Paedodontic and Preventive Dentistry, Journal of Endodontics, International Endodontic Journal were performed from January 1970 to May 2021. The combination of search term for electronic databases was as follows: MeSH headings, text words, and word variants for "primary tooth" and "root canal anatomy" and "diagnostic aid" which were combined using Boolean operator.

Collection and Analysis of Data

Screening and selection: The publications in English alone were considered. The titles and abstracts of studies were assessed by two reviewers, authors independently and for those studies for which data in title and abstract was insufficient, full articles were retrieved. The authors independently assessed the full text to identify studies meeting the inclusion criteria. Once the studies were selected, quality assessment and data extraction was done by two reviewers separately. Data analysis was done according to the number of teeth, number of roots present, number of root canals, length of roots, method of tooth analysis and root canal patterns. After discussion, studies relevant to the review were selected. Two hundred and fifteen were selected from the electronic data bases and hand-search. After abstract and full text screening and removing all the duplicated and those out of review criteria 15 articles were selected. Nine articles were selected after reviewing the articles independently for final qualitative assessment after excluding six articles in full text reading which did not involve the review requirements as per inclusion criteria [3-6,8-12].

Data Collection, Summary Measures and Synthesis of Results

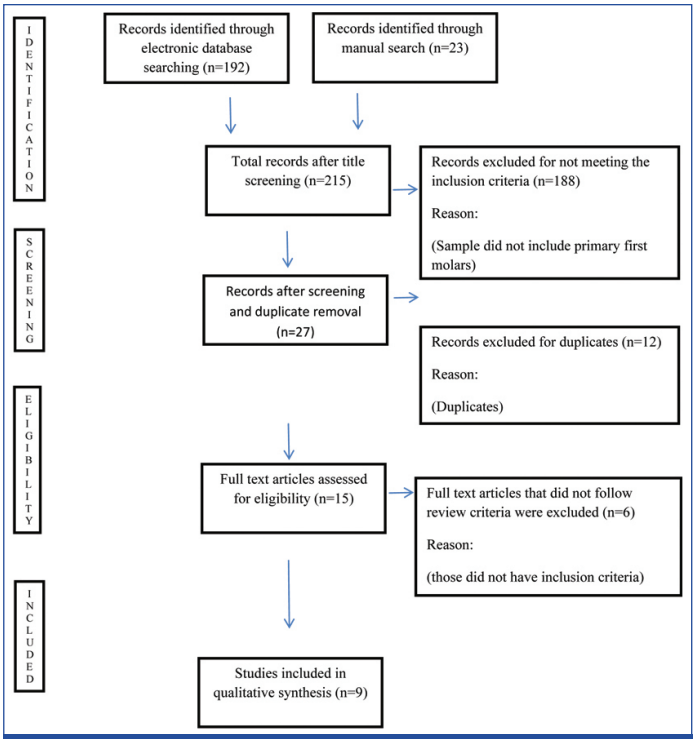
Information on the year the study was published, researchers, population on whom the study was done, diagnostic aids used, type of sample and study, number of teeth studied, number of roots, number of canals, length of roots, shape of roots and pattern of roots based on Vertuccis classification were summarised.

Assessment of Bias Across Studies

The risk of bias assessment of the included studies was done using AQUA tool [13]. Two authors independently assessed each study on the 5 domains such as: Aim and subject characteristics; Study design; Characterisation of methods; Descriptive anatomy; and Results reporting which contained set of dichotomous questions (Yes or No). Judging of each domain is done as "low", "high" or "unclear" based on how many yes or no judged, i.e., in a domain if all the questions is answered yes then, the study pertaining to that domain has a low risk of bias, if the signaling questions could not be answered owing to unreported or missing information, the risk of bias judged as "High". The "Unclear" option should be used when the reported data are insufficient to allow for clear judgment. In case of difference of opinion a third author was consulted to reach to a consensus.

RESULTS

The literature search through the databases Web of Science, Pub Med, Scopus, and Cochrane resulted in 192 articles. Through cross referencing and hand search another 23 articles were added out of which 15 remained after duplicates removal and title and abstract screening which underwent full text review. At the end of full text reviewing nine articles met with all the criteria were finalised [Table/Fig-1].



[Table/Fig-1]: Search strategy PRISMA flow chart.

A total of 219 primary first molar was examined in nine studies, out of which three studies were done using micro CT on China (n=2), Brazil (n=16) and Turkish (n=17) population, two studies with CT on Indian population (n=31), two studies with clearing technique on Indian (n=15) and Iran (n=27) population, one study with CBCT on Turkish (n=72) population and one study with radiography on Indian (n=15) population . The information on the articles- authors, year of publication, ethnic groups, diagnostic aids, study design, sample and sample size are detailed in [Table/Fig-2] [3-6, 8-12].

Authors/years	Population	Methods	Study design	Sample	Number of teeth
Gupta D et al., 2005 [9]	India	Roentgenographic and decalcification and clearing	In-vitro	Extracted tooth	30
Joseph T et al., 2005 [3]	India	CT	In-vitro	Extracted teeth	15
Bagherian A et al., 2010 [8]	Iran	Clearing technique	In-vitro	Extracted teeth	27
Wang YL et al., 2013 [6]	China	Micro CT	In-vitro	Extracted teeth	2
Fumes AC et al., 2014 [4]	Brazil	Micro CT	In-vitro	Extracted teeth	10
Ozcan G et al., 2015 [10]	Turkey	CBCT	Imaging study	CBCT images of children	72
Katge F et al., 2018 [5]	India	Clearing technique	In-vitro	Extracted teeth	30
Datta P et al., 2019 [11]	India	CT	In-vitro	Collected extracted teeth	16
Meryem Zİ et al., 2019 [12]	Turkey	Micro-CT	In-vitro	Extracted teeth	17

[Table/Fig-2]: List of selected studies with number of teeth examined by different diagnostic aids in different population [3-6, 8-12].
Micro CT: Micro computed tomography; CBCT: Cone beam computed tomography; CT: Computed tomography

[Table/Fig-3] consists of the studies with number of roots and canals. Out of nine studies [3-6,8-12] assessing the number of roots, total of seven studies appraised number of canals in primary mandibular first molar [3,5,6,8,10-12]. The most common morphology obtained through all the included diagnostic aids was two roots one mesial and one distal (99.9%) in all the included population. Considering the number of canals two canals in mesial and two in distal were evidently seen in Indian population when analysing via CT [3,5,11]. In Chinese population analysing the Micro CT results shows both the one distal canal and two distal canal variant were equally present [6]. Studies done by clearing technique and CBCT on Iran, Turkish and Indian population shows predominantly one distal canal variant [3,5,8,10-12]. On overall analysis of number of canals in all studies together shows slight dominancy of two mesial and two distal canal variants (four canal teeth-81.25%).

[Table/Fig-4] shows two studies done by CBCT and CT involving samples from Turkish and Indian population with respect to average length of mesial and distal roots which was around 9.4 mm for mesial root and 8.6 mm for distal roots [10,11].

[Table/Fig-5] represents the study mentioning the shape of each root canals evaluated by techniques except CT most commonly the canals was straight with 100% prevalence in most studies next to which ribbon shaped canals was seen in around 40% to 90% of samples and curved type of canals was seen around 25% to 85% most commonly in mesio buccal canal oval shaped canals were seen only in 10% sample and irregular canals was also around 10% [4,5,8-10]. Moreover, all the population showed predominantly straight configuration of root canals [5,12]. [Table/Fig-6] mentions the studies showing Vertuccis type of morphology of canals in the two studies most commonly Type-IV vertucci classification was seen in mesial canals with 81% prevalence followed by type I Vertucci classification that was around 73% in distal canals. [Table/Fig-7] mentions the risk of bias assessment by using AQUA tool and its interpretation. Based on the interpretation obtained the study by Ozcan G et al., had comparatively low risk of bias [10]. Study by Gupta DD et al., had high-risk of bias [9]. Study by Fumes AC et al., resulted in more of unclear answers for the questions in three domains hence it may also fall under high-risk of bias category [4]. Similarly, rest of the studies mentioned also had high-risk as they did not fulfil the low risk criteria [3,5,6,8,11,12].

Authors/Years	Sample	Number of teeth	Number of roots	Number of canals	
Gupta DD et al., 2005 [9]	Extracted teeth	30	2	-	-
Joseph T et al., 2005 [3]	Extracted teeth	15	2	Mesial root One canal-6.67% Two canal-93.33%	Distal root One canal-40% Two canal-60%
Bagherian A et al., 2010 [8]	Extracted teeth	27	2	Mesial root One canal-18.5% Two canal-81.5%	Distal root One canal-77.8% Two canal-22.2%
Wang YL et al., 2013 [6]	Extracted teeth	2	2	Mesial root One canal-0% Two canal-100%	Distal root One canal-50% Two canal-50%
Fumes AC et al., 2014 [4]	Extracted teeth	10	2	-	-
Ozcan G et al., 2015 [10]	CBCT images of children	72	2	One canal-0% Two canal-100%	One canal-77.8% Two canal-22.2%
Katge F et al., 2018 [5]	Extracted teeth	30	2	Mesial root One canal-20% Two canal-80%	Distal root One canal-76.67% Two canal-23.33%
Datta P et al., 2019 [11]	Collected extracted teeth	16	2	Mesial root One canal-0 Two canal-100%	Distal root One canal-18.75% Two canal-81.25%
Meryem Zİ et al., 2019 [12]	Extracted teeth	17	2	Mesial root One canal-0 Two canal-100%	Distal root One canal-100% Two canal-0%

[Table/Fig-3]: List of selected studies with respect to number of roots and canals [3-6, 8-12].

Authors/years	Sample	Number of teeth	Length of roots
Ozcan G et al., 2015 [10]	CBCT images of children	72	Mesial root- 7.1±1.3 mm Distal root- 6.4±1.5 mm
Datta P et al., 2019 [11]	Collected extracted teeth	16	Mesial root- 9.45±0.59 mm Distal root-8.42±0.40 mm

[Table/Fig-4]: List of studies showing the length of the roots [10,11].

Authors/years	Sample	Number of teeth	Shape of canals					
			Mesial-Root	Mesio-Buccal	Mesio-Lingual	Distal-Root	Disto-Buccal	Disto-Lingual
Gupta D et al., 2005* [9]	Extracted tooth	30	IOPA(B-L view) Mesial root Straight-66.7% Curved-33.3%	IOPA(M-D view) MB roots Straight-73.4% Curved-26.6%	IOPA(M-D view) ML roots Straight-80% Curved-20%	IOPA(M-D view) Distal root Straight-100% Curved-0% IOPA(B-L view) Distal root Straight-80% Curved-20%		
Gupta D et al., 2005** [9]	Extracted tooth	30		Clearing MB Straight-100% Curved-0%	Clearing ML Straight-93.33% Curved-6.67%		Clearing DB Straight-100% Curved-0%	Clearing DL Straight-100% Curved-0%
Fumes AC et al., 2014 [4]	Extracted teeth	10	Mesial root Round-30% Oval-0% Flat oval-10% Ribbon-50% Irregular-10%			Distal root Round-30% Oval-10% Flat oval-10% Ribbon-40% Irregular-10%		

Bagherian A et al., 2010 [8]	Extracted teeth	27	Mesial root Straight-20% Curved-80%	MB Straight-9.1% Curved-90.9%	ML Straight-81.8% Curved-18.2%	Distal root Straight-66.6% Curved-33.4%	DB Straight-66.6% Curved-33.4%	DL Straight-83.3% Curved-16.7%
Ozcan G et al., 2015 [10]	CBCT images of children	72	Mesial root Straight-22.2% Curved-69.4% S shaped-8.4%			Distal root	DB Straight-59.7% Curved-30% S shaped-9.7%	DL Straight-4.1% Curved-1.3% S shaped-0.2%
Katge F et al., 2018 [5]	Extracted teeth	30	Mesial root Straight-66.67% Curved-33.33%	MB Straight-29.17% Curved-70.83%	ML Straight-62.50% Curved-37.50%	Distal root Straight-66.67% Curved-33.33%	DB Straight-71.43% Curved-28.57%	DL Straight-62.50% Curved-37.50%

[Table/Fig-5]: List of studies representing shape of root canals [4,5,8-10].
MB: Mesio buccal; ML: Mesio lingual; DB: Disto buccal; D: Disto lingual; M: Mesial; D: Distal

Authors/Years	Sample	Number of teeth	Vrtuccis type							
			I	II	III	IV	V	VI	VII	VIII
Katge F et al., 2018 [5]	Extracted teeth	30	Mesial root-20% Distal root-76.67%	-	Mesial root-6.67% Distal root-0%	Mesial root-73.33% Distal root-0%	-	-	-	Mesial root-0% Distal root-23.33%
Meryem Zİ et al., 2019 [12]	Extracted teeth	17	Mesial root-0% Distal root-17.6%	-	Mesial root-0% Distal root-11.8%	Mesial root-47% Distal root-41.2%	Mesial root-5.9% Distal root-17.6%	Mesial root-11.8% Distal root-0%	-	Mesial root-5.9 Distal root -11.8%

[Table/Fig-6]: List of studies with respect to Vertuccis classification of canal morphology [5,12].

Domains Studies	Domain 1 Objective(s) and subject characteristics	Domain 2 Study design	Domain 3 Methodology characterisation	Domain 4 Descriptive anatomy	Domain 5 Reporting of results
Gupta DD et al., 2005 [9]	High	High	High	High	High
Fumes AC et al., 2014 [4]	High	Low	Un clear	Un clear	Un clear
Bagherian A et al., 2010 [8]	Un clear	Low	High	Un clear	Low
Ozcan G et al., 2015 [10]	Low	Low	Low	High	Low
Wang YL et al., 2013 [6]	High	Low	Un clear	High	Low
Joseph T et al., 2005 [3]	Low	Low	High	High	High
Datta P et al., 2019 [11]	Low	Low	Un clear	Un clear	Low
Katge F et al., 2018 [5]	Un clear	Low	Un clear	High	Low
Meryem Zİ et al., 2019 [12]	Low	Un clear	High	High	High

[Table/Fig-7]: Interpretation of each domain based on AQUA tool [3-6,8-12].

DISCUSSION

The primary mandibular first molar has been widely known to be a lime light teeth of primary dentition due to its peculiar crown morphology that do not resemble its permanent successor [9]. Considering this fact and with the concern of what can be expected in the root morphology of these unique teeth, this study was carried out as a systematic review of the root canal morphology of primary mandibular first molar.

Studies using various methodologies such as radiographic techniques with digital and contrast medium enhancement, by staining canals and clearing technique to appreciate the shape, standard radiographs, and micro computed tomography, computed tomographic techniques and CBCT to study the canal morphology of the roots of this teeth has been included in this review. The specifications such as number of canals and roots present, root length, shape of canals and configurations based on Vertuccis classification has been analysed [9,10,12,14-17].

This review has come up with rather simpler anatomical prevalence of two rooted (one mesial and one distal -100%) primary first molar teeth with four canals (two mesial canals and two distal canals -81.25%) having straight canal morphology (100%) and average length of 9.4 mm mesial and 8.6 mm distal roots with Type-IV Vetuccis classification (81%) [3-6,8-10,12]. Apart from that studies done by Katge F and Wakpanjar MM, Bagherian A et al., and Ozcan G et al., their team, showed higher prevalence of two rooted three canal (two mesial and one distal) variant, but considering the whole 219 teeth studied in all the nine studies the two rooted teeth with four canals were highly prevalent. This is to be considered in clinical application as the most common perception is to encounter three canals during pulpectomy, this review has given a caution fact to look into an additional distal canal in case not to be missed out [5,8,10].

Studies were done mentioning the shape of canals by Katge F and Wakpanjar MM, Fumes AC et al., Gupta DD et al., Bagherian A et al., Ozcan G et al,. In these next to straight, ribbon shaped canals was seen in around 40% to 90% of samples. Curved type of canals was seen around 25% to 85% that too most commonly mesio buccal canal. Oval shaped canals were seen only in 10% sample and irregular canals was also around 10% [4,5,8-10].

Ozcan G et al., Datta P et al., and their team's study showed length of roots and Katge F and Wakpanjar MM, and Meryem Zİ et al., mentioned Vertuccis pattern which revealed root length of 6.4 to 9.4 mm being an average length of roots and Vertuccis type of IV and I were reported to be prevalent [5,10-12]. The roots of primary teeth are extremely divergent to accommodate the successor tooth buds hence, have a common perception of canals being more complicated. Primary first molar especially being complicated in crown morphology [7,18] was obviously expected to have a complex internal root anatomy too. But, the present results showed a surprisingly controversial fact. While analysing the risk of bias of each study using AQUA tool, the study done by Ozcan G et al., with CBCT images of patients came up to be low risk of bias, yet the descriptive anatomy domain was not fulfilling the criteria to be at low risk [10]. Other eight studies included in this review had high-risk of bias.

Considering the strengths of studies involved Ozcan G et al., study gave clear evidence as the number of samples included as well as technique used for diagnosis (CBCT images of patients) were efficient in determining the canal morphology [10]. While other studies included comparatively less samples and mostly in-vitro evaluation was done [3-6,8,9,11,12]. Further researches can be done by using latest imaging techniques mentioning specific ethnicity. This could aid in the additional knowledge and understanding, which improves

the decision making for an endodontic procedure in the primary mandibular first molar in need of a treatment [18-21].

Limitation(s)

However, considering the studies included were pertaining only to what is considered to be common anatomy excluding canals other than main canals, the present study has a limitation in this aspect for not considering lateral and accessory canals.

CONCLUSION(S)

From nine studies investigating morphology of root canals in primary mandibular first molar reviewed considering the use of different diagnostic aids in various ethnic population. Most predominantly two rooted primary mandibular first molar (99.9%) with four canals (81.25%) of straight morphology (>90% even 100% in few studies) showing root length of 6.4 to 9.4 mm exhibiting Vertuccis type of I and IV were reported to be prevalent.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Aug 26, 2022
- Manual Googling: Sep 06, 2022
- iThenticate Software: Dec 27, 2022 (9%)

ETYMOLOGY: Author Origin

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