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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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PECULIARITIES OF THE SECOND MESIOBUCCAL CANAL IN MAXILLARY FIRST MOLAR: A RETROSPECTIVE ANALYSIS

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Abstract.

The first maxillary molar is one of the most difficult teeth for endodontical treatment; it presents the highest failure rates due to the impossibility of locating and treating the second mesiobuccal canal (MB2). The aim of our work was study of second mesiobuccal canal in maxillary first molar and compare obtained data with literature sources for increasing the efficiency of treatment.

Materials and methods: The study involved 59 patients with exacerbation of chronic pulpitis or chronic periodontitis who were distributed according to age: 14-20 years, 21-30 years and 31-40 years. The average age was 31±2.98 years. Patients were investigated by operating dental microscope and computer tomograph with description of peculiarities of second mesiobuccal canal in maxillary first molar. A type of canal according to Vertucci was detected; general 76 teeth were described.

Results: The second mesiobuccal canal was found in 65 (85.5%) of the 76 maxillary molars and in 29 (38.1%) of these MB2 canals it was accessible to the apex. We have detected that patients with chronic pulpitis or chronic periodontitis have significant different undetected MB2 canal in group 14-20 years (7.1%) and 31-40 years (19.4%), $p < 0.05$. Such differences between groups could be explained by the development of pulpal calcification with long term inflammatory processes.

Conclusion: First maxillary molar is possibly the most treated and least understood posterior tooth. Deep knowledge of anatomical and topological structure of the MB2 canal at the stage of diagnostics as well as during the course of endodontic treatment can help to decrease the percentage of unsuccessful treatment of the first molar. Clinicians need to be mindful of the possible presence of MB2 canal, which should motivate change in the routine practice of clinical endodontic treatment. Modifications in the endodontic access and detection techniques, as well as advancements in radiographic technique and magnification technology, aids in the location and treatment with the MB2 canal of the first maxillary molar.

Key words. Second mesiobuccal canal, maxillary first molar, chronic pulpitis, chronic periodontitis.

Introduction.

Endodontic treatment is considered to be one of the most common procedures in modern dentistry, which also leads to increasing the rates of complications. With a good knowledge of tooth anatomy, endodontists can implement the correct procedure for cleaning and shaping the root canal system and reduce treatment failure rates [1]. It is generally accepted that an inability to recognize the presence of all the canals of the root canal system and to adequately treat them may be a major cause of the failure of root canal therapy [2]. The ability to locate and clean all canals in a root canal system determines the eventual success of treatment [3,4]. Therefore, it is of utmost importance that all the canals are located and treated during the course of endodontic therapy [5] Clinicians should consider morphologic variation in the anatomy of the root canal system and the possibility that each tooth might have extra canals at the beginning of a treatment. All these canals should be detected, if possible [3,6].

It was reported that remnants of pulp tissue can be a reservoir for the growth of microorganisms, which may affect and compromise treatment outcomes [7,8] Leaving the canal untreated may allow microorganisms to colonize the space, leading to infection and treatment failure. Even partial treatment will enhance the chance of success [9,10]. The frequency and risk of missed anatomy are strictly linked with the complexity of the root canal system. This is especially true when working on molars [2].

The mesiobuccal (MB) root of the maxillary first molar has generated more research and clinical investigation than any root [11]. The reason is that the maxillary molars often have two canals in the MB root, as described by Hess in 1925 [3]. Wiene et al. were one of the first to acknowledge that inability to locate, instrument, and obturate the fourth canal (called second mesiobuccal or MB2) could lead to the failure of endodontic treatment of maxillary molars [3,11,12]. Endodontically retreated teeth were found to contain more undetected MB2 canals than first-time treated teeth, suggesting that failure to treat existing MB2 canals leads to a poorer prognosis [2,11]. Before undergoing root canal treatment, prior knowledge of the roots and root canal anatomy of the teeth is required [13].

The MB2 canal orifice in maxillary molars is usually located on an imaginary line between the MB and palatal (P) canal orifices and commonly about 2–3 mm palatal to the MB canal orifice [1,3,9,14]. Revealing the location of MB2 canal has proven to be the most formidable component of adequately treating these canals [12,15]. The orifice of the MB2 canal is small and not easily seen as the orifices of the other main canals in the floor of the pulp chamber due to the ledge of dentin frequently covers the orifice [2,16] With age maxillary molars often become pulpally involved due to mesial caries, attrition, erosion, etc. which, in turn, stimulates Tertiary dentin formation or other canal calcifications leading to difficulty in locating the canal [3,17].

Dentists can detect all canals more efficiently if they are aware of the anatomical peculiarities of the teeth beforehand [18]. It has also been reported that a missed MB2 canal during root canal therapy can lead to apical periodontitis. A poor long-term endodontic prognosis is associated with an untreated MB2 canal [19,20].

Morphological individual peculiarities of teeth structure is one of factor influence for development of pathological conditions and treatment procedure. In that connection the aim of our work was study of second mesiobuccal canal in maxillary first molar and compare obtained data with literature source for increasing the efficiency of treatment.

Materials and Methods.

The study involved 59 patients with exacerbation of chronic pulpitis or chronic periodontitis who were distributed according to age: 14-20 years (14 patients), 21-30 years (19 patients) and 31-40 years (26 patients). The average age was 31±2.98 years. Patients were investigated with operating dental microscope GLOBAL G6, computer tomograph Point Nix combi 500 C (Korea) with description of peculiarities of second mesiobuccal canal in maxillary first molar. Type of canal according to Vertucci [9] was detected; general 76 teeth were described.

All stages of the research complied with the principles of the Helsinki Declaration, including informed consent, privacy, and participant safety, and was reviewed by an independent ethics committee. The study was approved by the Ethics Committee of Kharkiv National Medical University (Protocol 7, 13.11.18).

Statistical analysis was performed using variation statistics methods. The normality of distribution was tested using the Shapiro-Wilk test, which indicated that the samples closely followed a normal distribution. Total percentage of MB2 root canals correctly identified (accuracy) was calculated with Student's t-test used for comparison. Correlation analysis was conducted using Spearman's rank correlation coefficient. A statistical difference was considered significant at $p < 0.05$ [21].

Results.

The second mesiobuccal canal was found in 65 (85.5%) of the 76 maxillary molars and in 29 (38.1%) of these MB2 canals it was accessible to the apex. Spreading by age groups is presented in Table 1. There is tendency to increasing number of teeth without detected canal, but significant difference is established between first and third groups only.

Distribution of different types of MB canals, classified according to Vertucci was presented by I-VII types (Table 2).

Discussion.

The complex anatomic configuration of the MB root canal system has long been the subject of considerable investigation [1]. There are case reports of the incidence of MB2 canals ranging between 18 and 96.1%. Generally, the permanent maxillary first molar has three roots and four canals. The incidence of five canals is reported to be 2.25–2.4%, and the incidence of six canals is reported to be 0.319 – 0.88% [13]. Kottoor et al., reported the endodontic management of the maxillary first molars with seven and eight canals, respectively [22].

Table 1. *Age distribution and incidence of MB2 canal.*

Age group (years)	Amount of teeth	MB2 found	MB2 not found
14-20 (N=14)	14	13 (92.9%)	1 (7.1%)
21-30 (N=19)	26	23 (88.5%)	3 (11.5%)
31-40 (N=26)	36	29 (80.6%)*	7 (19.4%)*

** - significant difference with the group 14-20 years, $p < 0.05$.*

In vitro studies of the MB root canal system have generally shown a higher prevalence of MB2 canals than have *in vivo* studies [2,3]. The differences among reports are due to the method used: whether done with or without dye penetration, radiographically, various sectioning techniques, record reviews, different social groups, different age groups, with or without magnification, definition of what constitutes a canal which varied with individual authors etc. Limited access and visibility in clinical settings, the tortuous pathway of some of these canals, which can include one or two abrupt curves in the coronal portion, as well as the risk of perforation, may explain the lower prevalence of MB2 canals *in vivo* studies as compared with *in vitro* studies [5,23].

In clinical trials, the percentage of MB2 canals varies from 18.6% to 80.3%. Laboratory studies showed a higher prevalence of MB2 canals, ranging from 30% to 96% [1]. For instance, Spagnuolo et al. demonstrated the presence of MB2 canals in 77.27% of analyzed MB roots, and 29.41% of them run completely detached from the respective first mesiobuccal canal (MB1). These results were in agreement with the other μCT studies, (15,16) which analyzed a similar number of first molars [1]. Table 3 shows the comparison of a few *in vivo* studies.

It can be presumed that factors such as ethnicity, age and gender may play a role in imparting variations in canal morphology [12,24-26]. There are less chances of locating the MB2 canals with increasing age of patients [2]. Rathi et al. detected the highest MB2 canal incidence in the age group of 51–60 years (29.50%), followed by 31–40 years and 21–30 years (19.67%), 41–50 years (16.39%), 61–70 years (8.19%), 10–20 years (6.55%) [5]. In a study by Das et al. the age of the patients was grouped into three groups as 18–25 years, 26–35 years, and 36–45 years and the frequency of MB2 canals were 74%, 73%, and 68%, respectively [2]. Sujith et al. were also able to locate MB2 canals easily in their younger patients (Table 4).

Hasan et al. reported that the males tend to have a higher proportion of MB2 canals (up to 31%) as compared to the females in whom the MB2 canals could be identified only 19% of the time [11]. In a study by Das et al, MB2 canals were detected in 73% and 71% of maxillary molars of males and females, respectively [2]. For successful endodontic therapy it is also important to know that the root canal morphology exhibit variations related to the racial origin [27,28]. If the prevalence of the MB2 is high in a population, time should be devoted to its location and treatment [3,29,30].

Various criteria have been proposed to consider the canal as MB2 canal [12,31]. Considered MB2 canal present if the author was simply able to instrument the canal to a depth of 3 to 4 mm after troughing. Furthermore, he stated that approximately 9% of the MB2 canals could not be fully instrumented and were thought to be rudimentary canals that did not exist in the apical one-half of the root [11]. In a study by Das et al, canal has to be traced till a depth of 4-5 mm from the Cemento-Enamel junction (CEJ) to be included and recorded as a MB2 canal. If less than 4 mm length was achieved then the orifice was labelled as an opening present but non-negotiable [2,32]. These criteria are consistent with Shenoi et al. and Hasan et al reports on canals [11,12,33].

Table 2. *Distribution of different types of MB canals.*

Type of canal according to Vertucci	Description [Raj UJ]	Age group		
		14-20 (N=14)	21-30 (N=19)	31-40 (N=26)
I	Single canal present from the pulp chamber to the apex	3	4	6
II	Two separate canals leave the pulp chamber and join short of the apex to form one canal	1	2	2
III	One canal leaves the pulp chamber, divides into two within the root, and then merges to exit in one canal		1	2
IV	Two separate and distinct canals are present from the pulp chamber to the apex	5	9	11
V	Single canal leaves the pulp chamber but divides into two separate canals with two separate apical foramina	2	1	3
VI	Two separate canals leave the pulp chamber but join at the midpoint and divides again into two separate canals with two separate apical foramina		2	2
VII	One canal leaves the pulp chamber, divides and rejoins within the canal, and finally redivides into two distinct canals short of the apex	1	1	
Unclassificable			3	3
Total amount of teeth where canal detected		12	23	29

Table 3. *Comparison of various studies [11].*

Reference	Number of teeth	Type of study	1 canal (%)	2 canal (%)
Pomeranz, Fishelberg (1974)	71	Clinical RCT(a)	72.0% (51)	28.0%(20)
Slowey, RR (1974)	103	Clinical radiographic examination	49.6% (51)	50.4%(52)
Sempira, HN and Hartwell, GR (2000)	130	Clinical RCT(a) using SOM(b) or loupes	66.9% (87)	33.1% (43)
Buhrley, LJ *et al* (2002)	208	Clinical RCT(a) using SOM(b) or loupes	29.9% (62)	71.1%(148)
Wolcott, J *et al* (2002)	1193	Clinical examination of RCT(a) treated and retreated teeth	39.0% (465)	61.0%(728)
Hasan M *et al*(2012)	53	Clinical RCT(a) and using loupes	49.1% (26)	50.9% (27)

(a)Root Canal Treatment; (b) Surgical Operating Microscope.

Table 4. *Age distribution in study and incidence of MB2 canal [9].*

Age group (years)	N	MB2 found	MB2 not found
14-20	14	12	2
21-30	23	20	3
31-40	23	10	13

The complexity of the root canal system is known such as furcation, accessory and lateral canal, intercanal connection and apical deltas [27,34]. Clinically, different canal configurations might require varying root canal procedures to facilitate complete cleaning, disinfection, and canal obturation [3,35].

In the maxillary molars, anatomic variations are not uncommon, with the number of canals, from one to eight [36,37]. In a study done by Peeters et al. the frequency of teeth with two MB canals with separate foramina was 52.6%, whereas the percentage of joined foramina was 47.4% [3]. Gianrico Spagnuolo et al. found the presence of single or multiple isthmuses in 63.63% of MB roots, and isthmuses were more frequently found in the middle third (48%) [1].

Categorization of the position of one or two canals into four groups [3]. Vertucci identified eight pulp space configurations [36,38]. Recently, 14 new additional canal types were reported by Sert and Bayirli, highlighting the complexity of the root canal systems [39]. However, there are many individual tooth variations and hence each case should be evaluated separately [5,40,41].

Tuncer et al. found the second mesiobuccal canal in 78% of the 110 maxillary molars and in 17 (19.8%) of these MB2 canals it was accessible to the apex. The teeth with no access to the apex were discarded and of the remaining 17, 3 (17.6%) had a Vertucci Type IV and 14 (82.4%) were Vertucci Type II canal system [27]. Abuabara A et al. reported that according to Vertucci's classification 48% of the mesiobuccal canals found were type I, 28% type II, 18% type IV and 6% type V [24].

Traditionally, most endodontic canal detection procedures have relied on the dentist's tactile dexterity, and mental image of the canal system because the ability to visualize the canal orifices is severely restricted [2]. When mesially located, it is often hidden under the shelf of the dentine wall or calcifications in a small groove. It often has to be exposed by selective removal of dentine [2,42,43]

Important condition for achieving positive results of endodontic treatment is a correct access to the root canal. If magnification is not used during root canal treatment, it is recommended that a rhomboid access be made to gain sufficient access to the floor

of the coronal cavity, [29] as it will increase the number of MB2 orifices that can be located and properly treated [3,43].

Access cavity locates in the mesial half of the tooth crown. The palatal canal is the largest and is the main mark in the pulp chamber. The MB2 canal locates under the corresponding tubercle. The distobuccal canal locates in 2-3 mm from MB canal and slightly palatal [44,45].

In endodontic therapy, the quality and quantity of the information obtained from radiographic examinations is very important because it affects the diagnosis, treatment planning, and prognostic stability [46, 47]. The most commonly used imaging method for the *in vivo* study of the dental anatomy and endodontic diagnosis is the periapical x-ray [29].

Conventional radiographic examination, though an essential pre-requisite for managing the endodontic problems, has its own limitations. The three-dimensional information is compressed into two-dimensionl anatomical image form [12,48]. In daily clinical practice, there are some cases where the conventional intraoral radiography and/or panoramic radiography alone does not provide enough information on the pathologic conditions, anatomical forms and structures, and positional relationships [5]. The interpretation becomes difficult when the background pattern is complex (e.g. posterior maxillary region). Actual extent of lesions and their relation to other structures in the direction of the X-ray beam is not shown. Other disadvantages include relatively higher radiation dose exposure, image distortion, processing errors and time consumption [12]. This examination provides only limited 2D information sensitive to the superposition of anatomical structures (zygomatic arch, maxillary sinus, dental roots) and distortion of the image because of the angulation used, which is why it is not a reliable method for the detection of accessory canals [29].

Limitations of conventional radiographic technique have led to introduction of advanced modalities such as Spiral Computed Tomography (SCT) and Cone-Beam Computed Tomography (CBCT). CBCT was introduced in the field of endodontics in 1990's [12]. It has the capacity to explore the anatomical structures in a three-dimensional reconstruction, from axial, transverse and sagittal planes, and provides adequate information about the root canals in different directions with no anatomical superposition, which cannot be detected clinically or by means of conventional x-rays [29]. CBCT system was developed for pre-surgical implant planning, TMJ examination, large cysts and tumors and Facial trauma cases [12,49]. The endodontic applications are 3D information of the teeth and surrounding tissues, analysis the topographic relationship of the upper tooth roots and the maxillary sinus and the lower tooth roots and the mandibular canal, endodontic treatment planning and checking root canal obturation, the follow state observation of periapical tissues after root canal treatment, including retreatment, detection of the root cracks, etc.

Combined use of different methods increased the detection of the second canal in MB roots [24]. With the use of specialized technology and a modified approach in the treatment of MB2 canals, the clinicians may report a higher success rate in the identification and treatment of these canals [2]. The more common use of operating microscope or loupes in recent clinical studies has resulted in an increased prevalence of the clinical detection of the MB2 canal.

Using magnification during endodontic treatment has particular advantages. It increases the confidence level of the operator by improving control during troughing and searching in the deep chambers of maxillary molars thereby reducing significant risk of perforations [11]. Magnification and variable intensity of light, which is focused down the shaft of the optic piece, parallel to the field of magnification by the dental operating microscope (DOM) provides clear view of the pulpal floor, helps in differentiating the color differences between the dentine of the floor and walls, thus leading to easier detection of MB2 small-sized canal orifice [2,9]. Consequently, magnification enhances the ability of the operator to effectively search for the second mesiobuccal canal and as a result leads to higher number of such canals being located and treated. Eventually, this may lead to higher quality endodontic treatment [11].

Because detection of the MB2 orifice is not easy, root canal treatment should be performed under microscopy with the help of an ultrasonic tip. The microscope provides good visibility, and the ultrasonic tip can create a deeper trough in the dentin. Use of these devices increases the likelihood of finding MB2 orifices [3]. In a study by Sujith et al. it has been demonstrated that troughing the chamber floor within 3 mm from the MB canal toward the palatal canal with an ultrasonic tip under DOM makes detection of MB2 canal more successful [9]. Peeters et al. showed that second orifices of six molars were covered by secondary dentin; therefore, such orifices could only be discovered by using an ultrasonic tip [3]. Furthermore, variations in the skill levels and experience of different operators in using DOM and ultrasonics can influence the outcomes [9].

In a study done by Das et al. [2] the floor of the pulp chamber was explored after access cavity preparation and location of main canals in order to locate the MB2 in three stages: using an endodontic explorer under direct vision (Stage I), under magnification with the aid of operating microscope (Stage II) and finally with the combined use of operating microscope and selective dentin removal (Stage III). The detection rates of MB2 canals in Stages I-III were 36%, 54%, and 72%, respectively (Table 5).

Table 5. *Detection rates of MB2 canal in different stages of canal location [2].*

Stage	Number of canals		Total
	1	2	
I	96	54 (36%)	150
II	68	82 (54%)	150
III	41	109 (72%)	150

A wise clinician will stop excavating the dentin if a canal orifice cannot be found, as serious errors can arise from overenthusiastic or inappropriate attempts to locate canals [3]. One of the dangers in searching for calcified canals using troughing is the possibility of perforation [2]. Moreover, the clinician should be attentive when instrumenting the MB2 canals to avoid thinning of furcal canal walls. Such factors as dentine thickness and the degree of the curvature of the canal are important risk factors of potential canal perforation.

Also, these may lead to transportation in the canal and over-preparation which can then increase the risk of perforation [14]. In a study by Peeters et al. of the 211 molars with an MB2, five were perforated, which shows that perforation can occur even when microscopy and ultrasonic devices are used [3]. It should be noted that in both MB1 and MB2 canals in the first maxillary molar, the dentine thickness decreased with increasing distance from CEJ [14].

Difference between groups could be explained also by development of pulpal calcification with long term of inflammatory process. That reason could be explanation why MB2 is more common in a younger population, as older patients have longer period of inflammatory changes and calcification in more pronounced. Our data correlate with information that use of magnification enhanced the ability to detect the MB2 canals [40] where the MB2 canals could not be detected in 16.5% of the teeth. Our results prove previous data that the majority of the MB2 canal orifices originate distal to the main MB canal and most of the MB2 canal orifices are normally in our vision of the classical triangular access cavity for this reason a careful examination of the pulpal floor should be conducted [27]. The presence of untreated canals significantly increased the risk of expansion and/or destruction. Therefore, identifying these conditions can also be useful in diagnosing untreated canals. Dentists should assess the anatomy of the tooth and the structure of the root canal to minimize the possibility of an untreated canal [34]. Careful examination of radiographs and internal anatomy of teeth helps to achieve better outcomes for the endodontic treatment of the first molars.

Conclusion.

First maxillary molar is possibly the most treated and least understood posterior tooth. Deep knowledge of anatomical and topological structure of the MB2 canal at the stage of diagnostics as well as during the course of endodontic treatment can help to decrease the percentage of unsuccessful treatment of the first molar. Clinicians need to be mindful of the possible presence of MB2 canal, which should motivate change in the routine practice of clinical endodontic treatment. Modifications in the endodontic access and detection techniques, as well as advancements in radiographic technique and magnification technology, aids in the location and treatment with the MB2 canal of the first maxillary molar. The second mesiobuccal canal was found in 65 (85.5%) of the 76 maxillary molars and in 29 (38.1%) of these MB2 canals it was accessible to the apex. We have detected that patients with chronic pulpitis or chronic periodontitis have significant different undetected MB2 canal in group 14-20 years (7.1%) and 31-40 years (19.4%), $p < 0.05$. Such difference between groups could be explained by development of pulpal calcification with long term of inflammatory process.

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