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Evaluation of Second Canals in Mandibular Incisors using Magnification: A Cross-Sectional Study

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ABSTRACT

Background: It is essential to have a thorough understanding of the typical anatomy of the root canal system, as well as the various common and uncommon anatomical variations, in order to achieve successful treatment outcomes.
Objective: To determine the frequency and pattern of two canals in mandibular incisors using magnifying loupe
Material and Methods: This study at Saidu College of Dentistry in Swat included 385 participants selected consecutively. Inclusion criteria were males and females aged 20-60 years with mandibular incisor-related dental conditions. Exclusion criteria were local anesthesia allergies, internal root resorption, calcified canals, and pregnancy. The number of canals was recorded radiographically using the SLOBE technique. Canals were classified using Vertucci's system. Canal frequencies were analyzed by gender and tooth types using chi-square tests ($p<0.05$).
Results: The mean age was 33.97±11.10 years. Of the participants, 215 (55.84%) were males. The highest numbers of tooth types were found among the left lateral incisors (n=148, 38.44%) and left central incisors (n=122, 31.69%). Second canal was found 139 participants (36.10%). Among these, Type I
(n=84, 21.82%) was the most common two-canal pattern, followed by Type III (n=36, 9.35%). When analyzing the canal types within the single canal group, Type I was the most prevalent in both males (23.26%) and females (20.00%). The frequencies of Types II, III, and IV were similar between genders and did not exhibit significant differences (p=0.865). The distribution of canal types varied across tooth types, with Type I being the most common, but not statistically significant (p=0.652).
Conclusion: The presence of a second canal in the mandibular incisors is quite common. The most common pattern of two canals, according to the Vertucci classification, was Type I, followed by Type III.
Keywords: Magnification, Mandibular incisors, Second canals, Vertucci classification

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INTRODUCTION

The presence of anatomical variations in the root canal system can present challenges during endodontic treatment.[1] Therefore, it is essential to have a thorough understanding of the typical anatomy of the root canal system, as well as the various common and uncommon anatomical variations, in order to achieve successful treatment outcomes.[2] Taking these anatomical variations into consideration can greatly improve the quality of endodontic procedures. On the other hand, inadequate knowledge and comprehension of the pulp space anatomy often result in complications encountered during and after root canal treatment.[3]

Research findings consistently support the notion that teeth exhibit anatomical variations, both internally and externally, which can be highly intricate. This is also applicable to mandibular incisors, where the presence of a second canal often goes unnoticed by many dentists. The existing understanding of pulp space anatomy primarily relies on studies encompassing diverse populations.[3] Numerous investigations have specifically targeted the root canal systems of mandibular incisors. However, a lack of consensus exists concerning the reported prevalence of second canals in these teeth. Discrepancies in findings may stem from differences in study design, such as contrasting approaches involving in vivo or ex vivo examinations, the utilization of various techniques to identify canals (e.g., radiographic examination, sectioning, and clearing), or even potential variations across different racial groups.[4,5]

CBCT offers numerous advantages as a precise imaging method that generates non-intrusive, three-dimensional pictures.[6] It delivers a reduced radiation dose to patients in contrast to conventional computed tomography and has received the endorsement of the European Society of Endodontology for assessing root canal structure, equipping clinicians with evidence-based guidelines.[7] Nonetheless, the elevated radiation levels associated with CBCT restrict its regular utilization in endodontic practice, demanding cautious evaluation prior to its application.[8]

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The utilization of a magnifying loop is a prevalent technique in endodontic procedures to observe the inner structure of the root canal system. This practice enables enhanced identification of supplementary canals, resulting in better treatment results and decreased chances of complications. The use of a magnifying loop holds particular significance when it comes to detecting the lingual canal, as it presents challenges due to its small dimensions and diverse morphology.[9]

In a prior research conducted in Germany, a total of 302 CBCT scans were employed, encompassing 1,208 mandibular incisors.[3] The findings of this study revealed that in 12.3% of the cases, all four incisors exhibited two root canals. Additional studies have also reported a range of 11% to 68% of mandibular incisors having two canals.[10,11]

The purpose of this study was to investigate the importance of identifying and treating all root canals to ensure successful root canal treatment. The particular challenge of locating the lingual root canal in mandibular incisors emphasizes the need for a more comprehensive understanding of the occurrence and internal structure of root canals in these teeth. Currently, there is a lack of research on the frequency of two canals in mandibular incisors within this specific population. Furthermore, the number of root canals in lower incisors varies among individuals due to genetic and environmental factors. Therefore, an exploration of the prevalence and anatomy of root canals in mandibular incisors can provide valuable insights for optimizing the outcomes of root canal treatment.

The objective of this study was to determine the frequency and pattern of two canals in mandibular incisors using magnifying loupe.

MATERIAL AND METHODS

This descriptive cross-sectional study was conducted at the Department of Operative Dentistry, Saidu College of Dentistry, Swat, from January 1, 2023, to June 30, 2023, using a consecutive non-probability technique. The sample size for this study was determined to be 385 participants, calculated using the WHO calculator. The calculation assumed a 95% confidence level and a 4% margin of error (i.e., desired level of precision), based on a previous study that reported a prevalence of two canals as 12.3%.[3]

In this study, the inclusion and exclusion criteria were defined to establish specific guidelines for participant selection. The inclusion criteria for this research included both males and females, ensuring a diverse sample. The age range of the participants was set between 20 and 60 years, as this encompassed a broad range of individuals who might have presented with dental conditions related to irreversible pulpitis, pulp necrosis, or periapical pathosis specifically in the mandibular incisor region. Patients who had a known allergy to local anesthesia were excluded to avoid any potential adverse reactions during treatment. Another exclusion criterion was the presence of internal root resorption, as this condition could have significantly impacted the study outcomes and treatment approaches. Additionally, individuals with calcified canals were excluded due to the potential challenges associated with accessing and treating these cases. Pregnant females were also excluded from the study since radiographic examinations, which might have been necessary for proper diagnosis and treatment planning, were contraindicated during pregnancy to ensure the safety of the fetus.

Upon approval from the hospital ethical committee (Dated: 02/01/2023, 6726/SCD/Swat/ERB), the study was initiated. Potential participants who met the inclusion criteria were extended invitations to take part in the study. Comprehensive explanations regarding the study's purpose, procedures, potential risks, and anticipated benefits were provided to them. To ensure their voluntary involvement, informed consent was obtained, prioritizing their understanding and agreement to participate. Furthermore, participants were reassured about the strict confidentiality measures in place to protect their personal and collected data from their records.

After conducting a comprehensive clinical and radiographic assessment of the mandibular incisors by FCPS qualified person, local anesthesia was administered to all enrolled participants. Rubber dam isolation was applied to ensure proper isolation of the teeth, and an access cavity was prepared using a round bur in a bucco-lingual direction. Subsequently, canal negotiation was performed using a number 15 k-file, and the number of canals was recorded clinically with the aid of magnification using a loupe of ten times(X10). In cases where the presence of two canals was suspected, periapical radiographs were captured using the horizontal SLOBE

technique, involving an approximately 45 degree angulation change between the two X-rays, which facilitated confirmation of the actual canal count.

In this study, the term "two canals" in mandibular incisors refers to the presence of two distinct and separate root canals within a single tooth. The confirmation of this condition was based on both radiographic and clinical examinations. The identification of two canals was conducted by experienced dental professionals who were specifically trained in the operative department and had more than one year of clinical experience. These professionals utilized both the SLOBE rule and magnifying loupe for accurate determination.

Vertucci's classification system was utilized to classify canals based on their characteristics. The classification includes five types, each with its own unique features. In Type I, there is a single canal that extends directly from the pulp chamber to the apex of the root. Type II involves two distinct canals that originate from the pulp chamber and then merge into a single canal before reaching the exit point. Type III is characterized by a single canal emerging from the pulp chamber, dividing into two separate canals within the root, and subsequently reuniting to form a single canal before exiting. Type IV consists of two separate and distinguishable canals that run independently from the pulp chamber to the apex of the root. Lastly, Type V describes a scenario where a single canal exits from the pulp chamber but then divides or bifurcates into two distinct canals.

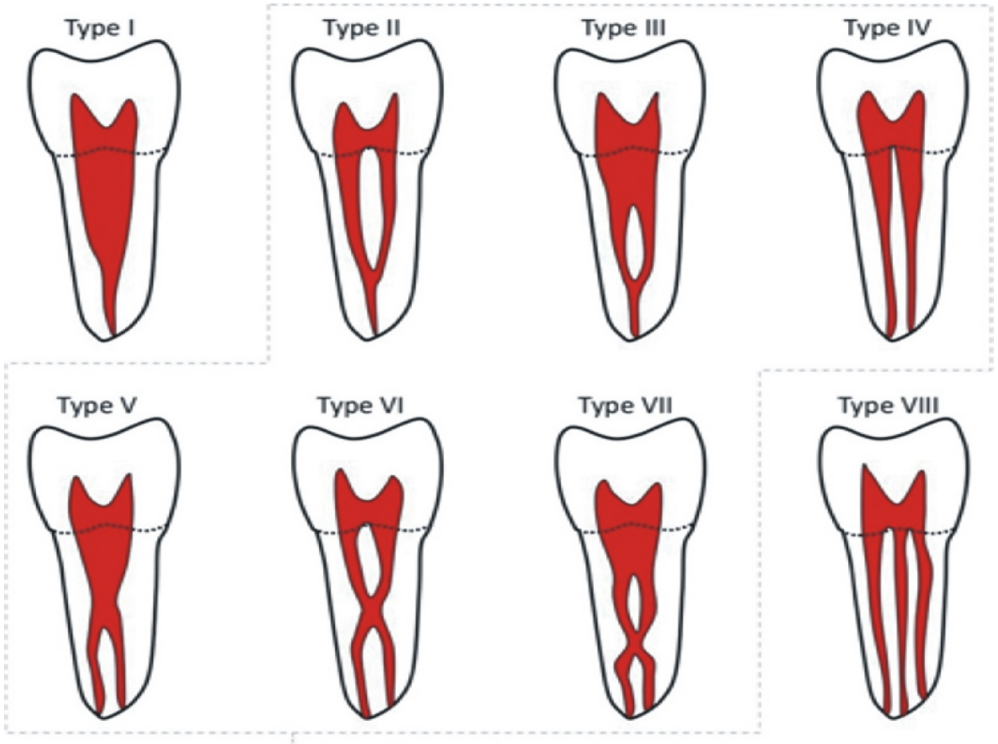


Fig 01. Vertucci's classification[12]

To mitigate bias and confounding variables, strict adherence to the predefined inclusion and exclusion criteria was upheld throughout the study. This ensured that only eligible participants meeting specific criteria were included in the analysis. Additionally, stratification techniques were implemented to further minimize potential biases and confounders, thereby enhancing the validity and reliability of the study design.

The data was analyzed using R version 4.12. For numerical variables like age, the mean and standard deviation were calculated. Qualitative variables such as gender and the number of canals in lower incisors were analyzed by determining frequency and percentage. The frequency of canals was stratified based on gender and tooth types. A post-stratification chi-square test was performed to compare differences in canal frequencies. If any assumptions of the chi-square test were violated, Fisher's exact test was utilized. The level of significance for all analyses was set at $p<0.05$.

RESULTS

The mean age of the participants was 33.97±11.10 years, ranging from 15 to 55 years. There were 215 males (55.84%), and the most common age group was 15-30 years (n=158, 41.04%), followed by 31-45 years (n=154, 40%). The most numerous tooth types were the left lateral incisors (n=148, 38.44%) and left central incisors (n=122, 31.69%). (Table 01)

In 139 (36.10%) participants, a second canal was found in the mandibular incisors. Based on the Vertucci classification, the most common pattern of two canals was Type I (n=84, 21.82%), followed by Type III (n=36, 9.35%). (Table 02)

Table 03 presents the frequency and pattern of canals in mandibular incisors, stratified by gender. In the female group (n= 170), 66.47% had a single canal, while 33.53% had two canals. In the male group (n = 215), 61.86% had a single canal, and 38.14% had two canals. The results were not statistically significant (p=0.407). Regarding canal types within the single canal group, the majority in both females and males were classified as Type I (20.00% in females, 23.26% in males). Types II, III, and IV were less prevalent but showed similar frequencies between genders. These differences were not statistically significant (p=0.865).

For the left central incisors (n = 122), 67.21% had a single canal, and 32.79% had two canals. The left lateral incisors (n = 148) had 58.11% with a single canal and 41.89% with two canals. Similarly, the right central incisors (n = 70) had 71.43% with a single canal and 28.57% with two canals, while the right lateral incisors (n = 45) had 62.22% with a single canal and 37.78% with two canals. However, the difference was not statistically significant (p=0.212). Regarding canal types within the single canal group, the most prevalent type varied across the tooth types, with Type I being the most common. However, there were no statistically significant differences in the distribution of canal types between tooth types, as indicated by the p-value of 0.652. (Table 04)

Table 01. Distribution of age, gender and tooth type

Variable	Characteristic	n(%)
Gender	Female	170 (44.16)
	Male	215 (55.84)
Age Group	15-30	158 (41.04)
	31-45	154 (40.00)
	46 & above	73 (18.96)
Tooth Type	Left central	122 (31.69)
	Left lateral	148 (38.44)
	Right central	70 (18.18)
	Right lateral	45 (11.69)

Table 02. Frequency and pattern of canal in lower incisors

Variable	Characteristic	n(%)
Number of Canals	single canal	246 (63.90)
	two canals	139 (36.10)
Canal Type	single canal	246 (63.90)
	Type I	84 (21.82)
	Type II	9 (2.34)
	Type III	36 (9.35)
	Type IV	10 (2.60)

Table 03. Frequency and pattern of canals in mandibular incisors stratified by gender

Variable	Characteristic	Female, n=170	Male, n=215	p-value*
Number of Canal	Single canal	113 (66.47)	133 (61.86)	0.407
	two canals	57 (33.53)	82 (38.14)	
Canal Type	Single canal	113 (66.47)	133 (61.86)	0.865
	Type I	34 (20.00)	50 (23.26)	
	Type II	3 (1.76)	6 (2.79)	
	Type III	16 (9.41)	20 (9.30)	
	Type IV	4 (2.35)	6 (2.79)	

* Pearson's Chi-squared test, **Fisher's exact test

Table 04. Frequency and pattern of canals in mandibular incisors stratified by tooth types

Variable	Characteristic	Left Central, n = 122	Left Lateral, n = 148	Right Central, n = 70	Right Lateral, n = 45	p-value*
Number of Canals	Single canal	82 (67.21)	86 (58.11)	50 (71.43)	28 (62.22)	0.212
	Two canal	40 (32.79)	62 (41.89)	20 (28.57)	17 (37.78)	
Canal Type	Single canal	82 (67.21)	86 (58.11)	50 (71.43)	28 (62.22)	0.652
	Type I	21 (17.21)	38 (25.68)	14 (20.00)	11 (24.44)	
	Type II	3 (2.46)	2 (1.35)	2 (2.86)	2 (4.44)	
	Type III	13 (10.66)	17 (11.49)	3 (4.29)	3 (6.67)	
	Type IV	3 (2.46)	5 (3.38)	1 (1.43)	1 (2.22)	

* Pearson's Chi-squared test

DISCUSSION

This study was aimed to determine the frequency and pattern of second canal in mandibular incisors. Our findings showed that second canal was found in the mandibular incisors of 139 participants (36.10%). Among these, Type I (n=84, 21.82%) was the most common two-canal pattern, followed by Type III (n=36, 9.35%). The difference in frequency and pattern of second in lower incisors with respect to gender and tooth type was not statistically significant.

The study included participants with a mean age of 33.97±11.10 years, ranging from 15 to 55 years. By including participants with a wide range of ages, from 15 to 55 years, we aimed to capture variations in canal morphology across different age groups. Age can potentially influence the development and complexity of tooth structures, including the presence of additional canals. Therefore, incorporating participants with diverse age ranges allows us to gain a comprehensive understanding of the frequency and patterns of second canals in lower incisors. The mean age of 33.97±11.10 years provides a central measure of the participants' age distribution, giving us a representative sample to draw meaningful conclusions about the presence of second canals in lower incisors.[13]

Our findings showed that second canal was found in the mandibular incisors of 139 participants (36.10%). The difficulty in identifying the existence of a second canal is a common factor contributing to the failure of root canal therapy in mandibular incisors.[14] Prior research has presented a wide range of occurrences for the second canal in mandibular incisors, with reported incidences ranging from 11.5% to 45%.[15-17] In another study, they observed the presence of a second canal in 23.9% of central incisors, 35% of lateral incisors, and 29.7% of both mandibular incisors.

In a study conducted by Sert et al.[18], they utilized clearing and staining methods on extracted mandibular permanent incisors. The findings indicated that the presence of a second canal was 68% in mandibular central incisors and 63% in mandibular lateral incisors. Discrepancies between their results and the current study may be due to variations in sample size, study methodology, and the specific racial group being studied. A case report demonstrated that all mandibular incisors possess two canals.[19]

Geduk et al.[20] used CBCT imaging to study mandibular incisor morphology. They found that most incisors had one root and one canal (Type 1) at 64.4%, consistent with our results. Type 3 canals were the second most common at 19.4%. In another study, Type 5 canals were the second most prevalent at 12.9%, followed by Type 4 canals at 0.7% and Type 2 canals at 0.3%.[17] Zitong Lin et al.[21] reported that Type 1 canals were the most common at 81.8%, and Type 3 canals were the second most prevalent at 12.7%. However, their study reported Type 2 canals as the third most common, while our study found Type 5 canals at a prevalence of 12.9%.

The study's single-center design limits its generalizability to other settings or populations. Furthermore, the expertise and experience of the operator performing the evaluations can introduce variability in the results. Although the study used magnification loupes, which can enhance visibility, it is worth noting that the gold standard for canal identification is cone-beam computed tomography (CBCT). CBCT provides more detailed and accurate imaging, which could potentially reveal additional canals that may have been missed with magnification loupes alone.

The strength of this study lies in its comprehensive approach to participant selection and diagnosis, with strict inclusion and exclusion criteria applied to ensure a diverse and relevant sample. The utilization of both radiographic and clinical examinations, guided by experienced dental professionals, adds robustness to the diagnostic process. However, some limitations should be acknowledged. The single-center nature of the study may limit the generalizability of findings to a broader population. Additionally, the potential for selection bias cannot be entirely ruled out, as participants were recruited from a specific demographic range. Finally, while the use of skilled professionals enhances diagnostic accuracy, variations in expertise could still introduce some degree of subjectivity to the results.

CONCLUSION

The present study identified the presence of a second canal in the mandibular incisors of a significant number of participants. The most common pattern of two canals, according to the Vertucci classification, was Type I, followed by Type III. These findings highlight the importance of comprehensive examination and awareness of the potential existence of second canals in mandibular incisors.

Conflict of Interest

Authors declare no conflict of interest

Grant Support and Financial Disclosure

NIL

REFERENCES

1. Tassoker M, Sener S. Analysis of the root canal configuration and C-shaped canal frequency of mandibular second molars: a cone beam computed tomography study. Folia Morphol. 2018;77(4):752-7.
2. Kim H-S, Jung D, Lee H, Han Y-S, Oh S, Sim H-Y. C-shaped root canals of mandibular second molars in a Korean population: a CBCT analysis. Restorat Dent Endod. 2018;43(4):672-9.
3. Baxter S, Jablonski M, Hülsmann M. Cone-beam-computed-tomography of the symmetry of root canal anatomy in mandibular incisors. J Oral Sci. 2020;62(2):180-83.
4. Sroczyk-Jaszczyńska M, Kołecki J, Lipski M, Puciło M, Wilk G, Falkowski A, et al. A study of the symmetry of roots and root canal morphology in mandibular anterior teeth using cone-beam computed tomographic imaging in a Polish population. Folia Morphol. 2020;79(4):835-44.
5. Ghabbani HM, Marghalani AA, Alabiri HR. Assessment of root canal morphology of mandibular incisors using cone-beam computed tomography among residents of Al-Madinah Al-Munawara Region, Saudi Arabia. Eur J Gen Dent. 2020;9(01):40-4.
6. Mazzi-Chaves JF, Camargo RV, Borges AF, Silva RG, Pauwels R, Silva-SousaYTC, et al. Cone-beam computed tomography in endodonticsstate of the art. Curr Oral Health Rep. 2021;8:9-22.
7. Martins JN, Marques D, Silva EJNL, Caramês J, Versiani MA. Prevalence studies on root canal anatomy using cone-beam computed tomographic imaging: a systematic review. J Endod. 2019;45(4):372-86. e4.
8. Kamburoğlu K. Use of dentomaxillofacial cone beam computed tomography in dentistry. World J Radiol. 2015;7(6):128-34.
9. Low JF, Dom TNM, Baharin SA. Magnification in endodontics: A review of its application and acceptance among dental practitioners. Eur J Dent. 2018;12(04):610-6.

10. Boruah LC, Bhuyan AC. Morphologic characteristics of root canal of mandibular incisors in North-East Indian population: An in vitro study. J Conser Dent. 2011;14(4):346-52.
11. Halker RB, Barrs DM, Wellik KE, Wingerchuk DM, Demaerschalk BM. Establishing a diagnosis of benign paroxysmal positional vertigo through the dix-hallpike and side-lying maneuvers: a critically appraised topic. Neurologist. 2008 May;14(3):201-4.
12. Al Mheiri E, Chaudhry J, Abdo S, El Abed R, Khamis AH, Jamal M. Evaluation of root and canal morphology of maxillary permanent first molars in an Emirati population; a cone-beam computed tomography study. BMC Oral Health. 2020;20:1-9.
13. Usha G, Muddappa SC, Venkitachalam R, VP PS, Rajan RR, Ravi AB. Variations in root canal morphology of permanent incisors and canines among Asian population: A systematic review and meta-analysis. J Oral Biosci. 2021;63(4):337-50.
14. Bagai A, Thavendiranathan P, Detsky AS. Does this patient have hearing impairment? JAMA. 2006 Jan 25;295(4):416-28.
15. Dorresteijn PM, Ipenburg NA, Murphy KJ, Smit M, van Vulpen JK, Wegner I, Stegeman I, Grolman W. Rapid systematic review of normal audiometry results as a predictor for benign paroxysmal positional vertigo. Otolaryngol Head Neck Surg. 2014 Jun;150(6):919-24.
16. Vanni S, Pecci R, Edlow JA, Nazerian P, Santimone R, Pepe G, Moretti M, Pavellini A, Caviglioli C, Casula C, Bigiarini S, Vannucchi P, Grifoni S. Differential Diagnosis of Vertigo in the Emergency Department: A Prospective Validation Study of the STANDING Algorithm. Front Neurol. 2017;8:590-9.
17. Mirhosseini F, Tabrizizadeh M, Nateghi N, Rad ES, Derafshi A, Ahmadi B, et al. Evaluation of root canal anatomy in mandibular incisors using CBCT imaging technique in an iranian population. J Dent. 2019;20(1):24-9.
18. Shih RD, Walsh B, Eskin B, Allegra J, Fiesseler FW, Salo D, Silverman M. Diazepam and meclizine are equally effective in the treatment of vertigo: an emergency department randomized double-blind placebo-controlled trial. J Emerg Med. 2017 Jan;52(1):23-27.
19. Daokar SG, Kalekar AS, Ghunawat DB, Kakde DD. All the mandibular incisors with double canals in a single patient: A rare case. J Int Oral Health. 2015;7(2):46-52.
20. Tsukamoto HF, Costa Vde S, Silva RA, Pelosi GG, Marchiori LL, Vaz CR, Fernandes KB. Effectiveness of a vestibular rehabilitation protocol to Improve the Health-Related Quality of Life and Postural balance in patients with vertigo. Int Arch Otorhinolaryngol. 2015 Jul;19(3):238-47.
21. Gottshall KR, Topp SG, Hoffer ME. Early vestibular physical therapy rehabilitation for Meniere's disease. Otolaryngol Clin North Am. 2010 Oct;43(5):1113-9.

DATA SHARING STATEMENT: The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

AUTHOR'S CONTRIBUTION

The following authors full fill authorship criteria as per ICMJE guidelines;

Afsar R, Ali A:	Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.
Afsar B:	Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.
Nasir U:	Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.
Maryam B:	Analysis and interpretation of data, critical revision,final approval, agreed to be accountable for all the work.

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