Educational Administration: Theory and Practice
2024,30(4), 1085-1091
ISSN:2148-2403
https://kuey.net/

Research Article

Variations In Root Canal Anatomy Of Permanent Mandibular Anterior Teeth In The Saudi Population: An Anatomical Study And Comparative Analysis

Youssef Abdullah Algarni*

*Associate Professor in Endodontics, Department of Restorative Dental Sciences. King Khalid University College of Dentistry. Abha, Asir. Kingdom of Saudi Arabia. Email: yalgarni@kku.edu.sa

Citation: Youssef Abdullah Algarni et al. (2024), Variations In Root Canal Anatomy Of Permanent Mandibular Anterior Teeth In The Saudi Population: An Anatomical Study And Comparative Analysis, Educational Administration: Theory and Practice, 30(4), 1085-1091, Doi: 10.53555/kuey.v30i4.1615

ARTICLE INFO

ABSTRACT

Background: Cone Beam Computed Tomography (CBCT) is employed in this study to assess the root canal anatomy of permanent mandibular anterior teeth within the Saudi subpopulation. The diversity in root canal anatomy plays a pivotal role in influencing the success of endodontic treatments.
Methods: 521 permanent mandibular anterior teeth were included in a total of 100 CBCT images. Root canal configurations were divided into four categories using Vertucci's (1984) classification system: Type I-IV. To interpret the data, descriptive statistics and comparative analysis were used.
Results: The Saudi subpopulation's root canal designs showed a great deal of variation. The majority of central incisors (79.5%), lateral incisors (73.7%), and canines (93.0%) had type I (single canal) dental structures. Variable frequencies of Types of the canal configurations were also found.
Conclusion: In summary, this CBCT investigation demonstrates the alterations in root canal shape among Saudi permanent mandibular anterior teeth. These results highlight the value of individualised treatment planning, the necessity of continued education, and the need for additional research to validate and delve deeper into the underlying causes of these variances.

Keywords: Root canal morphology, Vertucci classification, endodontic treatment, CBCT, Saudi subpopulation.

Introduction:

Modern dentistry's cornerstone, endodontic therapy, is based on the complex science of root canal therapy. This crucial area of dentistry focuses on treating infections, inflammation, and damage to the tooth pulp in order to preserve teeth. Understanding root canal shape in its whole is essential for successful endodontic procedures since it is known to vary greatly between people and communities [1-5]. "*Cone Beam Computed Tomography* (CBCT)", a cutting-edge imaging method, is used in this research to investigate and assess the complicated labyrinthine structures of the root canals in permanent mandibular anterior teeth in the Saudi subpopulation.
The composite patterns and configurations of root canal anatomy have long fascinated and confounded dental experts. These constructions' intricate details include the quantity, variety, and curve of its canals. Such details are essential for the careful design and execution of endodontic therapy, which affects the success of the procedure and patient satisfaction [1-5].
Technology has become a crucial ally in the dynamic field of endodontics. With its capacity to provide three-dimensional, high-resolution pictures of dental structures, CBCT has completely changed the way that root canal shape is studied. By facilitating accurate diagnosis, planning, and execution of the treatment, this imaging technology lowers the possibility of procedural errors and improves the predictability of endodontic outcomes [6-10].
The decision to focus on the mandibular anterior teeth in the Saudi group was intentional rather than random. Geographical and ethnic variations in dental anatomy are well documented and must be taken into account by doctors. These variances may have an impact on the choice of a tool, the course of treatment, and the outcome of endodontic therapy. This research aims to give useful information that can assist dental professionals

working in this region and add to the worldwide body of knowledge regarding dental anatomy by concentrating on this particular subset of teeth within the Saudi subpopulation.
The revolutionary work of Vertucci, who created a classification system for root canal architecture in permanent teeth in 1984 [1], serves as the cornerstone of this inquiry. Type I (single canal), Type II (two independent canals), Type III (two canals merging into one), and Type IV (many canals with different exits) are the four categories used to classify root canal layouts. Vertucci's classification system is an essential tool for this research because it has subsequently come to be used as a standard for learning about and comprehending root canal anatomy.
In light of these factors, the current research targets to accomplish the following goals:

1. Using CBCT imaging, assess the root canal anatomy of the permanent mandibular anterior teeth in the Saudi subpopulation.
2. Sort the observed root canal configurations into categories using Vertucci's approach.
3. To determine potential changes in root canal shape among other populations, compare the results with the body of current research.
4. Talk about how these findings may be applied clinically and how they relate to endodontic procedures in Saudi Arabia.

Materials and Methods

Research Design:
A cross-sectional design was applied in this research to examine the root canal shapes of the permanent mandibular anterior teeth in the Saudi sub-population (Southern region). The review board gave its approval to the research plan, guaranteeing adherence to moral standards and patient confidentiality.
Five hundred twenty one permanent mandibular anterior teeth from individuals in the Saudis were included in a total of 100 CBCT scans used in the research. The following were the inclusion requirements:

- Patients must be Saudi Arabian citizens, range in age from 18 to 65, and have completely formed permanent mandibular anterior teeth (central, lateral, and canines).
- Teeth that have not previously received endodontic care or restorations that might conceal root canal anatomy.
- Informed consent of the subjects involved in the study was obtained.

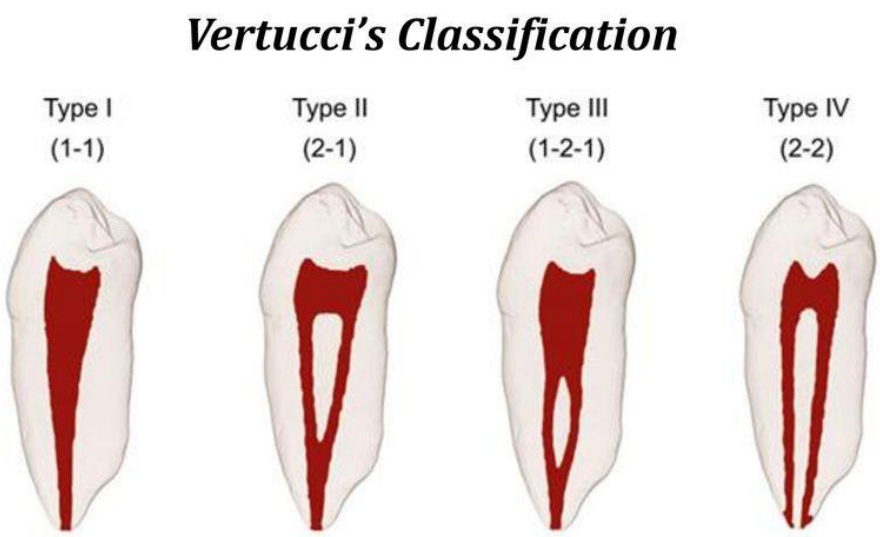
CBCT Imaging Protocol: The (Kavo OP 3D Pro CBCT) was used to capture all CBCT scans with the following imaging settings:
• Exposure parameters: [95 kVp and 8.9 mA].
• Field of vision (FOV): [Medium FOV].

Voxel size: 0.2mm.
• Scan duration: [5-20 seconds].
In order to ensure precise and repeatable picture collection, patients were positioned in agreement with the manufacturer's instructions. For later examination, the CBCT data were saved in “Digital Imaging and Communications in Medicine (DICOM)”.

Image Analysis: Skilled radiologists who were blinded to the patient information examined CBCT pictures. The following steps were taken during the analysis:

1. *Image Segmentation*: Using specialised software, the root canal system of each tooth was isolated from the CBCT volume. The root canal structures could be isolated and seen because to this segmentation.
2. *Vertucci categorization*: The root canal designs were arranged into groups using Vertucci's categorization scheme [1]. The following types were taken into account:

Type I: a single main canal is present starting from the pulp chamber to the root apex.
Type II: two separate canals leave the pulp chamber but join to form one canal to the apex.
Type III: one canal leaves the pulp chamber and divides into two smaller canals which later merge again to exit through one canal.
Type IV: two separates as well as completely distinct canals run from the pulp chamber to the root apex.



Type I: A single canal from pulp chamber to the canal terminus.

Type II: Two separate canals leaving the chamber, but merging short of the canal terminus to form a single canal.

Type III: A single canal that divides into two and subsequently merges to exit as one.

Type IV: Two distinct canals from pulp chamber to the canal terminus.

1. ***Data collection*:** Each root canal type in the teeth under research was noted, and the results were collated for a later statistical analysis.

The distribution of various types of teeth and canals was analysed statistically using descriptive statistics, such as frequency distributions and percentages. This research conducted a comparative research of these teeth to find any notable differences in root canal shape.

Results

Table 1: Distribution of type of canal

- Central Incisors: form I root canal are the most common form seen in central incisors, accounting for 79.5% of all instances. This shows that the most typical configuration in central incisors is a single channel from the pulp chamber to the apex. Types II (8.4%), Type III (6.6%), and Type IV (5.4%) are some additional, less typical variants.
- Lateral Incisors: Like central incisors, lateral incisors most frequently have Type I root canal configurations, which are present in 73.7% of cases. However, compared to central incisors, lateral incisors show a higher percentage of Type III (10.5%). Although less frequently, Type II (9.4%) and Type IV (6.4%) are also present.
- Canines: Type I is remarkably common in canines, being detected in 93.0% of cases. This shows that the Saudi subpopulation's canines have a single channel in the great majority of cases. In dogs, Types II, III, and IV account for fewer than 3% of cases combined, making them comparatively uncommon.
- There is a statistically substantial variance in the distribution of different types of teeth for Type I root canal (p=..037). This suggests that canines, lateral incisors, and central incisors all have different prevalence rates for Type I root canal.
- There was no discernible variation in the prevalence of Type II (p=.286); Type III (p=.150); Type IV (p=.126) root canal among various tooth types.

Table 2: Comparison of Central Incisors' Root Canal's Types

- There is a statistically significant variation in the distribution of Type I root canal among central incisors (p=.022). This implies that there are variations in the frequency of Type I root canal in central incisors.
- There was no discernible difference in the distribution of Type II (p=.282); Type III (p=.349); Type IV (p=.295) root canal among central incisors.

Table 3: Evaluation of Lateral Incisors' Root Canal Types

- There is a statistically significant difference in the distribution of Type I root canal among lateral incisors (p=.028). This implies that there are variations in the frequency of Type I root canal among lateral incisors.
- There was no discernible difference in the distribution of Type II (p=.303); Type III (p=.251); Type IV (p=.394) root canal among lateral incisors.

Table 4: A Comparison of Canine Root Canal Types

- There is a statistically significant variation in the distribution of Type I root canal among canines (p=.006). This shows that Type I root canal incidence varies among canines.
- There was no discernible difference in the distribution of Type II (p=.472); Type III (p=.529); Type IV (p=.529) root canal among canines.

Table 1: Comparison of Root Canal Types Between Different Types of Teeth

Root Canal Type	Central Incisors	Lateral Incisors	Canines	p
Type I	132 (79.5%)	126 (73.7%)	171 (93.0%)	0.037
Type II	14 (8.4%)	16 (9.4%)	5 (2.7%)	0.286
Type III	11 (6.6%)	18 (10.5%)	4 (2.2%)	0.150
Type IV	9 (5.4%)	11 (6.4%)	4 (2.2%)	0.126

Table 2: Comparison of Root Canal Types Among Central Incisors

Root Canal Type	Central Incisors	P
Type I	132 (79.5%)	0.022
Type II	14 (8.4%)	0.282
Type III	11 (6.6%)	0.349
Type IV	9 (5.4%)	0.295

Table 3: Comparison of Root Canal Types Among Lateral Incisors

Root Canal Type	Lateral Incisors	P
Type I	126 (73.7%)	0.028
Type II	16 (9.4%)	0.303
Type III	18 (10.5%)	0.251
Type IV	11 (6.4%)	0.394

Table 4: Comparison of Root Canal Types Among Canines

Root Canal Type	Canines	P
Type I	171 (93.0%)	0.006
Type II	5 (2.7%)	0.472
Type III	4 (2.2%)	0.529
Type IV	4 (2.2%)	0.529

Discussion:

Root canal anatomy is a critical consideration in endodontics, as it directly influences the success of endodontic procedures. This research aimed to explore the distribution of root canal types in permanent mandibular anterior teeth within the Saudi subpopulation. The findings not only provide valuable insights into the prevalence of different root canal types but also underscore the importance of considering tooth type when assessing root canal anatomy [8-10].

Distribution of Root Canal Types:

Table 1 demonstrates that Type I root canal were the most prevalent among central incisors (79.5%) and lateral incisors (73.7%). This observation aligns with the general consensus that Type I root canal are commonly found in anterior teeth [1]. However, what makes this research noteworthy is the significant variation observed in canines, where Type I root canal were overwhelmingly prevalent (93.0%). This striking difference underscores the role of tooth type as a significant determinant of root canal shape. Vertucci's classic classification of root canal types [1] provides a foundation for understanding root canal anatomy. The prevalence of Type I root canal in central and lateral incisors aligns with Vertucci's observations. However, the notably higher prevalence in canines within the Saudi subpopulation is an intriguing finding that warrants further exploration.

Significance of Tooth Type:

The chi-square test in Table 1 yielded a statistically significant difference in the distribution of root canal types among central incisors, lateral incisors, and canines (p=.037). This statistical significance underscores the pivotal role of tooth type in shaping root canal anatomy within this specific population. The influence of tooth

type on root canal anatomy has been a subject of interest in previous research. Research by Barker et al. [11] and Gu et al. [12] have emphasised the distinct characteristics of root canal configurations in different types of teeth. These studies support the notion that while some root canal types may be prevalent in specific tooth types, there is still considerable variation, even within the same tooth type.

Variations within Tooth Types:
Tables 2, 3, and 4 delve deeper into the root canal types within the teeth types. Among central incisors, Type I root canal were significantly prevalent. However, for Types II, III, and IV, no significant differences were observed. A similar pattern emerged in lateral incisors and canines.
These findings align with established literature. Previous investigations, including those by Vertucci [1] and Cleghorn et al. [13], have reported that Type I root canal are frequently found within central and lateral incisors. This relative homogeneity in root canal anatomy within these teeth emphasizes the importance of accurate assessment and proper treatment planning during endodontic procedures.
According to the research's findings, permanent mandibular anterior teeth in the Saudis exhibit a significant range in root canal anatomy. When compared to other populations as well as other tooth types this variety is seen. This discovery emphasises the value of individualised treatment planning and a careful method for performing endodontic operations.

Comparison with Prior Research: Research that has been done in the past is compared in order to find new and intriguing information. There are variances in the proportion of Type II-IV configurations, while the prevalence of Type I root canal (one canal) is consistent among populations. These variances can be a result of genetic, racial, or geographical variables. However, in order to prove statistical significance, additional research must be done with bigger sample sizes.

Clinical Implications: In clinical practise, it is crucial to comprehend the variety of root canal designs. When performing root canal procedures on patients in the Saudi subpopulation, dentists and endodontists need to be aware of any potential variations. This information influences treatment planning, instrument choice, and anticipated procedural difficulties. For instance, more complex equipment and rigorous cleaning may be necessary in situations with many canal (Type III and Type IV) to assure satisfactory outcomes [6-9].

Patient outcomes and Challenges: Patient outcomes may be affected by variations in root canal shape. The root canal system must be completely cleaned, shaped, and obturated for endodontic treatment to be successful. The risk of inadequate cleaning or insufficient obturation may rise when complicated setups are present. CBCT, for example, is an advanced imaging technology that is essential for accurate diagnosis and treatment planning.

Modification of Therapy Protocols:
The discovered disparities in root canal shape should prompt dental professionals in the Saudi subpopulation to modify their treatment plans. For each patient's particular root canal configuration, specialised instrumentation and obturation methods could be required. In addition, it's important to continue your education and professional development to stay abreast of the most recent developments in endodontics [8-10].

Limitations and Future Research: It's crucial to recognise that this research has some restrictions, such as the small sample size. In order to validate the results, future research should aim for larger, more varied sample sizes. Further research into the racial and genetic variations in root canal anatomy may yield insightful information.

Conclusion

In summary, this CBCT-based research provides significant insights into the root canal anatomy of permanent mandibular anterior teeth within the Saudi subpopulation. The different root canal configurations that have been seen highlight the need for specialised endodontic practise methods. These results highlight the value of cutting-edge imaging methods, constant learning, and customised treatment strategies. The quality of endodontic care in the Saudi subpopulation is expected to rise as dental professionals continue to adjust to these differences and enhance patient outcomes. It is necessary to do more research to confirm these conclusions and investigate the underlying causes of the variances in root canal shape.

References:

1. Vertucci FJ. Root canal anatomy of the human permanent teeth. Oral Surg Oral Med Oral Pathol. 1984;58(5):589–99.

2. Kim Y, Perinpanayagam H, Lee J, et al. Comparison of mandibular first molar mesial root canal morphology using micro-computed tomography and clearing technique. Acta Odontol Scand. 2015;73(6):427-432.
3. Al-Nazhan S. Incidence of four canals in root-canal-treated mandibular first molars in a Saudi Arabian sub-population. Int Endod J. 1999;32(1):49-52.
4. Al-Fouzan KS. C-shaped root canals in mandibular second molars in a Saudi Arabian population. Int Endod J. 2002;35(6):499-504.
5. Patel S, Dawood A, Ford TP, Whaites E. The potential applications of cone beam computed tomography in the management of endodontic problems. Int Endod J. 2007;40(10):818-830. doi:10.1111/j.1365-2591.2007.01299.x.
6. Al-Alawi H, Al-Nazhan S, Al-Maflehi N, Aldosimani MA, Zahid MN, Shihabi GN. The prevalence of radix molaris in the mandibular first molars of a Saudi subpopulation based on cone-beam computed tomography. Restor Dent Endod. 2019;45(1):e1. Published 2019 Nov 14. doi:10.5395/rde.2020.45.e1
7. Gu Y, Lu Q, Wang H, Ding Y, Wang P, Ni L. Root canal morphology of permanent three-rooted mandibular first molars: Part II—measurement of root canal curvatures. J Endod. 2010;36(8):1341-1346.
8. Zhang R, Wang H, Tian YY, et al. Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular molars in Chinese individuals. Int Endod J. 2011;44(11):990-999.
9. Al-Qudah AA, Awawdeh LA. Root canal morphology of mandibular incisors in a Jordanian population. Int Endod J. 2006;39(10):873-877.
10. Poorni S, Karumaran CS, Indira R. Mandibular first premolar with two roots and three canals. Aust Endod J. 2010;36(1):32-34. doi:10.1111/j.1747-4477.2009.00170.x
11. Barker BC, Parsons KC, Mills PR, Williams GL. Anatomy of root canals. III. Permanent mandibular incisors. Aust Dent J. 1974;19(6):408-13.
12. Gu Y, Lu Q, Wang H, Ding Y, Wang P, Ni L. Root canal morphology of permanent three-rooted mandibular canines: Part I—Anatomical analysis and case reports. J Endod. 2011;37(6):727-32.
13. Cleghorn BM, Christie WH, Dong CC. The root and root canal morphology of the human mandibular first premolar: A literature review. J Endod. 2007;33(5):509-16.

Figure 1: Type I

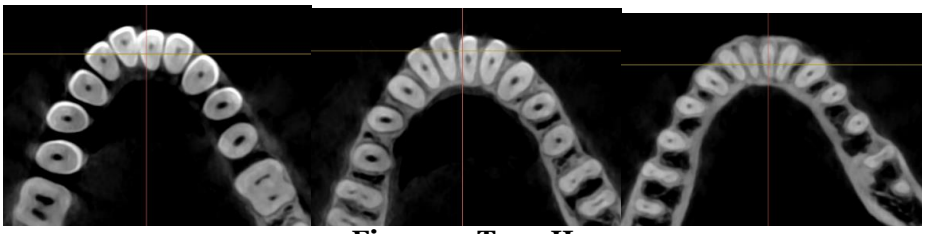


Figure 1: Type II

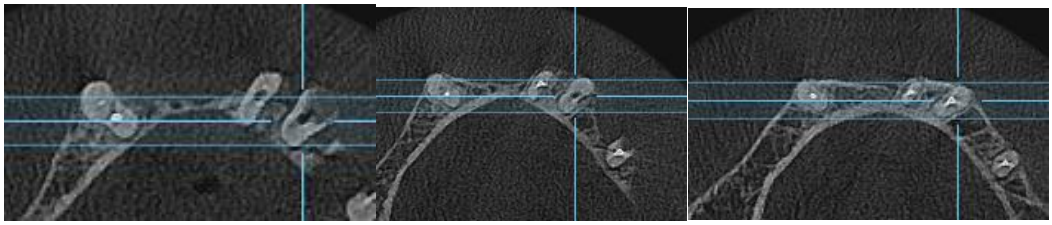


Figure 1: Type III

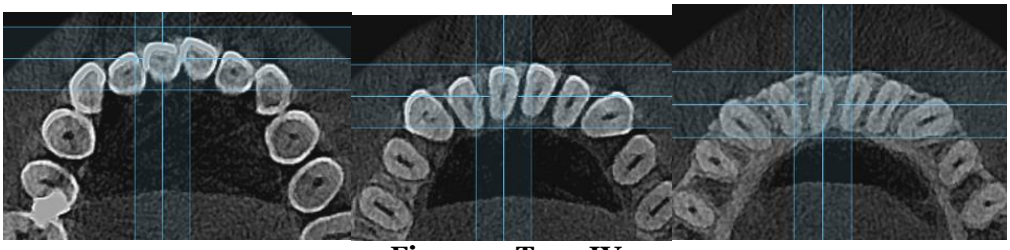


Figure 1: Type IV