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Bibliometric Analysis of Anatomical Variations of The Mandibular Canal in Dentistry

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ABSTRACT: Mandibular canal variations are anatomical structures that occur as a result of errors in the fusion of primitive canals during the embryological process and are of clinical importance in oral surgery, implantology, and local anesthesia. The aim of the present study was to examine the scientific production, conceptual structure, research trends, and thematic development of the literature related to these variations using bibliometric analysis. The data were obtained by screening articles indexed in the Web of Science Core Collection database between 1995 and 2025. For the bibliometric analysis, the bibliometrix package was used through R, RStudio, and Biblioshiny. Annual Scientific Production, Keyword Co-occurrence Analysis, Trend Topics Analysis, Thematic Map Analysis, and Thematic Evolution Analysis related to the topic were examined. Scientific production in the related field showed an increasing trend over the years. Keyword network analysis demonstrated that the terms “mandibular canal,” “inferior alveolar nerve,” “cone-beam computed tomography,” and “bifid mandibular canal” were prominent. Trend and thematic analyses showed that research trends shifted over time from implant surgery and basic anatomical variations toward CBCT-based imaging, surgical planning, and the prevention of complications. The results of this study demonstrated that scientific production related to mandibular canal variations has increased over the years and that research trends in the field have changed with the widespread use of three-dimensional imaging modalities, particularly cone-beam computed tomography.

KEYWORDS: Anatomical Variation, Bibliometric Analysis, Cone Beam Computed Tomography, Dental Implants, Mandibular Canal

INTRODUCTION

The mandibular canal is an intraosseous canal located bilaterally within the mandible. The neurovascular structures contained within the canal provide innervation to the teeth and mucosal tissues in the re
lated region and supply vascular support to the surrounding hard and soft tissues (1). After the second half of gestation, three separate canals develop on each side of the mandible: one for the incisor teeth, one for the canine teeth, and one for the molar teeth. Although these canals are normally expected to fuse into a single canal during development, this fusion may fail in some cases, resulting in the formation of bifid or trifid mandibular canals (2-4). Anatomical variations of bifid and trifid mandibular canals can be classified into several subtypes (5-7). These variations of the mandibular canal may lead to local anesthesia failure and complications during mandibular third molar extraction and implant surgery in clinical practice. Such complications include paresthesia, traumatic neuroma, and hemorrhage. In addition, the use of removable prostheses in severely resorbed ridges may cause discomfort due to pressure exerted on these canals (8-11).

Numerous studies have been conducted on the clinically significant anatomical variations of the mandibular canal (3, 12). The widespread use of advanced three-dimensional imaging modalities such as CBCT has enabled more detailed and reliable evaluation of anatomical variations of the mandibular canal (13). Previous studies have generally focused on investigating the frequency and morphometric characteristics of anatomical variations of the mandibular canal (14, 15). Although numerous studies have been conducted in this field, there is limited information in the literature regarding performance analysis, conceptual structure analysis, trend analysis, and thematic analysis related to this topic (16). Evaluating the main research themes and the development of the field has become increasingly difficult. Therefore, it is necessary to investigate the research trends and conceptual structure of the related field. Bibliometric analysis is a method that can address this gap. It has the ability to quantitatively reveal the characteristics of the field by examining Annual Scientific Production, Keyword Co-occurrence Analysis, Trend Topics Analysis, Thematic Map Analysis, and Thematic Evolution Analysis (17-19).

This study aims to provide an overview of the current status and evolution of the field by performing a bibliometric analysis of studies related to the mandibular canal and examining Annual Scientific Production, Keyword Co-occurrence Analysis, Trend Topics Analysis, Thematic Map Analysis, and Thematic Evolution Analysis in this research area.

MATERIALS and METHODS

This study was designed as a bibliometric analysis investigating research on anatomical variations of the mandibular canal in the field of dentistry. Due to the nature of bibliometric analysis, no human or animal subjects were involved; therefore, ethical committee approval was not required.

To obtain the data for this study, the following search query was entered into the advanced search section of the Web of Science Core Collection (WoSCC) database: (("mandibular canal" OR "inferior alveolar canal" OR "inferior alveolar nerve") AND ("variation" OR "bifid" OR "trifid" OR "accessory")). In the database analysis conducted between 1995 and 2025, only articles were included, while articles unrelated to anatomical variations of the mandibular canal, conference proceedings, and editorial letters were excluded to ensure the homogeneity of the dataset.

For the bibliometric analysis, the bibliometrix package (version 5.3.0) was used through R (version 4.6.0), RStudio, and Biblioshiny. Within the scope of performance analysis, Annual Scientific Production was evaluated; within the scope of conceptual structure analysis, Keyword Co-occurrence Analysis was performed; within the scope of trend analysis, Trend Topics Analysis was conducted; and within the scope of thematic analysis, Thematic Map Analysis and Thematic Evolution Analysis were examined.

Network-based clustering approaches were used to investigate the conceptual structure of the literature. In the Keyword Co-occurrence Analysis, the conceptual structure of the literature was examined using author-provided keywords. A network-based clustering algorithm was employed to identify the dominant themes in the literature. In the generated network structures, colors represent different thematic clusters, node size indicates keyword frequency, and edge thickness represents co-occurrence strength. In the thematic map analysis, basic themes, niche themes, motor themes, and emerging/declining themes were examined. In addition, thematic evolution analysis was performed to investigate the temporal changes of themes related to the topic.

RESULTS

A total of 278 articles indexed in the WoSCC database between 1995 and 2025 were analyzed. Although fluctuations were observed over the years in the Annual Scientific Production analysis, scientific production generally showed an increasing trend, with the highest scientific production observed in 2025 (Figure 1).

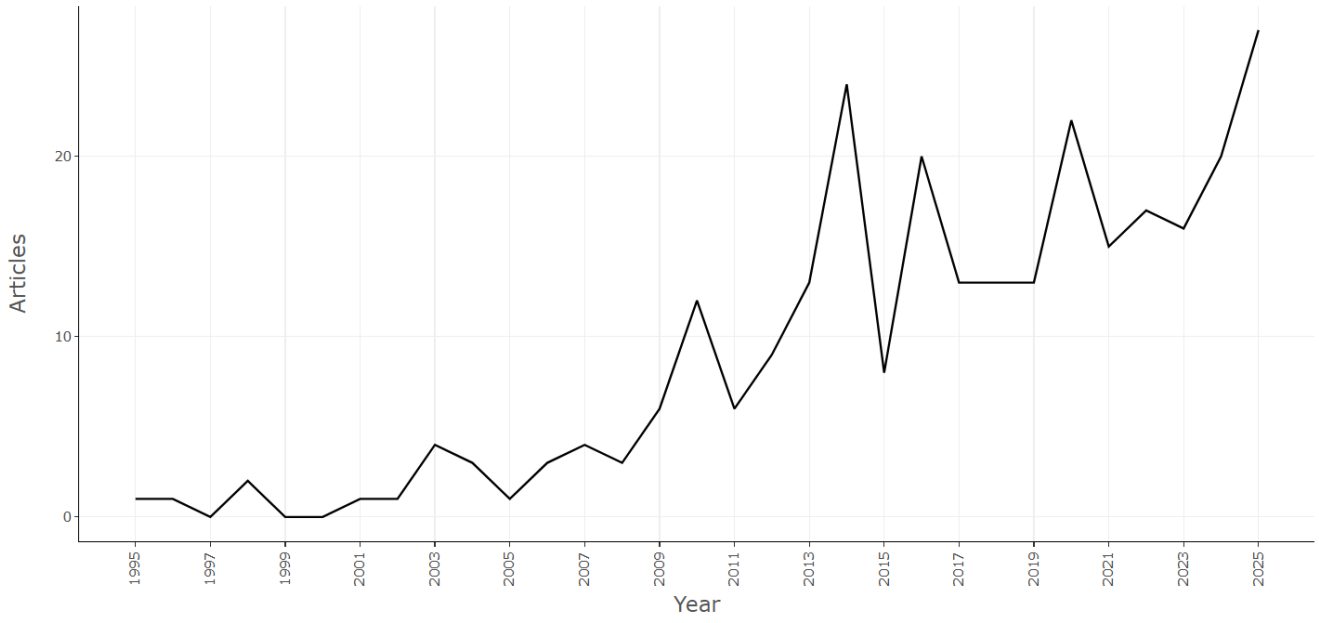

Figure 1. Annual Scientific Production of Publications on Anatomical Variations of the Mandibular Canal.

Co-occurrence Analysis of Authors' Keywords revealed that the term "mandibular canal" was located at the center of the network structure and showed strong associations with the terms "mandible," "cone-beam computed tomography," "inferior alveolar nerve," and "bifid mandibular canal." In Figure 2, different colors represent different thematic clusters. The terms "oral surgery," "third molar," "cone-beam computed tomography," "tomography," "dental implants," and "CBCT" also emerged as other major

research focuses in the field.

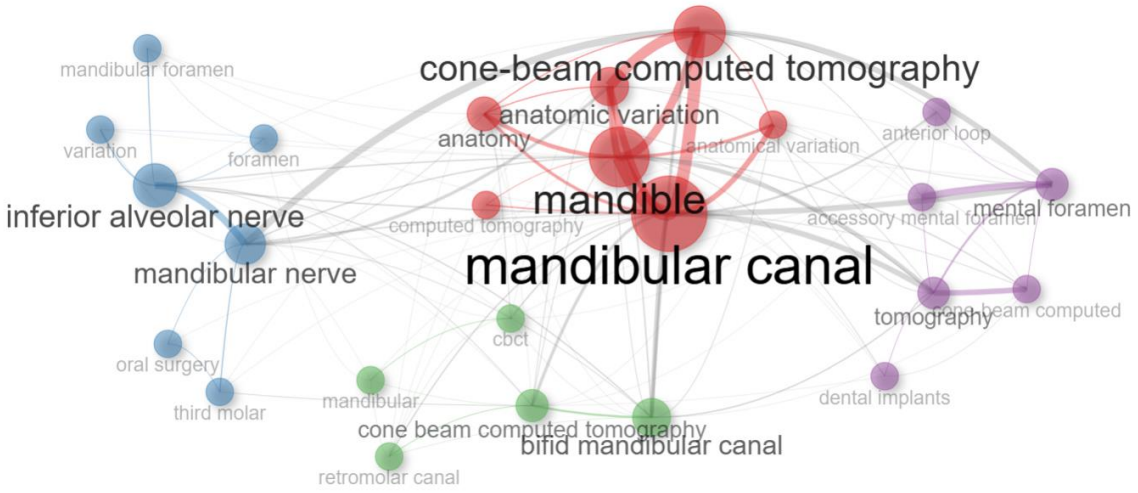

Figure 2. Co-occurrence Network of Authors' Keywords in Mandibular Canal Variation Research.

Trend Topics Analysis demonstrated that keyword trends in the field became more prominent after 2010 compared to earlier periods. No Trend Topics formation was observed before 2005 due to insufficient keyword frequency during that period. While the terms "dental implant" and "cone beam ct" were more frequently observed in the earlier years, the terms "inferior alveolar nerve," "accessory mental foramen," "bifid mandibular canal," "mandible," "anatomy," and "cone-beam computed tomography" became more prominent in subsequent years. In more recent years, the terms "mandibular canal," "CBCT," "oral surgery," "surgery," "anesthesia," and "anatomical variations" emerged as the dominant topics (Figure 3).

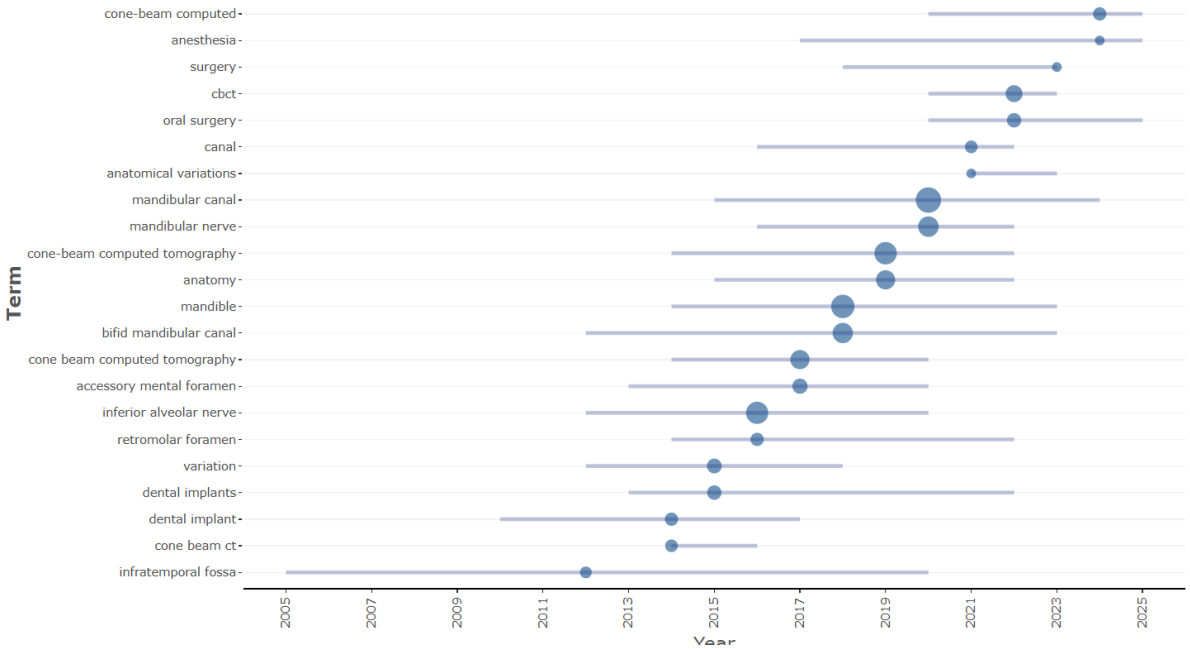

Figure 3. Trend Topics Analysis of Research on Mandibular Canal Variations.

Thematic Map Analysis revealed that the terms "mandibular canal" and "mandible" were located within the basic themes; "inferior alveolar nerve," "mandibular nerve," "retromolar canal," and "variation" were included within the motor themes; "bifid mandibular canal" and "dental implant" were positioned within the niche themes; and "radiography," "panoramic," "surgery," and "magnetic resonance imaging" were identified within the emerging/declining themes (Figure 4).

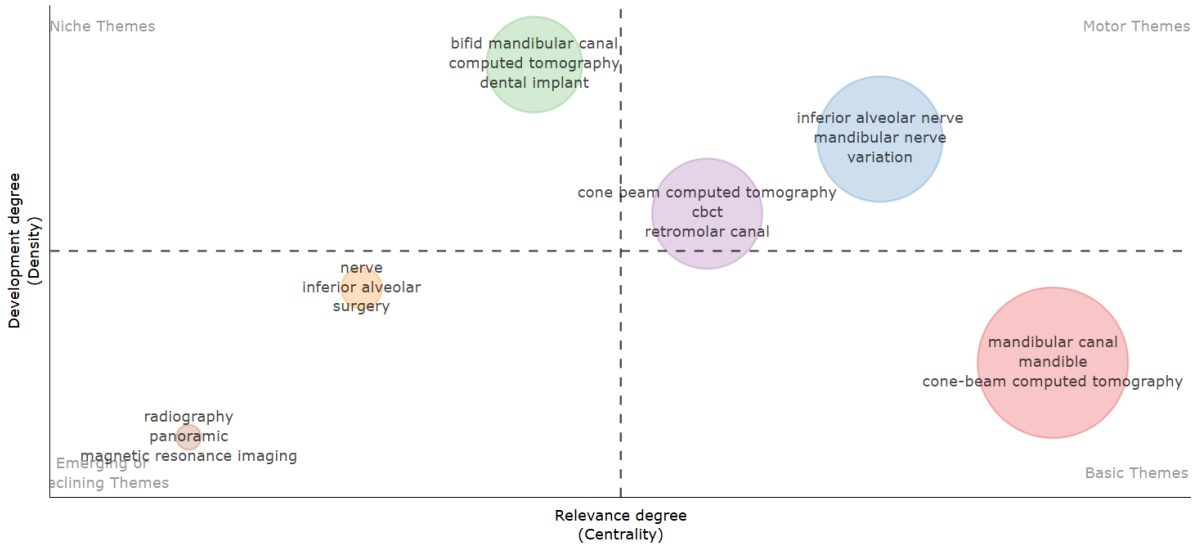

Figure 4. Thematic Map Analysis of Research on Mandibular Canal Variations.

Thematic Evolution Analysis demonstrated that the terms “mandibular canal,” “inferior alveolar nerve,” “mandibular nerve,” “mandible,” “mental foramen,” and “bone” were the dominant themes between 1995 and 2010. In the subsequent period, while the terms “mandibular canal,” “inferior alveolar nerve,” and “mandibular nerve” maintained their presence as dominant themes, the terms “bifid mandibular canal,” “computed tomography,” and “retromolar canal” also emerged among the prominent themes (Figure 5)

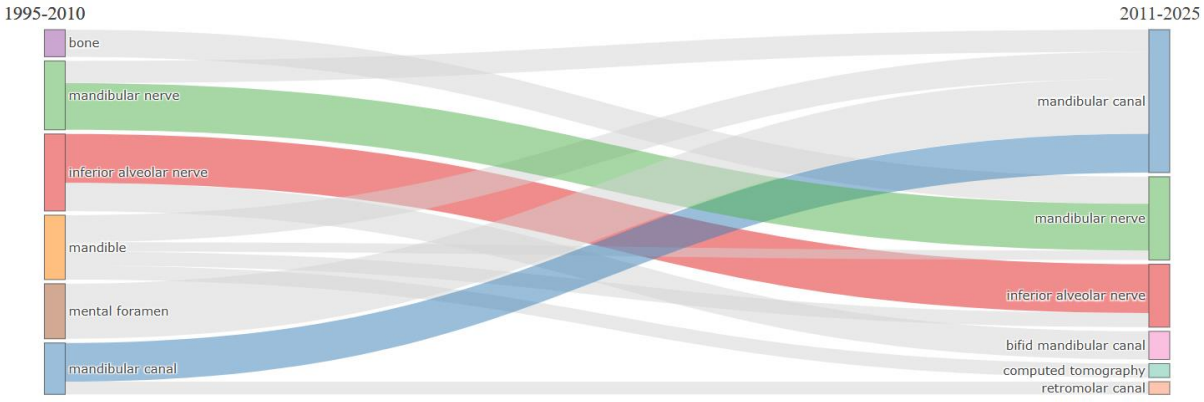

Figure 5. Thematic Evolution Analysis of Research on Mandibular Canal Variations.

DISCUSSION

The mandibular canal is an intraosseous structure that provides neurovascular support to the mandible. Due to the neurovascular structures it contains, this canal is of considerable clinical importance during procedures such as oral surgical interventions (20). During embryological development, a pair of primitive canals is observed in the mandible on both the right and left sides for each tooth group. These canals normally fuse during the developmental process. However, if any error occurs during the fusion process, bifid and trifid mandibular canals may develop (2-4). These accessory canals may be located superior, medial, or lateral to the main mandibular canal and may contain neurovascular bundles. Disruption of the structural integrity of these canals during various interventions may lead to complications such as hemorrhage, paresthesia, and traumatic neuroma. Therefore, understanding the morphological characteristics and prevalence of these accessory canals, which may be associated with surrounding teeth and other neurovascular structures, is of considerable importance (5, 20, 21).

Although numerous studies have been conducted in this field within dentistry, there is limited information in the literature regarding the investigation of its conceptual structure, research trends, and scientific production (16). Therefore, it is necessary to investigate the research trends and conceptual structure of the related field.

Evaluation of the Annual Scientific Production related to the present topic demonstrated that, although fluctuations were observed over time, scientific production in the field generally showed an increasing trend. The highest number of publications

being observed in 2025 indicates that interest in mandibular canal variations remains ongoing and that the field continues to maintain its relevance. The general increase in scientific production between 1995 and 2005 may be associated with advancements in imaging technologies and the widespread use of intraosseous implant applications in the mandibular posterior region, which is closely related to these anatomical variations (4, 22-24).

Co-occurrence Analysis of Authors' Keywords demonstrated that the term "mandibular canal" was positioned at the center of the network and showed strong associations with the term "cone-beam computed tomography." This finding suggests that cone-beam computed tomography is widely preferred for the evaluation of mandibular canal variations. This may be attributed to the ability of cone-beam computed tomography to clearly visualize anatomical structures within bone due to its high hard-tissue resolution (25, 26). A detailed examination of the network structure demonstrated that the terms "inferior alveolar nerve," "oral surgery," "variation," and "third molar" formed interconnected clusters. This finding suggests that variations of the mandibular canal occupy a critical position in terms of the potential risk of complications during third molar surgery, which may have contributed to the increasing number of studies in this field (4, 27). Co-occurrence Analysis of Authors' Keywords revealed a separate cluster containing the terms "computed tomography" and "dental implants." This finding suggests that three-dimensional imaging modalities play an important role in the evaluation of anatomical variations during implant procedures (24, 28).

Trend Topics Analysis demonstrated that the terms "dental implant," "variation," and "retromolar foramen" were prominent in the early period. This finding indicates that early studies mainly focused on anatomical variations and implant surgery. In more recent years, the terms "cone-beam computed tomography," "CBCT," "oral surgery," "surgery," "anesthesia," and "cone-beam computed" have become more prominent. This suggests that cone-beam computed tomography has been increasingly used in the evaluation of the mandibular canal and that the research field has become more focused on surgical planning, prevention of complications, and the investigation of anesthesia effectiveness.

Thematic Map Analysis demonstrated that the terms "mandibular canal" and "mandible" were positioned within the basic themes, indicating that these terms play a central role in the research field. The themes "inferior alveolar nerve," "retromolar canal," and "variation" were located within the motor themes, suggesting that these topics are current and extensively investigated research areas. The terms "bifid mandibular canal" and "dental implant" were identified within the niche themes, indicating that these topics represent more specific and specialized research areas. Thematic Evolution Analysis further demonstrated that the recent prominence of the terms "bifid mandibular canal," "computed tomography," and "retromolar canal" may reflect the growing interest in more specific research areas as a result of advancements in imaging technologies over time.

The limitations of the present study include the use of only the WoSCC database without the inclusion of other databases and the use of only English-language keywords in the search strategy. However, the widespread use of English in scientific publications and the high-quality indexing criteria of the WoSCC database increase the reliability of this study.

CONCLUSION

The results of this study demonstrated that the scientific production related to mandibular canal variations has shown an increasing trend over the years and that research trends in the field have changed with the widespread use of three-dimensional imaging modalities, particularly cone-beam computed tomography. Future studies are recommended to include different databases and to use search terms in multiple languages.

REFERENCES

1) Castro MAA, Lagravere-Vich MO, Amaral TMP, Abreu MHG, Mesquita RA. Classifications of mandibular canal branching: A review of literature. World journal of radiology. 2015;7(12):531.
2) Chávez-Lomeli M, Mansilla Lory J, Pompa J, Kjaer I. The human mandibular canal arises from three separate canals innervating different tooth groups. Journal of Dental Research. 1996;75(8):1540-4.
3) Asghar A, Priya A, Ravi KS, Iwanaga J, Tubbs RS, Naaz S, et al. An evaluation of mandibular canal variations: a systematic review and meta-analysis. Anatomical Science International. 2023;98(2):176-84.
4) Valenzuela-Fuenzalida J, Cariseo C, Gold M, Díaz D, Orellana M, Iwanaga J. Anatomical variations of the mandibular canal and their clinical implications in dental practice: a literature review. Surgical and Radiologic Anatomy. 2021;43:1259-72.
5) Naitoh M, Hiraiwa Y, Aimiya H, Ariji E. Observation of bifid mandibular canal using cone-beam computerized tomography. International Journal of Oral & Maxillofacial Implants. 2009;24(1).
6) D'Agostino S, Valentini G, Baldini A, Ferrara E, Dolci M. Cone-Beam Computed Tomography Assessment of Bifid and Trifid Mandibular Canals: A Cross-Sectional Study. Oral. 2023;3(2):266-75.
7) Mizbah K, Gerlach N, Maal T, Bergé S, Meijer GJ. The clinical relevance of bifid and trifid mandibular canals. Oral and maxillofacial surgery. 2012;16:147-51.

8) Iwanaga J, Takeshita Y, Matsushita Y, Hur M-S, Ibaragi S, Tubbs RS. What are the retromolar and bifid/trifid mandibular canals as seen on cone-beam computed tomography? Revisiting classic gross anatomy of the inferior alveolar nerve and correcting terminology. Surgical and Radiologic Anatomy. 2022:1-10.
9) Ngeow WC, Chai WL. The clinical anatomy of accessory mandibular canal in dentistry. Clinical Anatomy. 2020;33(8):1214-27.
10) Wyatt WM. Accessory mandibular canal: literature review and presentation of an additional variant. Quintessence international. 1996;27(2).
11) Langlais RP, Broadus R, Glass BJ. Bifid mandibular canals in panoramic radiographs. Journal of the American Dental Association (1939). 1985;110(6):923-6.
12) Shan S, Zhong S, Li J, Wang T. Systematic review and meta-analysis of mandibular canal variations on cone beam computed tomography. Oral Radiology. 2022;38(4):445-51.
13) Landfald IC, Łapot M, Olewnik Ł. Imaging-Based Clinical Management of Mandibular Canal Variants: PR–CBCT–Selective MRI. Biomedicines. 2025;13(11):2760.
14) Türker N, Kucuk Kurtgoz M, Cecen Erol E, Aktuna Belgin C. Bifid mandibular canals: anatomical variations and morphometric analysis based on a modified CBCT classification. Surgical and Radiologic Anatomy. 2026;48(1):117.
15) Naitoh M, Hiraiwa Y, Aimiya H, Gotoh M, Ariji Y, Izumi M, et al. Bifid mandibular canal in Japanese. Implant dentistry. 2007;16(1):24-32.
16) Yeung AWK. The usage of the terms mandibular canal, inferior alveolar canal, and inferior dental canal in the academia: a bibliometric analysis. Int j morphol. 2021;39(4):1058-62.
17) Ellegaard O. The application of bibliometric analysis: disciplinary and user aspects. Scientometrics. 2018;116(1):181-202.
18) Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM. How to conduct a bibliometric analysis: An overview and guidelines. Journal of business research. 2021;133:285-96.
19) Passas I. Bibliometric analysis: the main steps. Encyclopedia. 2024;4(2).
20) Cuozzo A, Vincenzo I-S, Boariu M, Rusu D, Stratul S-I, Galasso L, et al. Prevalence and anatomical characteristics of bifid and trifid mandibular canals: a computer tomography analysis. Oral Health & Preventive Dentistry. 2024;22:b5573959.
21) Claeys V, Wackens G. Bifid mandibular canal: literature review and case report. Dentomaxillofacial Radiology. 2005;34(1):55-8.
22) Behfarnia P, Meshkinnejad R, Ahmadishadmehri M, Afshari Z. Anatomic considerations for immediate implant placement in the mandibular posterior region–A systematic review and meta-analysis. BMC Oral Health. 2025;25(1):1924.
23) Peker I, Alkurt MT, Mihcioglu T. The use of 3 different imaging methods for the localization of the mandibular canal in dental implant planning. International Journal of Oral & Maxillofacial Implants. 2008;23(3).
24) Sekerci AE, Sahman H. Cone beam computed tomographic analyses of the position and course of the mandibular canal: relevance to the sagittal split ramus osteotomy. BioMed Research International. 2014;2014(1):945671.
25) Mallya S, Lam E. White and Pharoah's Oral Radiology: Principles and Interpretation: Mosby; 2018.
26) Weiss R, Read-Fuller A. Cone beam computed tomography in oral and maxillofacial surgery: an evidence-based review. Dentistry journal. 2019;7(2):52.
27) Sarikov R, Juodzbalys G. Inferior alveolar nerve injury after mandibular third molar extraction: a literature review. Journal of oral & maxillofacial research. 2014;5(4):e1.
28) -Mejía J, Ruge-Jiménez O, Aguilar-Méndez G, Ñáñez-López Ó, Oliveros-Torres G. Cone beam computed tomographic analysis of the position and course of the mandibular canal. Revista Facultad de Odontología Universidad de Antioquia. 2010;22(1):12-22.