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Editor
Samed ŞATIR

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Editor
Samed ŞATIR
ORCID iD: 0000-0002-5863-5928

Publishing Coordinator
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AUTHORS

Lecturer Murat Mert ATAPEK
Yeditepe University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology

Res. Asst. Fatma CEREN
Recep Tayyip Erdoğan University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology

Asst. Prof. Merve DALDAL
Fırat University, Faculty of Dentistry, Department of Oral and Maksillofacial Radiology

Assoc. Prof. Dilara Nil GÜNAÇAR
Recep Tayyip Erdoğan University, Faculty of Dentistry, Oral and Maxillofacial Radiology Department

Res. Asst. Medine SIMSEK
Recep Tayyip Erdoğan University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology

Asst. Prof. Tulin TASDEMIR
Nigde Omer Halisdemir University, Faculty of Dentistry, Department of Pediatric Dentistry

DDS PhD Sedef Ayşe TAŞYAPAN
Istanbul University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology

Assoc. Prof. Katibe Tugce TEMUR
Nigde Omer Halisdemir University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology

Chapter 1

ANATOMICAL VARIATIONS OF THE MANDIBULAR CANAL AND THEIR CLINICAL SIGNIFICANCE

Medine SIMSEK[1]

INTRODUCTION

The mandible is an important skeletal structure that contains numerous foramina, particularly on its medial surface, allowing the passage of nerves and blood vessels (1).

The mandibular canal (MC) is a bilateral structure extending between the mandibular foramen and the mental foramen and contains the inferior alveolar nerve (IAN), artery, and vein. On radiographs, it typically appears as a thin linear relatively radiolucent structure bordered by bony laminae; however, its superior and inferior borders may not always be clearly distinguishable (2).

The mandible usually contains a single mandibular canal bilaterally; however, the presence of additional canals has been reported in the literature (3). These structures are thought to develop as a result of incomplete fusion of the nerve branches that are expected to form the IAN during the prenatal period (4). The term "bifid" refers to a division into two parts, whereas "trifid" refers to a division into three parts; bifid mandibular canal (BMC) and trifid mandibular canal (TMC) are considered anatomical variations resulting from insufficient fusion of the nerve groups innervating the teeth during the embryonic period (5).

The MC may exhibit various anatomical variations, including the accessory mental foramen (AMF), retromolar foramen (RMF), mandibular lingual foramina (MLF), BMC, TMC, lateral lingual foramina (LLF), mandibular incisive canal (MIC) and the retromolar canal (RMC) (6, 7, 8).

Anatomical variations of the MC pose significant clinical risks in implant procedures and maxillofacial surgeries involving the mandible, as the canal contains the IAN and vessels (9). These variations may increase the risk of neurovascular

[1] Res. Asst., Recep Tayyip Erdoğan University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, medine.simsek@erdogan.edu.tr, ORCID iD: 0009-0004-8410-5586

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Accurate and detailed mapping of the incisive canal enables oral and maxillofacial radiologists to safely and reliably evaluate the interforaminal region, thereby minimizing the risk of iatrogenic complications during surgical interventions. Consequently, the use of three-dimensional imaging modalities, particularly CBCT, is strongly recommended in patient-specific treatment planning to ensure precise localization and comprehensive visualization of the MIC, facilitating informed surgical decision-making (33).

The detection rate of anatomical variations, particularly within the mandibular region, has substantially increased with the increasing prevalence and clinical application of CBCT in contemporary practice. Correspondingly, the number of studies describing atypical anatomical variants within the mandible has also expanded in recent years, highlighting the growing recognition of these structures in clinical practice. Therefore, accessory mandibular canals and other anatomical variants that are incidentally identified on CBCT examinations should be systematically reported, including comprehensive details regarding their number, size, and anatomical course. Enhanced awareness and meticulous documentation of these variations are crucial for preventing misdiagnosis, optimizing surgical outcomes, and reducing the necessity for additional or repeat radiological examinations, thereby contributing to improved patient safety and clinical efficiency (3).

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Chapter 2

COMMONLY ENCOUNTERED PARANASAL SINUS ANOMALIES

Fatma CEREN[1]

INTRODUCTION

Associated with the nasal cavity are four paired paranasal sinuses, namely the maxillary, ethmoid, frontal, and sphenoid sinuses, which represent mucosa-lined, aerated anatomical cavities embedded in the maxillofacial region and the skull base. (1). They are known to perform various physiological functions, including warming and humidifying inspired air, enhancing voice resonance, providing thermal insulation, contributing to facial skeletal development, protecting the brain against trauma, and reducing the overall weight of the skull (2).

Paranasal sinuses begin to form during the tenth week of intrauterine development and continue to mature throughout childhood, a prolonged process that predisposes them to anatomical variations and congenital abnormalities. In addition, these structures are vulnerable to infectious, inflammatory, and neoplastic conditions (2). Normal mucociliary clearance may be disrupted, increasing susceptibility to disorders such as chronic rhinosinusitis when anatomical variations involve the osteomeatal complex or sinus drainage pathways (3). Rare congenital anomalies and anatomical variations are of particular clinical relevance, as they may result in intracranial or infraorbital complications during functional surgical procedures; therefore, accurate preoperative assessment using advanced imaging techniques remains essential (4).

Development of the maxillary sinus begins around the second month of gestation from the primitive ethmoid infundibulum (2). It typically exhibits a pyramidal configuration and is commonly known as the Antrum of Highmore (4). Although its volume ranges between 6 and 8 mm^3, full development is generally achieved between 15 and 18 years of age (1). As the largest paranasal sinus, its

[1] Res. Asst., Recep Tayyip Erdoğan University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, ceren4623@gmail.com, ORCID iD: 0009-0000-2235-473X

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Chapter 3

RADIOLOGIC EVALUATION OF DENTOALVEOLAR TRAUMA

Sedef Ayşe TAŞYAPAN[1]

1. INTRODUCTION

Dentoalveolar trauma refers to injuries that disrupt the integrity of teeth, maxillofacial structures, and the surrounding soft tissues, often leading to both aesthetic and functional consequences (1-3). Although such injuries affect nearly 5% of the general population, they are observed far more frequently in children and young adults. Epidemiological data indicate that approximately one in four school-age children experiences dental trauma, and boys are reported to be at nearly twice the risk of girls, largely due to differences in physical activity patterns (4,5).

The causes of dentoalveolar trauma vary according to age and lifestyle. In very young children, falls during the crawling and early walking stages are the most common reason. In older age groups, sports injuries, traffic accidents, bicycle-related incidents, and interpersonal violence become more prominent factors (4,6). Owing to their anterior position in the dental arch, maxillary central incisors are particularly susceptible to traumatic forces and therefore represent the most frequently affected teeth (7,8).

Successful management of traumatic dental injuries depends primarily on an accurate diagnosis made as early as possible. The 2020 International Association of Dental Traumatology (IADT) Guidelines highlight the essential role of radiographic imaging in both the classification and diagnosis of dentoalveolar trauma (9-11). The diagnostic process begins with a detailed medical and trauma history, followed by careful clinical examination of the soft and hard tissues. Radiologic assessment is crucial at this stage, as root fractures, alveolar bone injuries, and various types of luxation may not be evident clinically (8,12,13). In

1 DDS, PhD, Istanbul University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, sedef.uyanik@istanbul.edu.tr, ORCID iD: 0000-0002-1880-9276

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In such situations, CBCT serves as a valuable complementary method. Its multiplanar imaging capability helps reveal occult fractures, socket wall defects, and complex dentoalveolar injuries that may not be evident on conventional radiographs. At the same time, it should be recognized that CBCT mainly provides information about hard tissues and has limited value in assessing the periodontal ligament and pulpal structures. In selected cases, USG and ddMRI may contribute additional information. Because they do not involve ionizing radiation, these methods can offer useful insight into soft-tissue conditions, pulpal perfusion, and periodontal responses.

Effective radiologic management depends not only on choosing the appropriate imaging technique but also on interpreting the images carefully. Proper use of the parallax principle, awareness of projection errors and superimposition, and the ability to distinguish normal anatomical variations from true traumatic findings are essential in reducing diagnostic mistakes.

Overall, imaging in dentoalveolar trauma should be regarded as a dynamic part of patient management. It supports diagnosis, guides treatment planning, and contributes to the evaluation of long-term prognosis. The most reliable approach is achieved when clinical findings and radiologic information are considered together and advanced imaging techniques are used only when truly necessary.

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Chapter 4

TRIGEMINAL NEURALGIA

Dilara Nil GÜNAÇAR[1]

INTRODUCTION

Persistent orofacial pain without an identifiable physical cause constitutes one of the most challenging clinical conditions encountered in dental practice. The broad spectrum and considerable prevalence of orofacial neuropathic pain indicate that dental practitioners are likely to encounter patients with neuropathic pain during routine clinical work. Neuropathic pain may closely resemble odontogenic pain or other forms of somatic pain, which can lead clinicians to apply conventional but inappropriate treatment strategies. Patients suffering from ongoing pain often consult multiple healthcare providers and may undergo numerous unnecessary diagnostic or therapeutic procedures before an accurate diagnosis is established and appropriate management is initiated. For this reason, dentists should possess a thorough understanding of the pathophysiology, clinical presentation, diagnostic principles, and treatment options related to orofacial neuropathic pain (1,2).

The term *neuralgia* originates from the Greek words *neuron* (nerve) and *algos* (pain) and is used to describe pain arising from a nerve, regardless of the underlying cause. Trigeminal neuralgia (TN) is a neuropathic pain disorder characterized by sudden onset, severe facial pain involving one or more sensory branches of the fifth cranial nerve, known as the trigeminal nerve (3,4). Although the condition has historically been referred to by alternative names such as *tic douloureux*, *Fothergill's disease*, or *trifacial neuralgia*, the term *trigeminal neuralgia* is currently the accepted and preferred terminology in contemporary medical literature (3).

Epidemiology

The reported frequency of trigeminal neuralgia ranges from approximately 4 to 13 cases per 100,000 individuals, while the condition has been documented in about

[1] Assoc. Prof., Recep Tayyip Erdoğan University, Faculty of Dentistry, Oral and Maxillofacial Radiology Department, dilaranil.tomrukcu@erdogan.edu.tr, ORCID iD: 0000-0002-9607-6362

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thorough history taking, together with early recognition of neuropathic pain features, is essential to prevent unnecessary and potentially invasive dental procedures. Effective identification and management of trigeminal neuralgia require a multidisciplinary approach involving primary care physicians, dentists, neurologists, anesthesiologists, and neurosurgeons to ensure timely diagnosis and optimal patient care.

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Chapter 5

INTRAORAL SCANNERS IN DENTISTRY

Murat Mert ATAPEK[1]

INTRODUCTION

Intraoral scanners are advanced digital impression systems that make it possible to take direct optical impressions of the oral cavity, thus completely changing the way dental procedures were traditionally carried out with physical molds made from impression materials (1). These advanced gadgets produce extremely accurate three, dimensional (3D) virtual models of dental anatomy, thus vastly improving the accuracy of diagnosis, treatment planning, and the fabrication of dental restorations and prostheses (2). The entire anatomy of the mouth can be digitized with this technology, and many of the limitations of the conventional method of taking impressions can be avoided, such methods being very often time, consuming and inaccurateWith this technology, the entire anatomy of the mouth can be digitized, and many of the limitations of the conventional method of taking impressions can thus be avoided, such methods being very often time, consuming and inaccurate. (3). The digital workflow starting by intraoral scanners not only guides clinical processes but also improves patient comfort by eliminating the need for wasteful and often unpleasant impression materials. A key element of this digital workflow is the intraoral scanner, which captures high-resolution three-dimensional3D images of the teeth and surrounding oral structures, effectively eliminating the need for traditional impression techniques and materials (4). The devices emit a light source on the dental arches, including prepared teeth, scans of implant abutments, and entire oral tissues, with the imaging sensors then capturing images of the dentogingival tissues which are processed to create a precise 3D digital model .(5). This capability allows for the creation of virtual models that can be used for a wide range of dental applications, including restorative dentistry, orthodontics, and implant planning (6,7). The integration of these scanners

[1] Lecturer, Yeditepe University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, mert.atapek@yeditepe.edu.tr, ORCID iD: 0000-0001-9800-7195

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(26). For laboratory part, a perfect impression is for them, easy to navigate the needs and meet the expectations of the dentist and patient. Additionally it lowers the waste from impression materials and infection control is more advanced (27).

However, mentioned iIntraoral scanners above are somewhat costly. A time is required to understand and operate fluently. In some clinical instances they do not seem to work efficiently like when scanning subgingival margins or areas with significant moisture or saliva contamination, which can compromise scanning accuracy. Moreover, factors such as operator experience, ambient lighting conditions, and the presence of existing restorations can significantly influence the accuracy of the scan outcomes (28).

CONCLUSION

The "best" intraoral scanner depends entirely on the practice's primary use like orthodontics, prosthodontics, restorative dentistry, or implant surgerology, alongside factors such as budget, desired features, and integration with existing digital workflows or the systems. However, it is crucial for practitioners to consider the ongoing advancements in artificial intelligenceAI within dentistry, which are increasingly enhancing the capabilities and applications of these intraoral scanning systems. The adoption of intraoral scanners, especially in large dental institutions, faces challenges such as the integration of IOS software with electronic health record systems, ensuring data security, managing data storage, and training clinicians and staff. Addressing these challenges is vital for successful implementation and to fully grasp the diagnostic and therapeutic potential of intraoral scanning technology in modern dental practice. Despite these, the ongoing evolution of intraoral scanning technology, particularly with integrated AI, promises to further diagnostic accuracy, treatment efficiency, and overall patient care in various dental disciplines.

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Chapter 6

ARTIFICIAL INTELLIGENCE ARCHITECTURES USED IN DENTISTRY

Merve DALDAL[1]

INTRODUCTION

Artificial intelligence (AI) refers to a broad set of technologies designed to enable computer systems to emulate human cognitive processes and to acquire learning capabilities through experience (1). AI technologies are widely applied across numerous disciplines, including medicine, engineering, computer science, and energy, and continue to evolve rapidly. Particularly in the healthcare domain—where human error may lead to critical consequences—the importance of AI applications has increased substantially due to their potential to support diagnostic and therapeutic processes. In this context, AI has emerged as a valuable tool for enhancing the quality of patient care, supporting clinical decision-making, and improving treatment outcomes (2).

In the field of dentistry, AI is increasingly being integrated into processes such as diagnosis, treatment planning, clinical decision-making, and prognostic assessment. Contemporary applications are primarily developed based on various deep learning architectures, which differ in terms of their strategies for information extraction from images, learning mechanisms, and potential for clinical decision support. AI architecture can be defined as the structural design that determines how a model processes data, which features it prioritizes, and how it generates decisions (3,4).

The most frequently employed architectures in the literature within the context of dental imaging and clinical data analysis include convolutional neural networks (CNNs), Vision Transformer (ViT)–based approaches that are distinguished by their ability to model global contextual information, and segmentation-oriented architectures aimed at the automated delineation of anatomical structures. Each

[1] Asst., Prof., Fırat University, Faculty of Dentistry, Department of Oral and Maksillofacial Radiology, mdaldal@firat.edu.tr, ORCID iD: 0000-0002-1767-3311

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and clinically interpretable AI models is expected to facilitate the broader and more reliable integration of these technologies into routine dental practice.

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Chapter 7

THE CONTRIBUTION OF ARTIFICIAL INTELLIGENCE-ASSISTED IMAGING TECHNOLOGIES TO RADIATION SAFETY IN PEDIATRIC DENTISTRY

Tulin TASDEMIR[1]
Katibe Tugce TEMUR[2]

INTRODUCTION

The integration of advanced computational methods into pediatric radiology is not merely a technological upgrade but also it is a biological imperative dictated by the unique physiology of the developing child. Pediatric patients are not simply "miniature adults". Moreover, they present a distinct and heightened radiobiological vulnerability. As emphasized in seminal reviews by Karimi (1) and Hedesiu et al. (2), children are characterized by a high rate of cellular mitosis and a larger proportion of red bone marrow relative to their body mass. According to the foundational law of Bergonié and Tribondeau, tissues that are actively dividing and undifferentiated are the most radiosensitive (3, 4). Consequently, the stochastic risks of ionizing radiation—specifically radiation-induced carcinogenesis—are exponentially higher in children than in adults. Furthermore, the longer life expectancy of pediatric patients provides a broader temporal window for these delayed effects to manifest, potentially decades after the initial exposure (5).

Despite these established risks, the utilization of ionizing radiation in pediatric dentistry is increasing globally. Ryoo et al. in a comprehensive five-year epidemiological study, highlighted a concerning upward trend in the cumulative effective dose delivered to children and adolescents (6). This increase is largely common usage of cone-beam computed tomography (CBCT), which, while offering superior diagnostic dimensionality compared to 2D imaging, carries a significantly

[1] Asst., Prof., Nigde Omer Halisdemir University, Faculty of Dentistry, Department of Pediatric Dentistry, dt.tulintasdemir@gmail.com, ORCID iD: 0000-0003-4884-4715

[2] Assoc. Prof., Nigde Omer Halisdemir University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, tugcetemur@ohu.edu.tr, ORCID iD: 0000-0001-9947-5679

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for a specific region of interest, replacing static "child mode" settings (31). Ultimately, technologies like GAN-based denoising, SR and synthetic imaging serve as invisible computational shields. For the pediatric patient, whose biological vulnerability demands the highest standard of care, this technological evolution ensures the uncompromised diagnostic clarity needed for oral health with the lowest possible biological risk.

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