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CHAPTER 1

MEDICATION-RELATED OSTEONECROSIS OF THE JAW (MRONJ): CURRENT CLASSIFICATION AND RADIOLOGICAL FINDINGS

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Hürü GÖZÜKARA[2]

1. INTRODUCTION

Osteonecrosis is a condition that develops due to the loss of vitality in bone tissue, resulting from short – or long-term disruption of blood circulation in the bone caused by various local or systemic factors (1). In general, causes of this condition developing in the jawbones may include medication-related osteonecrosis of the jaw (MRONJ), osteoradionecrosis (ORN), spontaneous osteonecrosis, and traumatic or non-traumatic osteonecrosis (2).

MRONJ is observed more frequently, particularly in elderly female patients, and predominantly affects the mandible (3).

While the disease is primarily associated with the use of antiresorptive (AR) and antiangiogenic (AA) medications, its pathophysiology has not yet been fully elucidated (4, 5). AR agents that inhibit bone resorption are widely utilized in the treatment of various diseases, such as osteoporosis, Paget's disease, malignancy-associated hypercalcemia, bone metastases, and osteogenesis imperfecta (6). The combination of AR and AA agents is frequently preferred in treatment protocols, particularly for patients with osteolytic bone disease and bone metastasis associated with solid tumors**.** By playing a crucial role in the prevention and management of skeletal-related events (e.g., pathologic fractures, bone pain, and spinal cord compression) arising from osteoporosis and bone metastases, these agents

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CHAPTER 2

ADVANCED VISUALIZATION IN CONE-BEAM COMPUTED TOMOGRAPHY (CBCT): FROM VOLUME RENDERING (VR) TO CINEMATIC RENDERING (CR)

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1. INTRODUCTION

Radiographic imaging in dentistry began with Wilhelm Röntgen's discovery of X-rays in 1895 and was introduced into clinical dentistry the following year with Otto Walkhoff's first self-exposed dental radiograph (1). This pioneering step made film-based intraoral and panoramic techniques the gold standard throughout much of the twentieth century, and clinicians became accustomed to interpreting anatomy through two-dimensional (2D) shadows (2). With the introduction of digital sensors, image acquisition became possible within seconds, chemical processing was eliminated, and dose optimization was supported through appropriate protocol selection and fewer repeat exposures (3). The rapid availability of images, contrast and brightness adjustment, and easier archiving and sharing accelerated the replacement of conventional films by digital radiography; software-based image enhancement further improved diagnostic accuracy (4).

Computed tomography (CT) introduced the three-dimensional (3D) era in medicine in the 1970s by allowing volumes to be interpreted as cross-sectional images. However, its widespread use in dentistry remained limited because of relatively high radiation dose and bulky equipment (5). Cone-beam computed tomography (CBCT) was developed to address this limitation. Because it can image the dentomaxillofacial volume within a selected field of view in a single rotation and, in most dental indications, operates within a lower dose range than medical CT, CBCT has become one of the main methods of 3D imaging in dentistry (5-6).

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CHAPTER 3

FIBRO-OSSEOUS LESIONS OF THE JAWS: RADIOLOGIC FEATURES AND DIFFERENTIAL DIAGNOSIS

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1. INTRODUCTION

Fibro-osseous lesions constitute a heterogeneous group of maxillofacial skeletal anomalies characterized by the replacement of normal bone with varying proportions of fibrous connective tissue and mineralized material (1,2). The mineralized component may be observed in the form of osteoid, woven or lamellar bone trabeculae, and cementum-like calcified structures (1). Rather than representing a specific diagnosis, the term "fibro-osseous lesion" serves as an umbrella term describing lesions with similar histopathological morphology (1,2). Lesions within this group may be developmental, dysplastic/reactive, or neoplastic in origin, and despite sharing similar microscopic features, they may demonstrate markedly different clinical behaviors, radiological appearances, treatment approaches, and long-term prognoses (2,3,4). The principal fibro-osseous lesions encountered in the jaw bones include fibrous dysplasia, cemento-osseous dysplasias, and ossifying fibromas (1,2). Rarer entities such as segmental odontomaxillary dysplasia and familial gigantiform cementoma are also considered within the fibro-osseous lesion spectrum in current classifications(2). The classification of benign fibro-osseous lesions is presented in Table 1. Because substantial overlap exists among these lesions at the histopathological level, differential diagnosis often relies on the evaluation of clinical findings and radiological features. Therefore, accurate diagnosis requires the integration of clinical, radiological, and histopathological findings (3,4).

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CHAPTER 4

CURRENT RADIOLOGICAL DEVELOPMENTS IN UNDERGRADUATE DENTAL EDUCATION

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1. INTRODUCTION

Dental education encompasses a process that integrates various domains of knowledge and skills, including visual diagnosis, radiographic evaluation, and understanding three-dimensional anatomy, in addition to clinical skills. In this process, oral and maxillofacial radiology stands out as one of the fundamental disciplines in which students both develop their theoretical knowledge and acquire clinical reasoning skills (1,2).

Traditional educational methods have long relied on lectures, interpretation of two-dimensional radiographic images, and hands-on practice using phantom models (3). Although these methods play an important role in providing fundamental knowledge and skills, they cannot always fully reflect the variable nature of the clinical environment and patient diversity. Phantom models used in preclinical education provide students with opportunities for practice; however, they represent anatomical variations and the diversity of clinical conditions encountered in real patients only to a limited extent. In addition, the limited feedback students receive during the process of radiological image interpretation may lead to slower progression in the learning process. This issue becomes even more pronounced in the learning of advanced imaging modalities such as cone-beam computed tomography (CBCT) (4).

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developments. The combined use of VR, AR, and AI technologies contributes to the development of hybrid learning environments that support students' visual and cognitive skills (4,6,15).

In the future, these technologies are expected to become more widely integrated into educational applications. In particular, AI-supported personalized learning approaches may provide content tailored to students' individual needs. In addition, the combined use of AR and VR systems with clinical data may strengthen the interaction between education and clinical practice (4,17,23).

5. CONCLUSION

Current developments in undergraduate dental radiology education demonstrate a transition from traditional teaching models toward digital, interactive, and AI-supported systems. While VR and AR technologies contribute to the development of students' spatial perception and clinical skills, AI systems support diagnostic processes and make the learning process more structured. E-learning and hybrid models facilitate the integration of these technologies into educational environments, providing a more flexible and accessible learning structure (3,6,13,15).

This process is not limited solely to changes in the technologies being used; it also represents a transformation in the educational approach to dentistry. In the future, radiology education is expected to continue evolving through more integrated digital systems and AI-supported learning approaches (6,15).

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CHAPTER 5

EXPLAINABLE ARTIFICIAL INTELLIGENCE IN ORAL AND MAXILLOFACIAL RADIOLOGY: FROM BLACK-BOX ALGORITHMS TO CLINICALLY TRUSTWORTHY IMAGING

Büşra ÖZTÜRK[1]

1. INTRODUCTION

Artificial intelligence (AI) has rapidly emerged as one of the most transformative technologies in modern healthcare and medical imaging. In recent years, significant advances in computational power, data processing capacity, and deep learning (DL) architectures have accelerated the integration of AI into various dental specialties, particularly oral and maxillofacial radiology (1, 2). Simultaneously, the transition from conventional radiographic techniques to fully digital imaging systems has substantially increased the amount and complexity of radiologic data generated during routine clinical practice. As a result, AI-based systems have gained considerable attention for their potential to improve image interpretation, diagnostic accuracy, workflow efficiency, and clinical decision-making in dentomaxillofacial imaging (3).

Among contemporary imaging modalities, cone beam computed tomography (CBCT) has become one of the most important diagnostic tools in oral and maxillofacial radiology because of its ability to provide high-resolution three-dimensional visualization of craniofacial structures while exposing patients to lower ra-

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gorithm focuses, future explainable systems may clarify why specific conclusions were reached and how alternative scenarios could influence diagnostic outcomes. Such developments may substantially improve the interpretability and educational value of AI-assisted imaging systems (18).

Human-AI collaboration is likely to become a defining characteristic of future healthcare environments. Rather than replacing clinicians, AI is increasingly viewed as a complementary technology that enhances human expertise and supports decision-making processes (63). In this collaborative framework, AI systems may assist with image analysis, data integration, and risk prediction, while clinicians remain responsible for contextual interpretation, ethical judgment, and patient communication. XAI may strengthen this partnership by providing transparent reasoning processes that clinicians can evaluate and incorporate into their diagnostic workflows. Future imaging systems may therefore function as collaborative platforms in which human expertise and computational intelligence operate synergistically to improve diagnostic performance and patient outcomes (64).

As AI technologies continue to mature, future innovations will likely focus on developing systems that are not only highly accurate but also understandable, ethical, and clinically reliable. The convergence of trustworthy AI, personalized radiology, explainable DL, and human-AI collaboration may ultimately redefine the role of AI in dentomaxillofacial imaging, supporting a more transparent and patient-centered approach to diagnostic imaging (60).

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CHAPTER 6

DYSGEUSIA

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1. INTRODUCTION

The human body inherently possesses the ability to perceive five different senses: vision, hearing, taste, smell, and touch (1). These senses enable the organism to interact with its environment and process the information necessary for survival. Among them, taste contributes directly to the regulation of energy intake and nutritional needs, thereby playing a crucial role in maintaining nutritional balance and supporting normal physiological functions (1).

In the literature, five primary taste modalities are generally recognized: sweet, salty, sour, bitter, and umami (1,2). In addition, recent studies have begun to identify novel taste profiles such as metallic, calcium, and fatty tastes (1). Through the sense of taste, individuals are able to identify the characteristics of consumed foods while obtaining essential nutrients required by the body. For example, sweet taste perception is linked to the detection of carbohydrates, a primary source of energy for the body; umami taste reflects the presence of L-glutamate and several other L-amino acids, thereby indicating protein content; whereas sour taste is thought to reflect the acid concentration of foods (2). Furthermore, this sensory system functions as a protective defense mechanism by identifying potentially toxic or harmful substances through bitter taste perception, thereby eliciting aversive responses and rejection of such substances (2). Salty taste, on the other hand, regulates the intake of sodium and other minerals, playing an essential role in maintaining blood homeostasis and electrolyte balance (2). Moreover, taste per-

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taste receptor sensitivity and gustatory neurotransmission (59,62). Dysgeusia in cancer patients is clinically significant because it may lead to decreased appetite, malnutrition, impaired treatment adherence, and reduced quality of life (58-62). Therefore, early diagnosis and a multidisciplinary approach, including nutritional support, appropriate oral care protocols, xerostomia management, and zinc supplementation in selected cases, may contribute to the alleviation of taste disorders (58,59,62).

4. CONCLUSION

Dysgeusia is a clinically significant and multifactorial sensory disorder that may affect nutrition, treatment adherence, psychosocial well-being, and overall quality of life, particularly in elderly individuals, patients receiving pharmacological therapy, individuals undergoing cancer treatment, and patients with viral infections such as COVID-19 (1,29,51,61). Advances in the understanding of taste receptor biology and gustatory signaling pathways have provided greater insight into the complex mechanisms underlying taste dysfunction and have highlighted the importance of comprehensive clinical evaluation in affected patients (2,17). Effective management of dysgeusia includes identification and treatment of the underlying cause, optimization of oral health, management of xerostomia and oral mucosal conditions, nutritional counseling, medication review, and supportive approaches such as zinc supplementation in selected cases (1,51,61). Early diagnosis and a multidisciplinary approach are of great importance for reducing the clinical burden of dysgeusia and improving patient comfort, nutritional status, and quality of life (1,29,51,61).

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CHAPTER 7

RADIOMICS IN ORAL AND MAXILLOFACIAL RADIOLOGY: CURRENT USES AND FUTURE PERSPECTIVES FOR QUANTITATIVE DENTAL IMAGING

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1. RADIOMICS: FUNDAMENTAL CONCEPTS AND ANALYTICAL FRAMEWORK

Radiomics is an imaging-oriented branch of the wider omics concept, alongside disciplines such as genomics, proteomics, and metabolomics. It involves converting medical images into high-dimensional numerical data that can be processed and interpreted with mathematical and computational methods. Features related to pixel or voxel intensity, spatial arrangement, texture, morphology, and signal distribution can provide information beyond conventional visual interpretation. Thus, radiomics may support diagnosis, prognostic assessment, treatment planning, and more objective, data-driven clinical decision-making (1).

The development of radiomics reflects the progressive use of computers in radiological interpretation. Lodwick's coding system was one of the early attempts to express radiographic findings in a form suitable for electronic data processing, thereby facilitating computer-assisted image assessment (3). Subsequently, Haralick et al. introduced gray-level co-occurrence matrix-based texture analysis, which enabled mathematical evaluation of gray-level spatial patterns and became a key basis of quantitative image analysis (4). The term radiomics was later defined by Lambin et al. in 2012, while Aerts et al. showed that radiomic features combined with machine-learning techniques could characterize tumour phenotype, estimate prognosis, and explore associations between imaging and genomic data (5, 6).

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Another limitation is that many dental radiomics studies are retrospective, single-centre investigations with small samples and insufficient external validation. These factors increase overfitting risk and limit generalizability. To support clinical translation, future studies should use standardized imaging protocols, reproducible segmentation and feature-extraction workflows, multicentre validation, and interpretable models that offer clear added value for clinicians. Radiomics should therefore be viewed as a supportive tool for objective and personalized decision-making rather than as a substitute for clinical judgement (48).

4.9. The Future and Clinical Potential of Radiomics in Dentistry

Future progress in dental radiomics depends on whether high-performing models can be applied reliably across different patient groups, institutions, and imaging systems. Large multicentre studies are needed to evaluate data from panoramic radiography, periapical radiography, CBCT, and MRI using standardized protocols. Reducing device – and acquisition-related variability, confirming segmentation and feature reproducibility, and validating models in independent datasets are essential for improving clinical reliability (29).

Combining radiomic features with clinical information, histopathological findings, genetic data, and artificial intelligence-based analyses may lead to more comprehensive and personalized decision-support systems. Such integrated models may be useful for estimating prognosis and metastatic risk in oral malignancies, monitoring treatment response in endodontic and periodontal diseases, supporting osteoporosis screening, and contributing to forensic age estimation (29).

For radiomics to be adopted clinically, future models should be accurate, interpretable, and compatible with routine workflows. Explainable artificial intelligence may increase clinician confidence by clarifying which imaging features influence model decisions. In this context, radiomics is likely to develop as an objective decision-support approach that complements clinical evaluation and treatment planning rather than replacing them (29).

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CHAPTER 8

ARTIFICIAL INTELLIGENCE-DRIVEN ANALYSIS OF INTRAORAL PHOTOGRAPHS IN ORAL AND MAXILLOFACIAL DIAGNOSIS

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Sümeyye ÇELİK ÖZSOY[2]

1. INTRODUCTION

Artificial intelligence (AI), as a multidisciplinary field that enables computer systems to acquire learning, pattern recognition and decision making capabilities by mimicking human cognitive processes, plays a central role in the transformation of modern medicine and dentistry. In particular, the development of deep learning algorithms has made it possible to achieve results that approach, and in some tasks even surpass, human performance in the analysis of large-scale medical image data. One of the most powerful application areas of AI in healthcare is image based diagnostic systems, and these systems are increasingly being integrated into clinical decision support processes (1).

The success of AI in medical image analysis has gained momentum, particularly with the development of convolutional neural networks (CNNs). Thanks to their ability to automatically extract features from images, CNN architectures have eliminated the need for manual feature engineering and have led to significant increases in diagnostic accuracy. This approach has established a new paradigm in dentistry, as well as in image intensive fields such as dermatology, radiology and ophthalmology (2).

Although AI applications in dentistry initially focused on radiographic images, in recent years intraoral photographs, clinical photo documentation systems and mobile imaging technologies have also become an important part of this

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In conclusion, AI assisted intraoral image analysis is a powerful technological tool that is reshaping diagnostic and decision support processes in modern dentistry. It is anticipated that the role of this technology in clinical practice will grow further with the development of approaches such as multimodal data integration, real time analysis systems and federated learning. However, to ensure this development is both safe and effective, it is essential to maintain a human centred, ethically grounded and scientifically validated approach.

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CHAPTER 9

RADIOGRAPHIC EVALUATION OF PERIAPICAL LESIONS: FROM CONVENTIONAL IMAGING TO ARTFICIAL INTELLIGENCE

Fatmanur KETENCİ ÇAY[1]

1. INTRODUCTION

Periapical diseases are predominantly inflammatory in nature, with more than 90% of cases categorized as apical granulomas, apical cysts, or abscesses. Once the dental pulp becomes infected, teeth serve as conduits for bacterial invasion into the surrounding supporting bone. Apical periodontitis is defined by infiltration of immune cells and subsequent bone resorption (1). On radiographic examination, apical periodontitis is identified by a periapical radiolucent area, which can present either as periodontal ligament space widening or as a distinct lesion (2).

Apical periodontitis is often discovered incidentally during imaging, including periapical radiographs, panoramic radiographs, and cone-beam computed tomography (CBCT) scans. CBCT enables the acquisition of high-resolution three-dimensional (3D) images, eliminating the distortion and anatomical superimposition inherent to conventional radiographic techniques (1). Multiple studies (1, 3-7) have assessed its diagnostic accuracy in comparison with panoramic, conventional, and digital periapical radiography. The evidence consistently indicates that CBCT demonstrates superior sensitivity in the detection of root canal morphology and periapical pathology relative to conventional periapical and panoramic imaging modalities. These findings indicate that CBCT enables more precise detection of periapical bone lesions, contributing to greater diagnostic accuracy, more effective treatment planning, and improved prognostic evaluation (1).

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10. CONCLUSION

The radiographic evaluation of periapical lesions has progressed from conventional two-dimensional methods to sophisticated three-dimensional imaging and AI-assisted analysis (22, 24). Artificial intelligence adds a new layer of opportunity by improving detection, standardization, and workflow efficiency, but it should be considered an adjunct to clinical expertise rather than a substitute for it (58, 81).

Ultimately, accurate diagnosis depends on integrating imaging findings with current biologic knowledge and patient-specific clinical information (3). The most effective future model is not radiography versus AI, but radiography enhanced by responsible AI and guided by expert human judgment (61, 81).

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CHAPTER 10

PARANASAL SINUS APLASIA: DEVELOPMENTAL ANATOMY, RADIOLOGIC FEATURES, AND ASSOCIATED CONDITIONS

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1. INTRODUCTION

Paranasal sinuses are four paired, air-filled cavities located within the bones of the skull surrounding the nasal cavity. They include the maxillary, ethmoid, frontal, and sphenoid sinuses (1,2).

The paranasal sinuses are considered to have several functional roles. These include contributing to facial growth, reducing the weight of the skull, acting as shock-absorbing spaces, and providing protection and thermal insulation for adjacent intracranial structures. They also assist in the conditioning and distribution of inspired air, contribute to voice resonance, increase the surface area of the olfactory mucosa, and participate in the production of nitric oxide (1-3).

Paranasal sinus aplasia and agenesis are terms that have frequently been used interchangeably in the literature to describe the complete absence or failure of pneumatization of one or more sinuses. By contrast, hypoplasia refers to reduced sinus volume or incomplete pneumatization. Because imaging-based distinction between aplasia and agenesis is not always consistent, the terminology should be used cautiously and, when possible, supported by a descriptive statement about the degree of pneumatization (1, 4-6).

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CHAPTER 11

ARTIFICIAL INTELLIGENCE IN RADIOLOGY REPORTING: THE ROLE OF NATURAL LANGUAGE PROCESSING AND LARGE LANGUAGE MODELS

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1. INTRODUCTION

Radiology reports are not simply brief notes added after an examination. In everyday practice, they combine the clinical indication, the imaging technique, the radiologist's observations, and the interpretation on which the next clinical decision often depends. This makes the report one of the main links between imaging and patient care. Many reports, however, are still prepared as free text (1,2). Although this gives radiologists the flexibility they need, it also makes the information harder to search, compare, audit, and reuse for research or quality-improvement purposes (1,3).

At first sight, a radiology report may seem unstructured, but most reports follow a fairly recognizable internal logic. Findings are usually described with reference to anatomical location, imaging appearance, size or extent, diagnostic certainty, temporal change, and negation. Because these elements recur so often, radiology reports have long been suitable material for Natural Language Processing (NLP) (1,3). A well-designed NLP system can convert narrative report text into data that are easier to retrieve, classify, and analyze. In practical terms, this can reduce manual chart review, support clinical decision-making, identify patient cohorts for research, and make large report archives more useful (1,3).

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The next major step is likely to involve multimodal systems that connect images with language (4,26-28). Such systems may eventually support workflows in which image findings, report drafting, annotation, prior examinations, and clinical context are handled more closely together (4,26-28). This could make reporting more personalized and clinically meaningful, provided that accuracy and accountability are preserved (4,8,27,28,36).

In practical terms, LLMs are currently most defensible as assistants for report simplification, structured-report conversion, impression drafting, proofreading, protocol recommendation, and education (4-8,22-25,29-33). More advanced uses, such as autonomous report generation or autonomous diagnostic decision-making, require stronger prospective validation, local calibration, transparent governance, and clear medico-legal responsibility before routine use can be justified (8,20,27,36,37).

These developments may also change how the radiologist's role is understood (8,10,28). The more realistic scenario is not that radiologists become passive reviewers of machine-written reports, but that they increasingly act as clinical interpreters who check AI-assisted outputs, protect patient safety, and translate imaging information into multidisciplinary decisions (4,8,10,28).

In conclusion, the future of LLMs in radiology reporting and workflow will depend less on the raw capability of the technology than on the way it is implemented (4,8,20,28). Sustainable progress will require hybrid workflows that preserve expert supervision, rigorous validation, data protection, and regulatory clarity (4,8,20,36,37). For now, the safest and most realistic vision is not fully autonomous radiology reporting, but a carefully governed partnership between human expertise and AI (4,8,20,27,36,37).

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