AN INTERDISCIPLINARY APPROACH TO TEACHING INSTRUMENTAL RESEARCH METHODS IN DENTISTRY: FROM CLINICAL PROBLEM TO DIAGNOSTIC SOLUTION

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ABSTRACT

Modern dentistry is characterized by the widespread use of instrumental diagnostic methods, which provide objective information on the condition of the teeth, jaws, temporomandibular joints, soft tissues, and other structures of the maxillofacial region. The expansion of diagnostic capabilities, including digital radiography, panoramic radiography (orthopantomography, OPG), cone-beam computed tomography (CBCT), multislice computed tomography (MSCT), magnetic resonance imaging (MRI), ultrasonography (US), and radionuclide imaging techniques, places new demands on the professional training of future dental practitioners. The aim of this scientific and methodological article is to substantiate an interdisciplinary approach to teaching instrumental diagnostics in undergraduate and postgraduate dental education. The article reviews the current capabilities of the principal imaging modalities, their clinical significance, and their role in the diagnostic algorithm of the dental practitioner. Particular

attention is given to developing students' skills in selecting an appropriate diagnostic modality according to the clinical problem, interpreting imaging findings, and applying diagnostic information to treatment planning. A clinically oriented educational model is proposed, based on the sequential framework of "clinical problem — diagnostic hypothesis — selection of the diagnostic modality — imaging — interpretation — clinical decision-making." The integration of radiological and instrumental diagnostics with operative dentistry, oral and maxillofacial surgery, prosthodontics, and orthodontics is shown to contribute to the development of clinical reasoning and enhance the diagnostic competence of future dental practitioners.

Keywords: *dentistry, instrumental diagnostics, diagnostic imaging, radiography, OPG, CBCT, CT, MRI, US, dental education, interdisciplinary approach, clinical reasoning.*

INTRODUCTION

Diagnostics is a fundamental component of dental practice. The quality of diagnosis directly determines the choice of treatment strategy, disease prognosis, and the safety of medical interventions. Traditional dental examination, including history taking, physical examination, palpation, percussion, and other clinical methods, is currently complemented by a wide range of instrumental diagnostic techniques.

The development of digital technologies has substantially expanded the capabilities of diagnostic imaging in dentistry. Digital intraoral radiography, panoramic radiography (orthopantomography, OPG), cone-beam computed tomography (CBCT), multislice computed tomography (MSCT), magnetic resonance imaging (MRI), ultrasonography (US), and Doppler ultrasonography have been increasingly incorporated into clinical practice (Lezhnev, et al., 2019; Petrovskaya, et al., 2019; Patel S. et al., 2019; White, & Pharoah, 2019). In specific clinical situations, scintigraphy and positron emission tomography (PET), including PET/CT, are also employed.

At the same time, the requirements for dental education are evolving. A contemporary dental practitioner must not only understand the diagnostic capabilities of individual imaging modalities but also be able to address a fundamental clinical question: which diagnostic modality is required for a particular patient to resolve a specific clinical problem? Therefore, the teaching of instrumental diagnostics should not be regarded as an isolated discipline but rather as an integral component of the comprehensive clinical training of dental practitioners.

The aim of this article is to analyze the potential of an interdisciplinary approach to teaching instrumental diagnostic methods in undergraduate dental education and to

develop a clinically oriented model for fostering diagnostic competence in future dental practitioners.

Interdisciplinarity as a Principle of Contemporary Dental Education

Interprofessional education (IPE) is defined as a process in which members of two or more healthcare professions learn together with the aim of improving teamwork and the quality of healthcare delivery. Despite the essential role of dentistry in maintaining patients' overall health, the integration of dentistry into interprofessional education programs remains insufficiently addressed in the literature (Khabeer, & Faridi, 2024).

The Centre for the Advancement of Interprofessional Education (CAIPE) defines IPE as a process in which members of two or more professions learn with, from, and about one another in order to improve collaboration and the quality of healthcare delivery (Centre for the Advancement of Interprofessional Education, 2015). According to the Institute of Medicine (IOM; renamed the National Academy of Medicine [NAM] in 2015), healthcare professionals should be trained in effective collaboration and teamwork to support the delivery of continuous, safe, and reliable patient care (Institute of Medicine, 2004). To achieve this goal, healthcare professionals should be educated to work collaboratively both during their initial professional education and throughout continuing professional development.

Incorporating IPE principles into educational curricula enables students from different healthcare professions to become familiar with the roles and responsibilities of other professionals. Accordingly, dental schools and specialized educational programs should serve as important settings for implementing interprofessional education aimed at strengthening collaboration between future dental practitioners and professionals from other healthcare disciplines from the early stages of professional training (Interprofessional Education and practice, 2018).

Khabeer A. & Faridi M.A. (2024) examined the current state of IPE in undergraduate dental and postgraduate education, with particular attention to barriers such as limited time, curricular gaps, and insufficient faculty engagement. Their review of the literature, including survey-based and empirical studies, indicates that although elements of IPE are increasingly being incorporated into dental education programs, incomplete curricular integration and limited resources continue to constrain the full potential of this approach. Furthermore, although dental students generally report positive attitudes toward IPE, translating these attitudes into tangible practical outcomes remains challenging. The authors also emphasize the need for innovation, particularly through the use of online learning and faculty development programs, to overcome existing barriers. Their recommendations include integrating IPE into clinical training, increasing faculty

engagement, and using educational technologies to facilitate collaborative learning, which may ultimately contribute to improved patient care outcomes (Khabeer, & Faridi, 2024).

An interdisciplinary approach involves the integration of knowledge and practical skills acquired across different medical disciplines. This approach is particularly relevant to dental education because pathological processes affecting the maxillofacial region may simultaneously involve the teeth, osseous structures, soft tissues, salivary glands, paranasal sinuses, temporomandibular joints (TMJs), and regional lymph nodes. Consequently, dental practitioners interact not only with radiologists but also with oral and maxillofacial surgeons, otorhinolaryngologists, oncologists, orthodontists, prosthodontists, and other healthcare professionals. Interdisciplinary competence should therefore be developed from the early stages of education. Dental students and postgraduate trainees should be taught not merely to recognize individual diagnostic modalities, but to understand their role within the broader clinical decision-making process.

An optimal diagnostic pathway can be represented as follows:

clinical problem → diagnostic hypothesis → identification of the anatomical target → selection of the diagnostic modality → image acquisition → interpretation → differential diagnosis → treatment planning.

Such an approach facilitates a transition from the mechanical memorization of diagnostic modalities toward the development of clinical reasoning and integrated diagnostic decision-making skills.

Radiographic Methods in Dentistry. Despite the development of advanced diagnostic technologies, intraoral radiography remains a fundamental component of dental diagnostics. Periapical radiographs are used in the diagnosis of dental caries, periodontal diseases, periapical lesions, traumatic injuries, pathological root changes, and endodontic pathology, as well as for assessing the quality of endodontic treatment. When teaching this modality, it is important to ensure that students understand the relationship between clinical findings and radiographic features. Panoramic radiography (orthopantomography, OPG) provides a comprehensive overview of the dentition and maxillofacial structures. To date, OPG remains a relevant and widely accessible imaging modality for evaluating anatomical structures of the maxillofacial region and is frequently used in dental practice. This method can facilitate the detection of neoplastic lesions at various stages of development, including in asymptomatic patients, as well as signs of chronic inflammatory processes, traumatic injuries, and other pathological conditions (Verbitskaya, et al., 2015; Popov, et al., 2023). At the same time, students should be made aware of the limitations of two-dimensional imaging, particularly the superimposition of anatomical structures, which may complicate the assessment of their spatial relationships.

Cone-Beam and Multislice Computed Tomography (CBCT and MSCT). One of the most significant advances in modern dental imaging has been the introduction of cone-

beam computed tomography (CBCT) (Avanesov, & Sedov, 2015; Horner, et al., 2015). Unlike two-dimensional imaging modalities, CBCT provides three-dimensional information and allows the region of interest to be assessed in multiple planes. CBCT enables high-quality visualization of hard tissues through the acquisition of a series of cross-sectional images and three-dimensional reconstructions, while generally delivering a relatively lower radiation dose than conventional medical computed tomography (CT) (Ottersen, et al., 2019; Pauwels, et al., 2012). CBCT is particularly important in implant dentistry, endodontics, oral surgery, and orthodontics. It has also become an important imaging modality for the assessment of degenerative changes of the mandibular condyle, demonstrating greater sensitivity for detecting superficial osseous lesions than conventional imaging techniques (Görürgöz, et al., 2023). However, the expanded diagnostic capabilities of CBCT also necessitate strict justification of its use. From the perspective of dental education, the use of CBCT places increased demands on the professional training of dental practitioners. Dentists require standardized training that encompasses not only the safe acquisition of CBCT images but also the interpretation of three-dimensional volumetric data. In addition, practitioners should be able to reliably distinguish normal anatomical variants from pathological changes (Parashar, et al., 2012). Educational curricula should emphasize the principles of radiation protection, optimization of imaging parameters, and the avoidance of unjustified use of three-dimensional imaging. An important component of CBCT training is adherence to the ALARA principle ("as low as reasonably achievable") to minimize radiation exposure (Kim, et al., 2019). During training, it should be emphasized that every CBCT examination must have a clearly defined clinical indication and should be performed using the smallest feasible field of view and the lowest radiation dose that maintains adequate diagnostic quality (Elshenawy, et al., 2019). Another important component of training is the mandatory documentation of the clinical justification for CBCT referral in the patient's medical records (Patel, & Harvey, 2021). This approach promotes evidence-based clinical decision-making, the development of critical thinking, and an understanding of the ethical and medico-legal aspects of diagnostic imaging. CBCT training programs should also incorporate current technological advances in the field. Increasing attention is being directed toward artificial intelligence (AI)-based technologies for improving CBCT image quality (Kazimierczak, et al., 2024). Thus, learners should understand the fundamental principle that CBCT should be selected not because it provides more images, but because the additional information it provides is necessary to address a specific clinical question. Educational programs should cover all aspects of the appropriate use of CBCT—from clinical justification and radiation protection to image interpretation—ensuring that dental practitioners understand both the capabilities and the limitations of this imaging modality (Zhao, et al., 2025). Multislice computed tomography (MSCT) is of particular importance in the assessment of complex

pathological processes involving the maxillofacial region. Major indications may include severe maxillofacial trauma, extensive inflammatory processes, neoplastic diseases, complex lesions of the facial skeleton, and pathological conditions extending beyond the dentoalveolar structures. In dental education, it is important to demonstrate the differences between conventional medical CT and CBCT and to clarify their respective areas of preferential application. CBCT is primarily oriented toward detailed assessment of the dentoalveolar structures, whereas MSCT has broader applications in the evaluation of complex pathological conditions of the head and neck. Currently, AI-based technologies for the automated interpretation of CBCT images are undergoing active development. In a 2021 study, an AI-based diagnostic system for dental CBCT was presented that was capable of automatically detecting specific pathological findings on CBCT images (Ezhov, et al., 2021). As AI technologies continue to advance, future dental curricula may incorporate AI-assisted diagnostic training, with an emphasis on the clinical application of such systems and on methods for human expert verification and critical evaluation of their diagnostic recommendations.

Magnetic Resonance Imaging (MRI). MRI is the imaging modality of choice when detailed assessment of soft-tissue structures is required. In dentistry and maxillofacial medicine, MRI is of particular importance for the evaluation of the temporomandibular joint (TMJ). MRI is considered the "gold standard" for assessing the soft-tissue components of the TMJ, particularly the articular disc and retrodiscal tissues (López-Arcas, et al., 2022).

Compared with CBCT, MRI provides superior visualization of the spatial relationship between the articular disc and the mandibular condyle and is effective for detecting joint effusion, inflammation, and edema of the surrounding soft tissues. In clinical practice, MRI is generally indicated when internal derangements, such as disc displacement, are suspected, as well as during preoperative assessment to accurately determine disc position and evaluate the overall condition of the joint (Li, & Leung, 2021).

MRI can also detect disc perforation or pronounced disc deformation associated with degenerative osseous changes (Elledge, 2024) Particular attention should be paid to these diagnostic criteria in dental education so that practitioners not only acquire the ability to interpret MRI findings but also understand their clinical significance. Contemporary educational programs should emphasize these MRI features and relate them to clinical findings as part of a comprehensive assessment of TMJ status.

During training, it is important to establish a clear conceptual distinction between the two modalities: CBCT is primarily used for the three-dimensional assessment of osseous structures, whereas MRI is primarily used for the evaluation of soft-tissue structures. This distinction should be taught not only theoretically but also through the analysis of relevant clinical cases.

In the near future, MRI interpretation may be further enhanced through the use of artificial intelligence (AI). Pilot studies have applied deep-learning methods to the analysis of TMJ MRI scans, enabling accurate automated detection of disc displacement (Bai, et al., 2024). As these technologies continue to develop, they may be incorporated into dental education, with students being trained to use AI-generated findings as a supplementary source of information when interpreting MRI data, while maintaining independent clinical assessment and expert judgment.

Ultrasonography (US). US plays an important role in the assessment of the salivary glands, lymph nodes, and soft tissues of the maxillofacial region, and Doppler techniques additionally enable the evaluation of blood flow (Erturk, et al., 2023). Ultrasonographic examination of the temporomandibular joint (TMJ) and masticatory muscles is an evolving diagnostic modality that has gained increasing recognition due to its accessibility, absence of ionizing radiation, and ability to provide real-time dynamic imaging. Modern high-frequency linear transducers (10–15 MHz and above) allow clear visualization of the mandibular condyle and articular eminence and, in certain imaging planes, even the articular disc, thereby opening new possibilities for the diagnosis of TMJ disorders (Wang, et al., 2024). From an educational perspective, ultrasonography requires hands-on training in proper transducer positioning and image interpretation. Before progressing to the identification of pathological changes, students should acquire a thorough understanding of the normal ultrasonographic anatomy of the TMJ (Tamimi, 2023). Ultrasonography can also contribute to a better understanding of the anatomical and functional characteristics of the joint. During the examination, students can visualize anatomical structures as well as the movement of the articular disc and mandibular condyle, allowing theoretical knowledge to be effectively integrated with dynamic imaging. Since specialized TMJ ultrasound phantoms are not yet widely available, training is primarily conducted using real patients or healthy volunteers. Within the educational process, ultrasonography can be presented as an example of a diagnostic modality capable of providing real-time information about soft-tissue structures and the vascular characteristics of a pathological lesion. Although this technique has not yet become a universally established standard in dental practice, it provides students with an excellent example of how technological innovations can expand diagnostic capabilities. Discussion and practical demonstration of this modality can prepare future clinicians to use ultrasonography—or appropriately refer patients for ultrasound examination—in relevant clinical situations, while also fostering adaptability in the context of the continuous evolution of diagnostic imaging technologies.

Radionuclide Methods and PET/CT. Radionuclide methods have more limited applications in routine dental practice; however, their importance increases in the assessment of complex bone disorders and oncological processes. Scintigraphy enables the detection of areas of altered functional activity within bone tissue. PET/CT combines

functional and anatomical information and is of particular importance in head and neck oncology.

For future dental practitioners, it is important to understand the role of these examinations within the overall diagnostic framework and to recognize clinical situations that require referral for specialized imaging.

Selection of the Diagnostic Modality as an Educational Task. One of the major challenges in teaching instrumental diagnostics is the excessive focus on describing the technical characteristics of diagnostic equipment.

To foster clinical reasoning, the emphasis should be shifted from technical descriptions toward clinical decision-making:

not "What is CBCT?", but rather: **"**In which clinical situation would CBCT change the diagnostic decision?" Similarly, instead of asking "What is MRI?", the question should be: "Why is MRI more informative than radiography for certain TMJ disorders?" This approach transforms the study of diagnostic imaging modalities into an integral part of clinical education.

Clinical Cases as a Basis for Interdisciplinary Learning. The use of clinical cases can serve as an effective educational tool.

Clinical Case 1. *Impacted Tooth*

A patient is scheduled for extraction of a mandibular third molar.

The student is asked to determine:

- what information can be obtained from the clinical examination?
- whether panoramic radiography provides sufficient information?
- when CBCT is indicated?
- which anatomical structures need to be assessed?
- how the imaging findings may influence the surgical approach?

Clinical Case 2. *TMJ Pathology*

The patient presents with clicking, pain, and limited mandibular movement.

The student is asked to determine the role of:

- clinical examination;
- radiography;
- CBCT;
- MRI.

The key educational question is: *Which anatomical structure is the target of the examination, and which imaging modality provides the most appropriate visualization of it?*

Clinical Case 3. *Salivary Gland Pathology*

A lesion is identified in the region of the parotid gland.

The student is asked to determine:

- the role of ultrasonography;
- whether Doppler ultrasonography is indicated;
- the indications for CT or MRI;
- whether consultation with other specialists is required.

Interdisciplinary Collaboration Between Dental Practitioners and Radiologists

A key principle in improving education and training in dental imaging is the integration of knowledge from different disciplines, combining approaches from dentistry, radiology, and related fields to develop a comprehensive understanding of pathological conditions. This requires an interdisciplinary approach to education. In recent years, a number of strategies aimed at improving the training of students and practicing professionals in this field have been proposed and recommended. Organizations such as the National Academies of Sciences, Engineering, and Medicine (NASEM) advocate the integration of interdisciplinary education programs into curricula to bridge the gap between dentistry and other areas of medicine (Garcia-Huidobro, 2024).

An important component of professional training is the ability to formulate an appropriate clinical question when referring a patient for diagnostic imaging. The statement *"The patient requires CT"* is insufficiently informative. A more appropriate formulation would be: *"A pathological process in the mandibular region is suspected; assessment of the extent of the lesion and its relationship to the inferior alveolar canal is required."* Such a clearly formulated clinical question enables the radiologist to focus the interpretation of the examination appropriately. Therefore, interdisciplinary communication should be regarded as a distinct professional competency for dental practitioners.

Digital Dentistry and Artificial Intelligence. Over the past several years, dentistry has undergone substantial technological advances. Significant improvements have been made in digital diagnostic imaging technologies, software, and communication systems, as well as in their application to image analysis, remote monitoring, and assessment of treatment outcomes (Al-Buhaisi, et al., 2024; Di Spirito, 2023; Eze, et al., 2020). For example, telediagnostics plays an important role in the early detection of dental diseases through the use of digital imaging technologies and remote consultations (Zotti, et al., 2022).

Contemporary dental imaging is increasingly integrated with digital technologies. Current applications include digital radiographic systems, 3D reconstructions, virtual implant planning, digital dental arch models, intraoral scanning, computer-assisted surgical planning, and artificial intelligence systems for image analysis.

Teledentistry expands access to dental care by enabling remote consultations, diagnosis, and patient management (Islam, et al., 2022; Kirkwood, 2021; Tantawi, et al.,

2023). The concept of teledentistry in orthodontics (teleorthodontics) directly reflects the growing demand for and active development of this field (Masood, et al., 2025). In an era of technological globalization, the world is becoming increasingly interconnected. Teleorthodontics not only facilitates communication and interaction between patients and healthcare professionals but also promotes more effective communication and collaboration among clinicians themselves (Abu Arqub, et al., 2024), thereby contributing to the continuing professional development of dental practitioners.

Teledentistry-based education is an innovative approach that expands educational opportunities for dental students, practicing clinicians, and patients through the use of digital platforms and communication technologies (Sujatha, et al., 2024). It provides access to high-quality educational materials, live lectures, recorded sessions, and interactive clinical case discussions, thereby reducing geographical barriers. With the development of e-learning tools, virtual simulation technologies, and artificial intelligence, technology-enhanced remote education has become an increasingly important component of contemporary dental training (Nascimento da Silva Mulder, et al., 2024).

One of the key advantages of remote education is the opportunity for students and professionals to interact with experts from around the world. Webinars, online courses, and virtual reality–based training enable learners to acquire knowledge and develop professional skills in real time without the need for physical attendance (Mardani, et al., 2020). This is particularly important for continuing professional education, as it enables dental practitioners to remain up to date with the latest scientific evidence, clinical techniques, and technologies.

Despite its advantages, remote education faces several challenges, including limited opportunities for hands-on experience, issues related to access to technology, and the need for appropriate accreditation of online educational programs. Nevertheless, with the continuous development of digital learning methods, remote education is expected to become an integral component of dental training, providing broader access to knowledge and professional development opportunities (Giraudeau, et al., 2022).

In recent years, artificial intelligence (AI) has demonstrated considerable potential in medical and dental education, particularly in improving radiographic image interpretation skills. For example, AI can automatically identify key anatomical structures of the TMJ on MRI scans, including the mandibular condyles, articular discs, and articular eminences, while also providing immediate feedback on the accuracy of students' identification of these structures (Li, et al., 2022). In addition, AI-based clinical cases allow students to enter their provisional diagnoses and compare them with verified reference data, receiving targeted feedback when discrepancies occur. Although these technologies remain at an early stage of development, they have substantial potential to promote self-directed learning. The integration of AI into the training of specialists in oral diseases may

enrich students' educational experience and prepare them to adapt effectively to the increasingly widespread use of these technologies in future clinical practice. Furthermore, AI may assist in the diagnosis of TMJ disorders by analyzing imaging data together with clinical information (Dashti, et al., 2024). Accordingly, teaching students to interpret AI-generated findings and critically evaluate its diagnostic recommendations is likely to become an integral component of future clinical education, ultimately contributing to the development of intelligent approaches to diagnosis and treatment in this field.

The development of artificial intelligence opens up new opportunities for the automated detection of pathological changes and support for diagnostic decision-making (Batra, et al., 2022; Németh, et al., 2023; Strunga, et al., 2023). At the same time, although a substantial proportion of dental practitioners appear to regularly use various electronic communication tools for consultations or communication with patients, there is a recognized lack of knowledge regarding the effective and safe use of these communication channels (Maqsood, et al., 2021). Therefore, dental practitioners should receive additional training in this area through continuing professional development programs, and in the future, such training should also be incorporated into undergraduate dental curricula (Rouanet, et al., 2021). Thus, future dental practitioners should understand that an artificial intelligence algorithm is a decision-support tool for the clinician rather than a substitute for clinical reasoning (Surdu, et al., 2025).

Methodological Model for Teaching Diagnostic Imaging. A course on diagnostic imaging modalities can be delivered using clinical cases and scenarios as its primary educational framework. For example, in the context of TMJ disorders, such a course extends beyond the simple presentation of theoretical knowledge: the curriculum incorporates clinical case discussions that require students to determine whether imaging is indicated, select the appropriate imaging modality, interpret the findings, and use the results to develop a treatment plan. This approach closely replicates the real-world process of clinical decision-making (Garcia-Huidobro, et al., 2024).

For example, an instructor may present a case of a patient with unilateral TMJ pain and limited mouth opening. Students analyze the clinical presentation and review MRI findings demonstrating disc displacement without reduction, and then determine an appropriate treatment plan. Through such exercises, students learn to interpret imaging findings and understand how these findings influence treatment decisions. In addition, they develop critical-thinking skills and an understanding of the clinical situations in which imaging is actually indicated. According to evidence-based recommendations, imaging should be performed when the diagnosis remains uncertain or when initial conservative treatment fails to produce the expected clinical response.

Teaching can also incorporate simulation technologies and virtual reality (VR). The use of simulation technologies in dental education has expanded beyond traditional training

in surgical skills to encompass a range of areas, including diagnostic imaging of TMJ disorders. Advances in VR technology have facilitated the development of innovative educational models that allow students to perform and analyze imaging studies in a virtual environment (Lang, et al., 2024). Computer-based software can be used to create three-dimensional models of the TMJ based on CBCT or MRI data, enabling students to dynamically visualize anatomical structures and thereby improve their spatial understanding of imaging findings. This immersive approach deepens students' understanding of the anatomical structures represented on diagnostic images.

Teaching subjects such as medical imaging often requires specialized expertise that is not available among all dental faculty members. Many dental schools lack dedicated oral and maxillofacial radiologists, which can make the systematic teaching of these topics challenging. In addition, obtaining appropriate educational materials can be difficult. For example, providing students with TMJ MRI cases for study may require collaboration with a hospital radiology department. Some institutions may also lack CBCT equipment because of financial constraints, while the implementation of VR technology can likewise be costly (Annamma, et al., 2024). Consequently, although there may be a willingness to incorporate imaging education into the curriculum, practical resource limitations often represent a substantial barrier to achieving this educational objective.

Furthermore, faculty members may require continuous professional development to remain up to date with the latest advances in diagnostic imaging technologies. Instructors who received their training before the widespread adoption of CBCT may require additional education to develop the necessary expertise before they can teach the technology effectively (Robotti, et al., 2021) Therefore, promoting faculty professional development in this area is essential. However, this need is often overlooked, while educational resources tend to remain focused on traditional subjects.

It should also be emphasized that an excessive focus on imaging modalities at the expense of clinical skills is inappropriate. For example, curricula should not create the impression that every case of a TMJ disorder requires imaging. On the contrary, as repeatedly emphasized, imaging modalities should be used judiciously, and their findings should be interpreted in the context of the specific clinical situation. Excessive reliance on imaging may lead to neglect of the fundamentals of clinical diagnosis (Waheed, et al., 2022). Although imaging is a valuable adjunct to physical examination, it should never replace it. A practical approach to this issue is to provide education based on evidence-based medicine, with clearly defined indications for diagnostic imaging (Tay, et al., 2025). For example, students may learn that "if the patient's condition improves substantially following conservative treatment, imaging may not be necessary," whereas "if significant functional impairment persists or unusual symptoms are present, imaging should be considered."

RESULTS AND DISCUSSION

A five-stage model is proposed for teaching instrumental diagnostics in undergraduate dental education.

Stage 1. Clinical Presentation.

The student or clinical resident is provided with the patient's chief complaints, medical history, and findings from the clinical examination.

Stage 2. Formulation of a Diagnostic Hypothesis.

The most likely pathological processes are identified based on the available clinical information.

Stage 3. Selection of the Diagnostic Modality.

The student is required to justify the choice of a specific diagnostic imaging modality (Table 1).

Stage 4. Image Analysis.

The relevant anatomical structures and pathological changes are systematically assessed.

Stage 5. Clinical Decision-Making.

The imaging findings are integrated with the clinical data and used to determine the subsequent management strategy.

This model can be applied in practical classes, seminars, case-based learning activities, and summative assessment of students' knowledge and clinical reasoning skills.

Table 1.

Selection of the Instrumental Diagnostic Modality

Clinical problem	Primary modality	Additional modality
Dental caries and its complications	Intraoral radiography	—
Endodontic diagnosis	Radiography	CBCT
Complex root canal anatomy	CBCT	—
Implant planning	CBCT	—
Impacted tooth	Panoramic radiography (OPG)	CBCT
Complex maxillofacial trauma	CT	CBCT
TMJ pathology	MRI	CBCT
Salivary gland pathology	Ultrasonography (US)	MRI/CT
Soft-tissue tumor	MRI	CT
Extensive head and neck tumor	CT/MRI	PET/CT
Bone metabolic pathology	Scintigraphy	CT/CBCT

The analysis demonstrates that contemporary dental education requires a substantial expansion of the traditional understanding of instrumental diagnostics. Knowledge of the technical principles underlying individual diagnostic modalities alone

does not ensure diagnostic competence. More importantly, students should develop the ability to define the diagnostic problem, select the most appropriate modality, and critically evaluate the information obtained.

Particular attention should be paid to training in three-dimensional imaging. The widespread use of CBCT in dental practice requires future dental practitioners to understand its indications, diagnostic capabilities, limitations, and principles of radiation safety.

Equally important is the ability to correlate findings obtained using different imaging modalities. For example, in the assessment of the TMJ, CBCT and MRI provide different types of diagnostic information and should therefore be regarded as complementary rather than competing technologies.

A promising direction is the transition from a discipline-based educational model toward a clinically integrated approach. Within such an educational framework, a single clinical case can simultaneously be used to develop knowledge and skills in surgical dentistry, orthodontics, endodontics, diagnostic imaging, and other disciplines.

CONCLUSION

Contemporary instrumental diagnostics is an integral component of professional dental practice. The development of digital radiography, CBCT, CT, MRI, ultrasonography, and other diagnostic modalities has substantially expanded the diagnostic capabilities available for diseases of the dentoalveolar and maxillofacial regions. Accordingly, the dental curriculum should provide students not only with knowledge of the principles underlying individual modalities but also with the ability to select the most appropriate imaging technology in accordance with the clinical question.

An interdisciplinary approach makes it possible to integrate clinical dentistry and instrumental diagnostics into a unified framework of professional reasoning:

clinical problem → diagnostic hypothesis → selection of the diagnostic modality → imaging → interpretation → clinical decision-making → treatment strategy.

The use of clinical cases, digital images, 3D reconstructions, interdisciplinary teaching sessions, and contemporary digital technologies may improve the effectiveness of dental education and develop students' skills in the rational use of instrumental diagnostic modalities.

In the future, further development of integrated educational programs combining dental disciplines with diagnostic imaging, digital dentistry, and artificial intelligence technologies appears warranted.

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ԱՄՓՈՓՈՒՄ

ՍՏՈՄԱՏՈԼՈԳԻԱՅՈՒՄ ԳՈՐԾԻՔԱՅԻՆ ՀԵՏԱԶՈՏՈՒԹՅԱՆ ՄԵԹՈԴՆԵՐԻ ԴԱՍԱՎԱՆԴՄԱՆ ՄԻՋԱՌԱՐԿԱՅԱԿԱՆ ՄՈՏԵՑՈՒՄ. ԿԼԻՆԻԿԱԿԱՆ ԽՆԴՐԻՑ ՄԻՆՉԵՎ ԱԽՏՈՐՈՇԻՉ ՈՐՈՇՈՒՄ

Վահե Ազատյան, Լազար Եսայան, Մինաս Պողոսյան, Քրիստինա Պորկշեյան

Ժամանակակից ստոմատոլոգիան բնութագրվում է գործիքային հետազոտության մեթոդների լայն կիրառմամբ, որոնք հնարավորություն են տալիս ստանալ օբյեկտիվ տեղեկատվություն ատամների, ծնոտների, քունք-ստորինծնոտային հոդերի, փափուկ հյուսվածքների և դիմածնոտային շրջանի այլ կառուցվածքների վիճակի վերաբերյալ: Ախտորոշման հնարավորությունների ընդլայնումը, ներառյալ թվային ռենտգենագրությունը, օրթոպանտոմոգրաֆիան (ՕՊՏԳ), կոնաձև ճառագայթով համակարգչային տոմոգրաֆիան (ԿՃՀՏ), բազմաշերտ համակարգչային տոմոգրաֆիան (ՄՇՀՏ), մագնիսառեզոնանսային տոմոգրաֆիան (ՄՌՏ), ուլտրաձայնային հետազոտությունը (ՈւՁՀ) և

ռադիոնուկլիդային մեթոդները, նոր պահանջներ է առաջադրում ապագա ստոմատոլոգների մասնագիտական պատրաստվածության նկատմամբ:

Սույն գիտամեթոդական հոդվածի նպատակն է հիմնավորել ստոմատոլոգիայում գործիքային ախտորոշման դասավանդման միջառարկայական մոտեցումը նախադիպլոմային և հետդիպլոմային կրթության շրջանակներում: Ներկայացվում են հիմնական պատկերային ախտորոշման մեթոդների ժամանակակից հնարավորությունները, դրանց կլինիկական նշանակությունը և տեղը ստոմատոլոգի ախտորոշիչ ալգորիթմում: Հատուկ ուշադրություն է դարձվում սովորողների մոտ կլինիկական խնդրին համապատասխան հետազոտության մեթոդի ընտրության, ստացված արդյունքների մեկնաբանման և բուժման պլանավորման ընթացքում ախտորոշիչ տեղեկատվության կիրառման հմտությունների ձևավորմանը:

Առաջարկվում է կլինիկակենտրոն ուսուցման մոդել, որը հիմնված է հետևյալ հաջորդականության վրա՝ «կլինիկական խնդիր → ախտորոշիչ վարկած → մեթոդի ընտրություն → պատկերային հետազոտություն → մեկնաբանում → կլինիկական որոշում»: Ցույց է տրվում, որ ճառագայթային և գործիքային ախտորոշման ինտեգրումը թերապևտիկ, վիրաբուժական, օրթոպեդիկ ստոմատոլոգիայի և օրթոդոնտիայի հետ նպաստում է կլինիկական մտածողության ձևավորմանը և բարձրացնում ապագա բժշկի ախտորոշիչ կոմպետենտությունը:

Բանալի բառեր՝ *ստոմատոլոգիա, գործիքային ախտորոշում, ճառագայթային ախտորոշում, ռենտգենագրություն, օրթոպանտոմոգրաֆիա, կոնաձև ճառագայթով համակարգչային տոմոգրաֆիա (ԿՃՀՏ), համակարգչային տոմոգրաֆիա (ՀՏ), մագնիսառեզոնանսային տոմոգրաֆիա (ՄՌՏ), ուլտրաձայնային ախտորոշում, ստոմատոլոգիական կրթություն, միջառարկայական մոտեցում, կլինիկական մտածողություն*:

РЕЗЮМЕ

МЕЖДИСЦИПЛИНАРНЫЙ ПОДХОД К ПРЕПОДАВАНИЮ ИНСТРУМЕНТАЛЬНЫХ МЕТОДОВ ИССЛЕДОВАНИЯ В СТОМАТОЛОГИИ: ОТ КЛИНИЧЕСКОЙ ЗАДАЧИ К ДИАГНОСТИЧЕСКОМУ РЕШЕНИЮ

Ваге Азатян, Лазарь Есаян, Минас Погосян, Кристина Поркшеян

Современная стоматология характеризуется широким использованием инструментальных методов исследования, которые обеспечивают получение объективной информации о состоянии зубов, челюстей, височно-нижнечелюстных суставов, мягких тканей и других структур челюстно-лицевой области. Расширение

диагностических возможностей, включая цифровую рентгенографию, ортопантомографию (ОПТГ), конусно-лучевую компьютерную томографию (КЛКТ), мультиспиральную компьютерную томографию (МСКТ), магнитно-резонансную томографию (МРТ), ультразвуковое исследование (УЗИ) и радионуклидные методы, предъявляет новые требования к профессиональной подготовке будущего стоматолога. Целью настоящей научо-методической статьи является обоснование междисциплинарного подхода к преподаванию инструментальной диагностики в дипломном и постдипломном образовании в стоматологии. Рассматриваются современные возможности основных методов визуализации, их клиническое значение и место в диагностическом алгоритме стоматолога. Особое внимание уделяется формированию у обучающихся навыков выбора метода исследования в зависимости от клинической задачи, интерпретации результатов и использования диагностической информации при планировании лечения. Предлагается модель клинико-ориентированного обучения, основанная на последовательности «клиническая задача — диагностическая гипотеза — выбор метода — визуализация — интерпретация — клиническое решение». Показано, что интеграция лучевой и инструментальной диагностики с терапевтической, хирургической, ортопедической стоматологией и ортодонтией способствует формированию клинического мышления и повышает диагностическую компетентность будущего врача.

Ключевые слова: *Стоматология, инструментальная диагностика, лучевая диагностика, рентгенография, ортопантомография, КЛКТ, КТ, МРТ, ультразвуковая диагностика, стоматологическое образование, междисциплинарный подход, клиническое мышление.*

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