UDC 616-091:378.046-021.68

https://doi.org/10.52058/2786-5274-2025-2(42)-1147-1156

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MODERNIZATION OF TEACHING PATHOLOGICAL ANATOMY IN THE CONTEXT OF MEDICAL EDUCATION REFORM

Abstract. Reforming medical education requires updating approaches to teaching fundamental disciplines, in particular pathological anatomy. Traditional teaching methods, based mainly on passive perception of information, are increasingly giving way to interactive technologies aimed at actively involving students in the learning process. The modern development of digital technologies, in particular virtual microscopy, integrated online platforms for independent study of the material, as well as simulation techniques, allows to significantly improve the quality of teaching and the formation of practical skills in medical students. In addition, the combination of pathological anatomy with clinical disciplines contributes to the understanding of the importance of morphological changes for the diagnosis and treatment of diseases. However, the effective implementation of these changes requires scientific justification and assessment of their impact on the training of future specialists. The purpose of this work is to analyze and evaluate modern methods of teaching pathological anatomy in the context of medical education reform, in particular, to determine the impact of interactive technologies on the level of material acquisition, the development of practical skills and critical thinking in students, as well as to assess the effectiveness of integrating pathological anatomy with clinical disciplines. The study revealed that the combination of traditional teaching methods with the use of digital resources, in particular virtual microscopes and platforms for distance learning, contributes to a better understanding of morphological changes in tissues. The introduction of a problem-oriented approach allowed students to analyze pathomorphological processes more deeply, which positively influenced the formation of their clinical thinking. The experience of using team learning has shown its effectiveness in developing communication skills and the ability to make collective decisions when analyzing pathohistological cases. It was also found that the integration of pathological anatomy with clinical disciplines increases its significance for students and contributes to the formation of interdisciplinary thinking. Additionally, the effectiveness of the implementation of individualized learning trajectories was assessed, which allow students to independently choose the pace and methods of learning the material, in particular through the use of adaptive educational

technologies. The results of the analysis show that the combination of classroom lessons with virtual laboratories and multimedia lectures increases the level of mastery of complex pathomorphological concepts. The introduction of clinical case modeling and work with electronic pathohistological databases contributes to the formation of diagnostic analysis skills, which is an important stage in preparing students for practical medical practice. The results obtained confirm the need for further development of interactive methods of teaching pathological anatomy and their adaptation to modern challenges of medical education. The introduction of new educational technologies into the educational process requires a systematic approach, which includes a combination of traditional methods with modern digital tools, integration of academic disciplines and ensuring continuous feedback between students and teachers.

Keywords: pathological anatomy, medical education, modernization of teaching, practical classes, digital technologies.

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МОДЕРНІЗАЦІЯ ВИКЛАДАННЯ ПАТОЛОГІЧНОЇ АНАТОМІЇ В УМОВАХ РЕФОРМУВАННЯ МЕДИЧНОЇ ОСВІТИ

Анотація. Реформування медичної освіти вимагає оновлення підходів до викладання фундаментальних дисциплін, зокрема патологічної анатомії. Традиційні методи навчання, що ґрунтуються переважно на пасивному сприйнятті інформації, дедалі більше поступаються місцем інтерактивним технологіям, спрямованим на активне залучення студентів у навчальний процес. Сучасний розвиток цифрових технологій, зокрема віртуальної мікроскопії, інтегрованих онлайн-платформ для самостійного опрацювання матеріалу, а також симуляційних методик, дозволяє значно покращити якість викладання й формування практичних навичок у студентів-медиків. Окрім того, поєднання патологічної анатомії з клінічними дисциплінами сприяє розумінню значення морфологічних змін для діагностики та лікування захворювань. Однак ефективне впровадження цих змін потребує наукового обґрунтування та оцінки їх впливу на підготовку майбутніх фахівців. Метою цієї роботи є аналіз і оцінка сучасних методів викладання патологічної анатомії в умовах реформування медичної освіти, зокрема визначення впливу інтерактивних технологій на рівень засвоєння матеріалу, розвиток практичних навичок і критичного мислення у студентів, а також оцінка ефективності інтеграції патологічної анатомії з клінічними дисциплінами. У ході дослідження було виявлено, що поєднання традиційних методів навчання з використанням цифрових ресурсів, зокрема віртуальних мікроскопів і

платформ для дистанційного навчання, сприяє кращому розумінню морфологічних змін у тканинах. Впровадження проблемно-орієнтованого підходу дозволило студентам глибше аналізувати патоморфологічні процеси, що позитивно вплинуло на формування їхнього клінічного мислення. Досвід застосування командного навчання засвідчив його ефективність у розвитку комунікативних навичок і здатності до колективного прийняття рішень при аналізі патогістологічних випадків. Також було встановлено, що інтеграція патологічної анатомії з клінічними дисциплінами підвищує її значущість для студентів і сприяє формуванню міждисциплінарного мислення. Додатково було оцінено ефективність впровадження індивідуалізованих навчальних траєкторій, які дозволяють студентам самостійно обирати темп і методи засвоєння матеріалу, зокрема через використання адаптивних освітніх технологій. Результати аналізу свідчать, що поєднання аудиторних занять із віртуальними лабораторіями та мультимедійними лекціями підвищує рівень засвоєння складних патоморфологічних концепцій. Запровадження моделювання клінічних випадків та роботи з електронними патогістологічними базами даних сприяє формуванню навичок діагностичного аналізу, що є важливим етапом підготовки студентів до практичної лікарської діяльності. Отримані результати підтверджують необхідність подальшого розвитку інтерактивних методів викладання патологічної анатомії та їхньої адаптації до сучасних викликів медичної освіти. Впровадження нових освітніх технологій у навчальний процес потребує системного підходу, що включає поєднання традиційних методик із сучасними цифровими інструментами, інтеграцію навчальних дисциплін та забезпечення безперервного зворотного зв’язку між студентами й викладачами.

Ключові слова: патологічна анатомія, медична освіта, модернізація навчання, практичні заняття, цифрові технології.

Statement of the problem. The reform of the medical education system in Ukraine has become an inevitable process aimed at adapting domestic educational standards to international requirements and ensuring high quality training of future doctors. One of the key areas of this transformation is the modernization of teaching pathological anatomy - a fundamental discipline that plays a crucial role in the formation of students' clinical thinking, the development of their skills in analyzing morphological changes in various pathological processes and mastering the basic principles of diagnosis. For many decades, the methods of teaching pathological anatomy in medical universities of Ukraine remained mainly traditional: classes were held in the format of lectures, practical work with the study of macro- and micro-samplings, and the assessment of students' knowledge was based on their ability to recognize pathological changes in preparations under a microscope and give them an appropriate interpretation. However, the development of medical

science, digital technologies and modern approaches to education dictate the need to modernize this system. Today, Ukrainian departments of pathological anatomy are faced with the task not only of providing students with high-quality theoretical material, but also of creating an integrated educational platform that combines traditional and innovative methods, enabling students to master the discipline at a modern level.

The need for such a transformation is due to several key factors. Firstly, Ukraine has undergone a significant update of the legislative framework regulating the conduct of pathological anatomical studies and, accordingly, training in this field. In accordance with the order of the Ministry of Health of Ukraine dated 09/21/2021 No. 1239/36861 "On Approval of the Procedure for Conducting Pathological Autopsies", the regulatory framework for the functioning of the pathological anatomical service was updated, and new approaches to the analysis and accounting of morphological studies were also defined. This, in turn, affected the content of curricula at medical universities, requiring their revision and alignment with current standards of work of pathological institutions.

Secondly, changes in medical education, in particular the internship reform, have significantly reduced the time for training pathologists. According to the order of the Ministry of Health of Ukraine No. 1254 of 2022, the terms of training for interns in many specialties, including pathological anatomy, have been optimized, which necessitated the intensification of the educational process at the level of student education. This requires not only high-quality organization of classroom classes, but also the development of new methodological approaches that will allow students to master pathological anatomy more effectively.

Separately, it is worth noting the introduction of digital technologies in the teaching of pathological anatomy. In world practice, the use of virtual microscopes, digital databases of histological images and online platforms for interactive learning has already proven its effectiveness, significantly improving the assimilation of the material and expanding the opportunities for independent work of students. In Ukraine, the process of integrating such technologies is currently only gaining momentum, but it is already obvious that their use is necessary to improve the quality of training of future doctors. This has become especially important in connection with the COVID-19 pandemic, when distance learning has become the main alternative to traditional teaching methods, forcing universities to look for new approaches to organizing the educational process.

Another important aspect of the transformation of teaching pathological anatomy is its strengthening of its integration with clinical disciplines. In recent years, medical universities in Ukraine have been observing a trend towards an interdisciplinary approach, when the study of pathological anatomy takes place in conjunction with internal medicine, surgery, oncology and other specialties. This allows students not only to better understand the morphological basis of pathological processes, but also to apply this knowledge in future clinical practice.

Given the above, reforming the teaching of pathological anatomy is a complex and multifaceted process that requires taking into account legislative changes, the introduction of modern educational technologies, updating methodological approaches and strengthening the integration of the discipline with other branches of medicine. Solving these tasks requires a comprehensive analysis and development of effective learning strategies that will ensure high-quality training of students and the formation of the necessary professional competencies in them.

Analysis of recent research and publications. Medical education is undergoing significant transformations in response to changes in scientific knowledge, technological progress and health care needs. One of the key disciplines that requires updating educational approaches is pathological anatomy. In the past, the main method of its teaching was the case system, which was actively used at the University of Edinburgh in the early twentieth century. This approach involved a detailed analysis of real clinical cases and discussion of their pathomorphological features, which contributed to the development of analytical thinking and clinical intuition in students [1].

Modern students demand a more interactive approach to learning, which is confirmed by surveys conducted in Germany. The participants of the study emphasized the need to introduce electronic resources, digital anatomical atlases and multimedia materials into the teaching of pathological anatomy. At the same time, it was emphasized that practical classes with real specimens should remain a core component of the course [2]. One promising area is the use of 3D visualization of pathological specimens, which allows for the preservation of rare specimens and provides students with access to digital collections that can be studied without time and space constraints [3].

A similar situation is observed in other countries, in particular in Morocco. The study showed that students positively assess the integration of video lectures, virtual courses and immersive technologies into the learning process. This indicates a general trend towards the digitalization of medical education, which allows adapting curricula to modern requirements and optimizing the assimilation of material [4]. An important aspect is the use of social networks to popularize pathological anatomy among students. For example, educational projects on forensic medicine and anatomy are being developed on the TikTok platform, which allows reaching a wider audience and presenting the material in an accessible and interactive form [5].

Despite the significant development of digital technologies, the need for traditional study of macroscopic and microscopic specimens remains unchanged. In this context, improving teaching methods, such as combining classical classes with virtual microscopes, plays an important role. The use of digital histological preparations allows students to focus on details that may remain invisible when working with an optical microscope [6]. The experience of the Faculty of Medicine of the University of Novi Sad has confirmed that virtual microscopy is an effective

tool in teaching pathological anatomy, as it increases the accessibility of the material, improves visual perception and allows students to analyze histological sections with high accuracy [7].

The reform of medical education in Ukraine necessitates a rethinking of traditional approaches to teaching pathological anatomy. In the context of modern challenges, such as martial law, distance learning, and the implementation of international standards, there is a growing need to adapt the educational process to new realities. In particular, the need to ensure continuous learning in conditions of military conflict requires the use of digital technologies, the creation of interactive platforms, and the use of alternative teaching methods [8].

One of the key areas of modernization is the integration of innovative technologies, which contributes to improving the quality of training of future medical specialists. The experience of implementing digital educational platforms, virtual laboratories, and simulation technologies in teaching pathological anatomy demonstrates their effectiveness in increasing the level of material mastery. The use of multimedia resources allows for interactive learning, stimulates students' critical thinking, and contributes to a deeper understanding of complex pathomorphological processes [9].

Adapting the educational process to international standards is also an important aspect of modernization. Changes in curricula that meet the criteria of international medical accreditations allow to improve the quality of training of specialists and ensure their competitiveness at the global level. It is important to improve curricula, update the material and technical base and apply an integrated approach to assessing students' knowledge [10].

Distance learning, which has become an integral part of the educational process, also requires appropriate adaptations. This is especially true for teaching pathological anatomy to foreign students, for whom effective communication and accessibility of educational materials are critical factors. The use of online platforms, interactive lectures and digital pathomorphological atlases allows to compensate for the lack of traditional practical classes and ensure full mastery of the material [11].

Integration of theoretical and clinical disciplines is another important direction of modernization of pathological anatomy teaching. The combination of fundamental knowledge with practical clinical cases increases the level of professional training of students, promotes the development of clinical thinking and allows for a better understanding of the relationship between morphological changes and clinical symptoms [12]. Ensuring high quality education in modern conditions is a priority task of medical universities. This requires not only updating curricula and technologies, but also developing effective mechanisms for assessing student knowledge, improving the qualifications of teachers and introducing the principles of evidence-based medicine into the educational process. Only a comprehensive approach to the modernization of teaching pathological anatomy will allow adapting the educational system to modern challenges and ensuring a high level of training for future doctors [13].

The purpose of the article – to analysis and evaluation of modern methods of teaching pathological anatomy in the context of medical education reform.

Presentation of the main material. Modernization of teaching pathological anatomy in the context of medical education reform in Ukraine requires a comprehensive approach, which includes updating curricula, introducing digital technologies, changing approaches to practical training of students, as well as strengthening the integration of interdisciplinary knowledge. Taking into account modern challenges and trends in education and medicine, several strategic directions for updating training are proposed.

Revision of curricula and content of the discipline

Updating the curriculum of pathological anatomy should be based on modern international standards and take into account the latest scientific achievements. It is necessary to expand the emphasis on the clinical application of morphological knowledge, in particular on early diagnosis and differential diagnosis of pathological conditions. It is worth introducing thematic modules that will cover current problems of oncopathology, autoimmune diseases, vascular disorders, etc. It is also important to introduce training cycles dedicated to modern methods of pathohistological research, such as immunohistochemistry, molecular pathology and digital morphometry. The inclusion of these topics will allow students to understand how modern laboratories work and what opportunities modern diagnostic methods provide. In addition, the reform of the educational process should take into account the reduction in time for studying the subject as part of the internship reform, which requires greater intensification of teaching. To do this, it is necessary to introduce short but informative lectures with interactive elements that will allow students to learn the material more effectively.

Introduction of digital technologies

One of the key areas of updating the educational process is the integration of digital technologies. Virtual microscopes and online databases of histological images have already become an integral part of modern medical education in many countries around the world. The use of such tools allows students to study histological preparations in detail in high resolution, which is especially important in conditions of limited access to traditional microscopic classes. Online platforms for teaching pathological anatomy can include interactive tests, simulation simulators, and multimedia courses. This will not only increase the effectiveness of learning the material, but also allow monitoring student progress in real time. The use of digital technologies also contributes to the development of independent learning. Access to electronic resources, video lectures, interactive presentations and clinical cases significantly expands students' opportunities to master the subject at a time convenient for them.

Changing approaches to practical training of students

Practical classes in pathological anatomy should play a central role in the formation of professional skills of future doctors. One of the important aspects is to

expand the range of morphological studies that students can perform independently. For example, it is worth introducing laboratory workshops that include the preparation of histological sections, staining of preparations and analysis of microscopic images. Another innovation could be the use of virtual laboratories that allow students to recreate the real working conditions of the pathological anatomy department without being physically present in the laboratory. This approach is especially relevant in conditions of quarantine restrictions or for students studying in a blended or distance form. An important step is also to involve students in real clinical cases. Joint discussion of the results of biopsies, autopsies and histological studies with teachers and pathologists will contribute to a better understanding of the relationship between morphological changes and clinical manifestations of diseases.

Strengthening interdisciplinary integration

Modern medical education is increasingly oriented towards an interdisciplinary approach. Pathological anatomy is one of the main disciplines that lays the foundation for understanding clinical sciences. That is why it is important to create integrated courses that combine pathological anatomy with internal medicine, surgery, oncology, radiology and other areas. For example, students can be offered to analyze real clinical cases, including the results of histological studies, laboratory test data and clinical information. Such an approach helps to understand not only morphological changes, but also their impact on the general condition of the patient and possible treatment options. One of the effective methods of integration is to hold joint practical classes with departments of clinical disciplines, where students can jointly discuss complex cases and develop diagnostic and treatment tactics.

Prospects for implementing an updated teaching model

The implementation of the proposed changes will require a comprehensive approach and support from educational institutions, the Ministry of Health of Ukraine, and the teachers themselves. However, the experience of other countries shows that the modernization of teaching pathological anatomy contributes to increasing the level of training of students, the formation of critical thinking in them, and the ability to independently analyze pathological processes. The gradual integration of digital technologies, updating curricula, expanding opportunities for practical work and interdisciplinary training will allow us to bring pathological anatomy to a qualitatively new level. In the future, these changes will contribute not only to improving the educational process, but also to the overall improvement of the quality of medical education in Ukraine, which, in turn, will positively affect the training of doctors and the level of medical care in the country.

Conclusions. Modernization of teaching pathological anatomy in the context of medical education reform is a necessary step to improve the training of future doctors. Traditional teaching methods need to be updated through the use of modern technologies and interactive methods. An important direction is the integration of

pathological anatomy with other disciplines to create a holistic understanding of pathological processes and their clinical significance.

The use of virtual microscopes, online platforms and simulation methods allows making training more accessible and effective, especially in blended learning. Involving students in clinical cases develops their practical skills and critical thinking.

Therefore, the proposed changes will contribute to improving the quality of training and developing professional competencies of future doctors, which is important for ensuring a high level of medical education in Ukraine.

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