



TRAINING OF PATHOLOGISTS IN THE DIGITAL MACROSCOPIC PHOTOGRAPHY

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The pathology practice environment varies per healthcare setting. However, anatomic pathology is a visual applied science discipline and incorporation of high-quality images into a surgical pathology report is essential. Each specimen received for morphological examination is unique and variation in the description can exist between prosectors and their experience. That is why gross descriptions supported with digital photographs can eliminate the insufficiency of macroscopic examination. To form and strengthen pathologists' competencies in digital macroscopic photography a problem-based learning approach is used for training. A problem-based learning ensures the strength of the acquired knowledge since it is obtained in an independent activity. The article discusses what type of problems a pathologist should solve when taking a macroscopic photograph of a surgical specimen. An analysis of literature on modern equipment for digital macroscopic photography was performed. Recommendations for step-by-step photographing, and schematic mapping for surgical specimen triaging are provided. An option is proposed for actively developing professional competencies including creation of digital photo archives of surgical gross specimens, as well as study sections and discussions by professionals at forums such as society meetings. It was concluded that pathologists' competency in digital macroscopic photography is necessary to maintain a high standard of medical care.

Keywords: postgraduate medical education; pathological anatomy; digital photography.

ОБУЧЕНИЕ ВРАЧЕЙ-ПАТОЛОГОАНАТОМОВ ЦИФРОВОЙ ФОТОГРАФИИ МАКРОПРЕПАРАТОВ

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Условия работы в патологоанатомической практике варьируют в зависимости от медицинского учреждения. Однако следует помнить, что патологическая анатомия — это визуальная научно-прикладная дисциплина, поэтому включение высококачественных цифровых изображений в патологоанатомическое заключение имеет большое значение. Каждый макропрепарат, поступивший для морфологического исследования, уникален, и все же его макроскопическое описание может отличаться в зависимости от опыта прозектора. Цифровая фотодокументация, в дополнение к текстовому описанию, помогает избежать неточности при исследовании. Для формирования компетенций у врачей-патологоанатомов в цифровой макросъемке нами используется проблемно-ориентированный подход к обучению. Проблемное обучение обеспечивает прочность приобретаемых знаний, так как они добываются в самостоятельной деятельности. В статье идет обсуждение проблем, которые должен решить при

проведении съемки макропрепарата врач-патологоанатом. Проведен анализ литературы по современному оборудованию для цифровой макросъемки. Даны рекомендации по последовательности фотосъемки макропрепарата и составлению карт-схем для сортировки операционного материала. Предложен вариант выработки профессиональных компетенций: активное участие в создании цифрового архива фотографий макропрепаратов, дискуссии в профессиональном сообществе. Сделан вывод, что компетенции врача-патологоанатома в области цифровой макросъемки необходимы для поддержания высокого уровня медицинского обслуживания.

Ключевые слова: последипломное медицинское образование; патологическая анатомия; цифровая фотография.

In contemporary medicine, two processes are being implemented: (1) continuous improvement of technologies and introduction of advanced technology, equipment, and new materials and (2) increasing requirements for training and professional competence of employees. Generally, competence is developed by combining all forms of learning, i.e., when the lecture material is analyzed and mastered in practical classes, elaborated in the course of independent work, and tested by progress monitoring. One of the modern methods of developing competencies is a problem-oriented approach [3]. The problem-based approach to learning dates back to the Socratic era. In pedagogy, problem-learning theory has been developed since the mid-1950s [1, 2]. Problem-based learning refers to the active use of learning technologies and is considered as the most promising direction for the development of the creative abilities of an individual [4–7]. Problem-based learning also ensures acquisition of knowledge, since it is gained in independent activity. Analysis of the pathological anatomy curriculum in medical institutions revealed that due attention is not given to gross specimen imaging. Thus, this area requires greater levels of knowledge and skills. The fundamental idea of the problem-learning method is the formulation of a challenging problem. The problem should arouse interest among students, motivate them to independently search for additional information, and enable them to correlate new knowledge with existing ones. They should remember that the problem must relate to real life [2]. For example, what problems should a pathologist solve when photographing a gross specimen? First, he/she must be able to navigate modern equipment for macroscopic photography and use it independently. Second, using real clinical cases, he/she should learn to take correct and high-quality macroscopic photographs of a preparation, save them

in appropriate file format, and import digital macroscopic photographs into a laboratory information system (LIS) and a medical information system (MIS). Third, a pathologist should utilize macroscopic photography to draw a schematic map for sorting of operational and biopsy materials for further histological and molecular genetic analysis. Thus, our study was aimed at the following:

- 1) Analysis of the literature on modern equipment for digital macroscopic photography in pathological anatomy.

- 2) Generalization of our own long-term experience in teaching pathological anatomy and digital photography and making recommendations for gross specimen imaging and creation of schematic maps for sorting the surgical material.

- 3) Analysis of the digital archive of gross specimen photographs (presented for discussion in “Pathomorphology,” an Internet resource, a link to which is posted on the website of the Russian Society of Pathologists) [17].

Digital imaging of a gross specimen requires a minimum set of equipment, which should be available in any morbid anatomy department. Digital imaging commonly requires a digital camera, a tripod for fixing the camera, a table for placement of gross specimen with a plastic cutting board (colored texture), a solution for cleaning optical lenses, a pointer (e.g., probe), a ruler, and a sample marker [15]. Nowadays, various digital cameras can be used for taking photographs of a gross specimen. The main categories include compact cameras, interchangeable lens digital cameras, single-lens reflex cameras, mobile and smartphone cameras, and desktop web cameras. Each of these cameras has advantages and disadvantages. Compact cameras are quite affordable, have a liquid-crystal display, and can take high-quality photos. However, such cameras do not

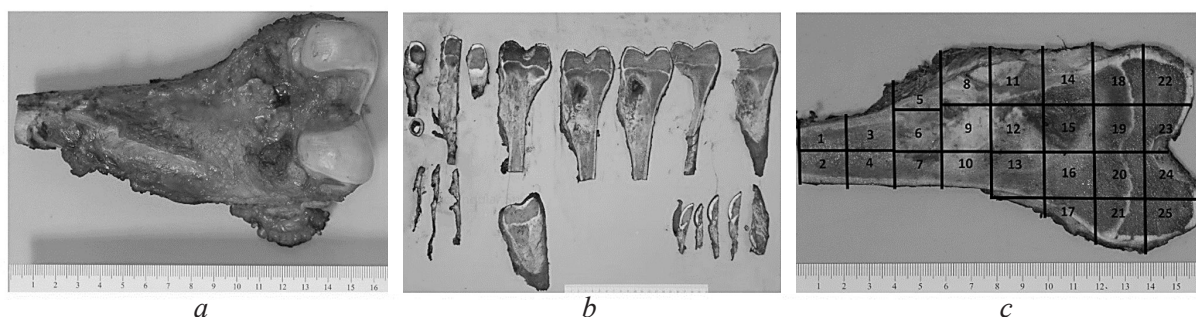


Fig. 1. Macroscopic photographs of the left femoral segmental resection specimen for osteosarcoma: *a* – a view of the intact specimen; *b* – the serial sections of the specimen; *c* – a map of the central slab of the bone resection

Рис. 1. Цифровые фотографии макропрепарата сегментарной резекции левого бедра по поводу остеосаркомы: *a* – общий вид интактного макропрепарата; *b* – серийные распилы макропрепарата; *c* – карта-схема центральной костной пластины

have a wide selection of lenses, and digital photographs must be loaded manually into the LIS [14]. Interchangeable lens cameras can take high-quality photographs, which unfortunately require manual loading of images into the LIS. Smartphones can capture high-quality photographs, which can be sent immediately by e-mail or as a text file and sent to any operator through a wireless network. However, smartphones do not have direct access to the LIS, and the ability to send a medical digital image could infringe patient's data confidentiality. Therefore, the use of smartphones for taking photographs of a gross specimen is widely disputed in the literature [11, 13]. High-resolution web cameras can capture real-time photographs, can be used in teleconsultation, and can be integrated into the LIS and MIS. Currently, several types of international and Russian digital systems for imaging gross specimens are available on the market, such as Spot Imaging Solutions, rmtConnect™-Grossing RMT, Nikon Mi Macro Imaging Station, MacroPATH Milestone, PAXcam, and ePath [18–23]. Most of these camera systems not only can capture images of a gross specimen, but also can import immediately images into the LIS [10]. Usually, commercial digital systems are presented in three categories, namely, free-standing mobile station, fixed station, and system built into a cutting station. The mobile station is ideal for use in large laboratories, and it can be used for autopsy photography. Fixed stations are usually used in small laboratories. Systems built into a cutting station enable continuous workflow. Such systems can be considered the

gold standard equipment for macroscopic photography, but they are usually expensive, complex, and cost-intensive [9].

In the field of anatomical pathology, the principles and sequence of taking photographs are important. The so-called fresh intact preparation should be photographed first (Fig. 1, *a*). “Fresh” means unfixed and intact preparation implies that the gross specimen was delivered to the morbid anatomy department for examination. Then, images of the dissected specimen are taken, in which the structure of the tissue on the section should be clearly visible. The relationship of the pathological focus with the surrounding tissues (e.g., tumor invasion) and the resection margins is assessed and documented [15]. After cutting the gross specimen into separate segments, a general image is taken, which helps determine the position of individual slices relative to each other (Fig. 1, *b*), and then spot photographic images are taken (Fig. 1, *c*). Subsequently, images are used in the schematic map to indicate where the material was collected for histological examination. A gross specimen image is also used to document the material with additional research methods (Fig. 2).

If the investigated specimen has papillary structures or consists of cysts, photographs should be taken with the specimen in a saline solution. If a formalin-fixed specimen has been submitted for study, some authors recommend putting the sample in a container with absolute ethyl alcohol for 2 h to restore the original color. However, this issue remains controversial [15].

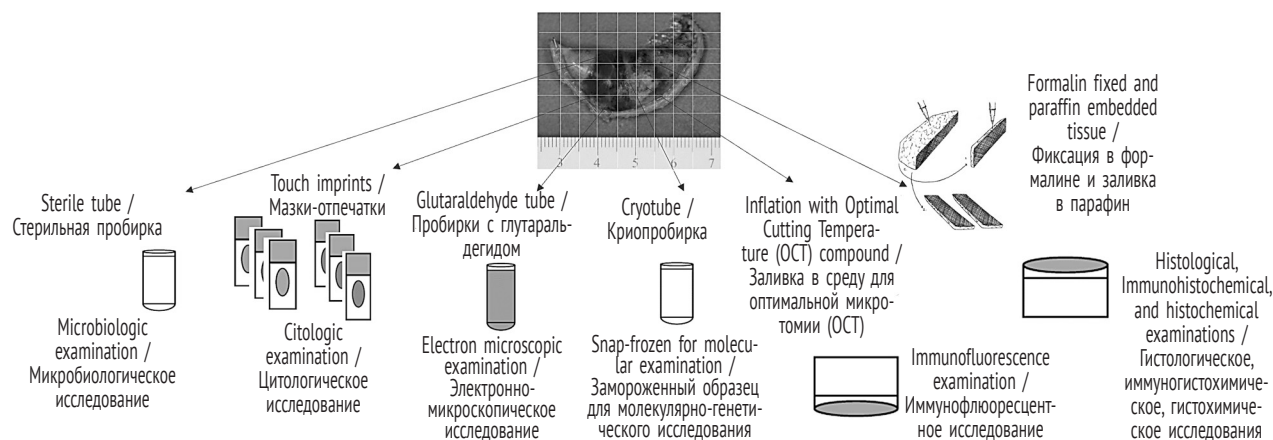


Fig. 2. A map for surgical specimens' triage of segmental resection of the lung

Рис. 2. Карта-схема сортировки операционного материала после сегментарной резекции легкого

After taking photographs, the pathologist should decide on the format of macroscopic photographs and incorporate them into the LIS. The most common format for common digital photographs is the Joint Photographic Experts Group (JPEG) format. In this format, images are compressed to 8 bits. However, a number of important metrics are lost during compression. Note that a medical photograph is currently considered as a legal document. Thus, we, including forensic doctors [8], recommend saving photographs of gross specimens in a raw image format. It is usually mildly larger than JPEG and ranges from 12 to 14 bits, but this format preserves all original information. Most raw image formats, which may be named differently by different manufacturers, are based on the tag image file format. For physical storage of digital images in daily practice, USB drives, optical disks, hard drives, servers, and a virtual cloud infrastructure with a web interface can be used. Ideally, all information should be transferred to the LIS at the end of the working day [9, 14]. In practice, this stage can cause insuperable difficulties. This is because that there are different types of LIS and they may be incompatible with the software used for capturing digital images [14]. At present, two ways can be employed to control the loading of digital images in the LIS: (1) LIS supplier provides commercial software that loads and manages the digital image in the LIS [14] and (2) the acquisition procedure and the image storage procedure are done separately [16]. Thus, to launch a digital archive,

reliability, security, and ease of access should be ensured.

An example of a digital archive that is used for educational purposes is a photo gallery of the pathomorphology site. It consists of macroscopic and microscopic photographs obtained from various laboratories in Russia. Macroscopic images are grouped by anatomical location. In addition to photographs, samples of macroscopic descriptions are provided. This collection can be useful for students, residents, and aspiring pathologists. This gallery helps participants not only improve their competencies in the field of digital photography of a gross specimen but also enables them to receive an independent assessment from colleagues, take part in a discussion, and make friends and like-minded fellows. This gallery is created by “pathologists for pathologists.” By respecting rules of patient’s privacy, images of gross specimens can be posted for discussion on the website of a professional community and be assessed independently.

In conclusion, previously, obtaining and importing digital images into the LIS appeared to be a fashionable and advanced computer functionality, but at present, it is a necessity. In the era of molecular genetic tests, methods for sequencing genomes of cells in tissue samples and formulation of a post-mortem diagnosis using the updated classifications of the World Health Organization impose increasing requirements on morbid anatomists. Nowadays, to maintain a high level of medical care and formulate an integrated diagnosis according to modern stan-

dards, the pathologist must have access not only to clinical data (electronic history), macroscopic and microscopic descriptions, and digital images but also to the results of all additional studies [12]. Photographic documentation of a gross specimen is becoming an integral part of the daily work of pathologists; thus, more attention should be paid to the development of competencies in this field.

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