New teaching aid "Physical Methods of Medical Introscopy”

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Abstract. Description of a new teaching aid, in which new methods of reconstruction of hidden images by means of nuclear magnetic resonance, X-gamma-ray, and ultrasonic tomography, is presented. The diagnostics and therapy methods of various oncological diseases with the use of medicine proton and ions beams, as well as neutron capture therapy, are considered. The new teaching aid is intended for senior students and postgraduates.

1. Introduction

Modern imaging techniques and their application in science and technology are very diverse. Among them medical introscopy, which is widely used for the diagnosis of various diseases, has a distinguished position. Thanks to the development of physics, mathematics, electronics and computer technology new possibilities for medical imaging have appeared today. In this area the most advanced scientific equipment permitting doctors to study different biological structures in detail is used.

To make the use of modern equipment for medical introscopy more effective, skilled specialists are required to have a high level of knowledge in medicine as well as other fields, including physics, mathematics, electronics and computer technology.

Today, in order to operate various medical scanners it is necessary to form several professional groups which are responsible for the work of individual units of equipment and for processing, analysis and interpretation of tomography data.

The amount and variety of information, that needs to be processed by the equipment maintenance staff, is so large that, as a rule, it is quite difficult for a single person to do it.

It should be noted that the system of modern education is constructed in such a way that it is complicated, and sometimes impossible, for students and postgraduate students to obtain such a large amount of complex knowledge which is necessary to work with complex modern equipment.

One of the problems in training qualified specialists in this area is insufficient literature, where the basic physical principles and methods of modern medical introscopy stated in an understandable form. For this reason the issue of new publications where this problem is considered in detail is now extremely important.

Writing a new teaching aid or a tutorial designed to enhance the overall level of education in the field of medical introscopy can be very useful, since nowadays the task of preparing qualified specialists to work with a variety of scanners is still very pressing.

This article describes the new teaching aid [1], in which the physical basis of medical introscopy methods and its application for diagnosis of various diseases are considered.

2. The structure of the teaching aid

The teaching aid consists of eight chapters. The first six chapters consider certain types of electromagnetic radiation that are used in modern medical introscopy, ranging from radio to gamma radiation. Table 1 shows the ranges of electromagnetic radiation that are described in the teaching aid and some medicine areas where they are used.

Table 1. Ranges of electromagnetic radiation.

The ranges of electromagnetic radiation	Wavelength	Application area
Radio wave radiation	$5\cdot10^{-5} – 10^{10}$ m	Nuclear magnetic resonance tomography.
Infrared radiation	$700 – 10^{5}$ nm	Oncology, neurology, hagiology, traumatology, general surgery, etc.
Visible light	400 –760 nm	Spectral analysis, chromo Therapy, fotogemoterapy, endoscopy, ophthalmology, etc.
Ultraviolet radiation	200 – 400 nm	Dermatology, fluorimetry, dentistry, etc.
X-rays	$80 – 10^{-4}$ nm	Computed X-ray tomography
Gamma-rays	$< 10^{-4}$ nm	Emission computed tomography

The fourth chapter is devoted entirely to the laser radiation, which in recent years has begun to be widely used in various fields of medicine, including medical introscopy. In the sixth chapter of this guide devoted to gamma radiation, along with a description of the existing equipment, information on radioactive sources used for medical diagnosis and therapy purposes is provided. As an example, a list of radio nuclides used in positron emission tomography is given in table 2.

Tabel 2. The list of radio nuclides used in positron emission tomography.

Radionuclides	^{11}C	^{13}N	^{15}O	^{18}F	^{57}Fe	^{68}Ga	^{82}Sr	^{52m}Mn	^{82}Rb
Half-life ($T_{1/2}$)	20,38 min	9,97 min	2,04 min	109,8 min	8,28 days	68,0 min	25 days	21,1 min	82 min

The seventh chapter deals with the possibility of using beams of elementary particles for the diagnosis and treatment of various diseases. In particular, information about the proton and ion therapy of cancer is provided.

The last chapter contains a description of medical ultrasound equipment and methods of its use for the diagnosis and treatment of various diseases.

Thus, the teaching aid describes the main types of medical introscopy that allows one to get a clear idea about general principles underlying in this branch of medicine.

An important feature of this manual is a general presentation of the structure of all the areas of medical imaging. At the beginning of each chapter the historical information about a discovery of a given radiation type as well as the basic idea of its physical nature, involving the necessary materials from the respective branches of modern physics and mathematics are considered.

Natural and artificial sources of radiation, as well as instruments for its detection are then presented.

The next step is to consider the basic principles and methods of image restoration, obtained by means of various devices. That is followed by the description and specifications of the equipment used (e.g. different scanners or microscopes).

At the end of each chapter, main health areas using one or another kind of equipment are listed. In addition, main advantages of various systems and the list of restrictions on the use of the particular type imaging as well as possible negative consequences for a patient are considered.

As an example, the general scheme of successive consideration of X-rays, which is presented in the fifth chapter of the teaching aid is given:

1. Historical information about the discovery of X-rays;
2. Main physical characteristics of X-rays;
3. Sources of X-rays;
4. X-rays detectors;
5. X-ray image, reconstruction methods;
6. Fundamentals of computer X-ray tomography;
7. Principles and methods of 2D and 3D tomographic images reconstruction;
8. Modern X-ray tomography and its physical and technical characteristics;
9. Use of X-rays in medicine (diagnostics, therapy and development prospects).

Such a sequence of presentation, according to the authors' opinion, is most appropriate, as it allows the reader to consider the development of many scientific disciplines, evaluate their past accomplishments and see the results of the implementation of these studies in medical introscopy. This teaching aid allows the readers to form a clear idea of the importance, opportunities, problems and prospects of development of the area in medicine.

The photo of the teaching aid is shown in figure 1.

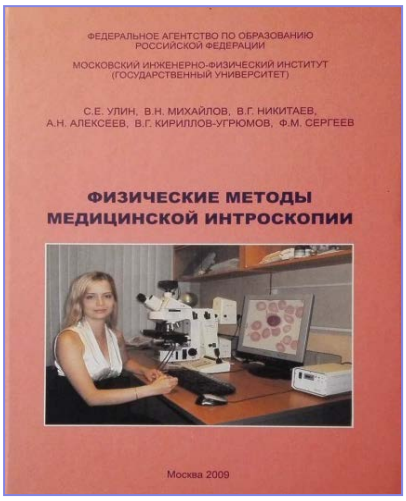

Figure 1. The photo of the teaching aid.

3. Conclusion.

Modern methods of medical imaging are developing so rapidly that the teaching aid has to be continuously improved and some new achievements in this scientific field should be included in it.

At the moment the second edition of the teaching aid is being prepared. New edition will contain more information on mathematical methods of image restoration, as well as advanced medical imaging applications. The textbook is also planned to be translated into English.

References

[1] Ulin S E *et al.* 2009 (in Russian) *Physical Methods of Medical Introscopy* (Moscow) p 309 (original Russian title: *Fizicheckie mentody medicinscoy introscopii*)