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Современные проблемы в медицинской физике

Учебное пособие
для студентов факультета нано- и биомедицинских технологий

ИЗДАТЕЛЬСТВО САРАТОВСКОГО УНИВЕРСИТЕТА
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Пособие предназначено для обучения переводу научно-технической литературы с английского языка на русский и дает возможность детального изучения и обсуждения современных проблем медицинской физики и биомедицинской инженерии.

Пособие предназначено для студентов, обучающихся по специальности “Медицинская физика” и направлению “Биомедицинская инженерия”, а также научных сотрудников, аспирантов, инженеров, занимающихся улучшением знаний языка по техническому переводу специализированной медико-технической научной литературы.

Рекомендуют к печати:

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FOREWORD

В основу курса положены оригинальные сообщения о современных достижениях науки в области таких разделов медицинской физики как компьютерная томография регенерации конечностей, оптоакустическое сканирование новообразований, применение трехмерных изображений магниторезонансной томографии в нейрохирургии, рентгеновская электронная томография, хирургические методы в кератопластике, позитрон-эмиссионная томография, многоканальные технологии визуализации в инфракрасном диапазоне, системы визуализации в кардиологии, лазерная навигация при хирургическом вмешательстве, контрастное ультразвуковое доплеровское сканирование, спектральная магниторезонансная томография.

Учебное пособие, составленное по современным проблемам биомедицинской физики, позволяет проводить целенаправленную подготовку студентов, обучающихся по специальности “Медицинская физика” и направлению “Биомедицинская инженерия”, и адаптировать знания студентов к требованиям технического перевода специализированной медико-технической научной литературы.

Данное пособие ставит перед преподавателем цель научить студентов речевым умениям и навыкам, необходимым для чтения и понимания оригинальной литературы по специальности, а также для выражения своих мыслей в монологической форме в пределах тематики по специальности.

В процессе преподавания уделяется внимание и на развитие разговорных навыков. Выделен строгий минимум слов, подлежащих обязательному запоминанию, даются значения этих слов, приводятся примеры их употребления, производные синонимы и антонимы к вводимым лексическим единицам. Подобраны предтекстовые упражнения для закрепления лексических единиц, предназначенных для активного усвоения, тексты по специальности с послетекстовыми упражнениями для развития навыков чтения, перевода и понимания специальной литературы.

LESSON ONE

COMPUTED TOMOGRAPHY PROVIDES NEW VIEWS OF LIMB REGENERATION

Pre-text exercises

1. Read the following for pronunciation:

computed tomography [kəm´pju:tid tə'mɔgrəfi]
limb regeneration [lim riˌʤenə'reiʃəˌn]
biological phenomena [ˌbaiə'lɔʤikal fə'nɔminə]
to regenerate lost limb [tə ri'ʤenəreit lost lim]
mystery imaging ['mistəri ' imæʤiŋ]
multiple angles ['mʌltipl 'æŋglz]
3-D rendering ['əri: 'di: 'rendəriŋ]
wound healing ['wu:nd 'hi:liŋ]
micro CT imaging ['maikrəu 'si: 'ti: ´imæʤiŋ]

aquarium [ə´kwɛəriəm]

reiteration [ri:ˌitə'reiʃəˌn]
malfunction [mæl'fʌŋkʃən]

mechanism ['mekənizm]
opaque [ou'peik]
technique [tek´ni:k]
colleaque ['kɔli:g]
tissue ['tiʃu:] [tisju:]
cartilage ['ka:t(ə)liʤ]
gene [ʤi:n]

2. Try to guess the meanings of words in bold type:

accomplish *v.* 1) succeed in doing, 2) finish successfully

The mechanism by which they accomplish this remains a puzzle.

replace *v.* 1) being used instead of another thing, 2) remove something from its place, and put a different thing there

A better understanding of this process could lead to new ways of replacing damaged or malfunctioning tissues or organs in humans.

provide *v.* 1) give, supply (what is needed or useful), 2) do what is necessary

Micron-scale computer tomography (CT) apparatus, otherwise, known as micro CT, is beginning to provide answers to the long-standing mystery imaging.

tissue *n.* the material forming animal or plant cells

The purely optical-based method of pulse oximetry won't work in the brain because the tissues between the probe and the brain are too thick.

opaque *adj.* not allowing light to pass through, that cannot be seen through

Micro CT allows you to image an optically opaque volume with excellent resolution.

reveal *v.* 1) show something that was previously hidden, 2) make known something that was previously secret or unknown

The images revealed both expected and surprising elements of the regeneration process.

sample *n.* a small part or amount of something that is examined in order to find out something about the whole

The microversion depends on the mathematics reconstruction of data obtained by directing x-ray beams through a sample from multiple angles.

delay *n.* 1) the length of time between the moment when something should start and the moment it actually does start, 2) a situation in which some or something is made to wait

The unforeseen result was a delay in the metamorphosis of cartilage to bone near the amputation site.

evidence *n.* facts, objects or signs that make you believe that something exists or is true

Simon said that there is evidence from other researchers that a similar regeneration process occurs in young humans – in an amputated finger, for instance.

malfunction *n.* a fault in the way a machine or computer operates

There are new ways of replacing malfunctioning tissues or organs in humans.

3. Give the English for the following:

неисправная работа, конечности, ампутировать, кость, хрящ, ближайший к месту прикрепления, отдаленный (от центра), повторять, обнаруживать, задержка, непрозрачный, заменять, доказательство.

COMPUTED TOMOGRAPHY PROVIDES NEW VIEWS OF LIMB REGENERATION

Of all the unexplained biological phenomena in the world, the ability of newts to regenerate lost limbs may be one of the most fascinating, but the mechanism by which they accomplish this remains a puzzle. A better understanding of this process could lead to new ways of replacing damaged or malfunctioning tissues and organs in humans.

At Northwestern University in Chicago, micron-scale computed tomography (CT) apparatus, otherwise known as micro CT, is beginning to provide some answers to the long-standing mystery imaging. As with the standard technique, the micro version depends on the mathematical reconstruction of data obtained by directing x-ray beams through a sample from multiple angles. The spatial resolution can be obtained with CT, the small spot size can resolve features down to 10 μm.

It is this resolution that is allowing an unprecedented view of the details of tissue and bone regeneration, said research team member Hans-Georg Simon, assistant professor at Northwestern's Feinberg School of Medicine and Children's Memorial Institute for Education and Research. In a paper published in February, Simon and his colleagues detailed recent micro CT studies of forelimb development in adult newts.

The researchers amputated the lower portion of the right forelimbs of newts and returned the animals to their aquariums to carry on as usual. At various times between 37 and 85 days after amputation, they euthanized the animals and excised the damaged limbs for CT analysis. They also cut off the untouched left limbs as a control.

Fig. 1. Three-dimensional micro CT renderings of a newt's right forelimb (right) some weeks after it had been amputated at the distal end of the humerus showed that ossification near the amputation site proceeded more slowly than in the other skeletal elements. The left forelimb (left) served as a control for comparison.

A micro CT scanner operating at 45-kV tube potential, 88-μA tube current and a 0.30-s integration time, imaged slices of the excised limbs, which the scanner's image analysis software reconstructed into 3-D renderings. Team member

Stuart Stock, professor at Northwestern's Institute for Bioengineering and Nanoscience in Advanced Medicine, said that a micro CT scanner was the best option for witnessing the process of tissue developing into cartilage, muscle and bone.

"Micro CT allows you to image an optically opaque volume with excellent resolution," Stock explained "With cofocal microscopy, you need to get light in and out, but it's hard to do with larger volumes, particularly mineralized tissue. MRI doesn't give the same resolution."

The images revealed both expected and surprising elements of the regeneration process. As suspected, the missing limb skeletal elements grow back in a proximal-to-distal fashion; that is, extending from the "stump". Simon said that the cells at the amputation site become embryonic again, essentially repeating the unforeseen result which was a delay in the metamorphous of cartilage to bone near the amputation site, compared with other areas of bone formation.

Despite the forelimb's reiteration of developmental processes, a previous study by the group showed that the regeneration and developmental processes are controlled by different gene activities. And Simon said there is evidence that regeneration process occurs in young humans — in an amputated finger, for instance — if the body is left to its natural healing capacity. He also said that these studies have scratched the surface of a process that, when better understood, might lead to new thinking in the areas of human wound healing, broken bone repair or even tissue or organ regeneration.

Although the newts were euthanized in the most recent studies, the researchers are now conducting experiments that follow the regeneration process in live animals. In addition, Stock said that the group is using micro CT imaging with x-rays generated by a synchrotron source, which is more inconvenient because of limited availability but which provides better resolution and faster imaging times.

Words and word-combinations to be remembered

at the amputation site	на месте ампутации
to provide	снабжать
view	вид
limb regeneration	восстановление конечности
ability	способность
to accomplish	выполнять, совершать
malfunction	неисправная работа
sample	образец, проба
multiple	многократный, многочисленный
tissue	ткань
option	выбор
witness	доказательство
opaque	непрозрачный, непроницаемый
to reveal	обнаружить

resolution	разрешение
volume	объем
delay	v. отложить, n. задержка
site	участок
healing	лечение
availability	достижимость
to regenerate lost limbs	восстанавливать утраченные органы
to lead to new ways	приводить к новым методам
3-D CT rendering	трехмерное изображение компьютерной томографии

Exercises

1. State the part of the following words pointing out the word building elements. Give their Russian equivalents.

generate — regenerate — generator — generation
depend — dependent — dependence
opaque — opaqueness
fashion — fashioner — fashionist — fashionable — fashionless — fashionably
compare — comparable —comparative — comparatively
conduct — conductor — conductive — conductance — conductivity
avail — available — availability
image — imageable — imaginable — imaginary — imagination — imaginative — imagine

2. Arrange the words given in A and B in pairs of synonyms

A		B	
	remote		to link
	to restrict		to develop
	enormous		to limit
	merely		tremendous
	to collect		simply
	to connect		distant
	to evolve		to gather

3. Arrange the words given in A and B in pairs of antonyms

A	able	B	disabled
	to cover		vast
	tiny		to resist
	finite		to reveal
	to exclude		boundless
	to fill		to include
	to obey		to empty

4. Give derivatives of the following words

publish, develop, convenient, solve, construct

5. Match the words in a) with the words in b)

a)	b)
the ability of newts	damaged or malfunctioning tissues and organs
to replace	witnessing the process of tissue developing into cartilage, muscle and bone
recent micro CT studies of	to regenerate lost limbs
the best option for	forelimb development in adult newts
new thinking in the areas of	human wound healing, broken bone repair or even tissue or organ regeneration

6. Find noun groups in paragraphs 2, 3, 7.

7. Translate into Russian paying attention to the emphatic constructions.

- “It is this resolution that is allowing an unprecedented view of the details of tissue and bone regeneration”, said Mr. Simon.
- And when the systems do compensate, the glare is all that can be detected.
- It was not until the seventeenth century that man began to understand pressure.
- It is the problem that involved a number of difficulties.
- Stable atoms do exist.
- The first technique does use a cutting laser to outline cells.
- It is this technique that avoids direct manipulation of cells.
- The researchers did use change detection analysis – also calling statistical probability mapping.
- Associated with the bombardment of atom in the upper atmosphere by particles from the Sun is an aurora.

- The cells of the early embryos did express the proteins of a new embryo.
- Now in the pipeline at leading pharmaceutical companies are a number of such drugs.
- It is IR technology that has held the interest of medical and veterinary communities as a mean of detecting damage that is invisible to the naked eye.

8. Read the text and state the main ideas in 5 – 6 sentences in Russian.

Lizards hear with their lungs

Some lizards and all salamanders lack a middle ear but have an inner ear with receptor cells that respond to sound. These are not very vocal animals, but they need their hearing to detect predators. Researchers have not known how the sound reaches the inner ear. Laser Doppler vibrometer experiments on several species of salamanders and lizards have added evidence to the theory that these animals hear via their lungs.

To study how the sound reaches the inner ear, Tom Hetherington of Ohio State University in Columbus anasthetized an animal, placed it in a sound chamber and subjected it to various frequencies between 100 and 5000 Hz. He used an OFV 1000 laser Doppler vibrometer to measure the velocity of oscillation of the animal's body. This no contact vibration-measuring device enables direct measurement of body wall movement. It works by detecting the Doppler shift of laser light that is scattered from a small area on the object.

"We use tiny reflective glass beads placed on the skin surface to improve reflectivity", Hetherington said. "The plain skin absorbs a lot of energy and scatters much. The glass beads do not load the surface much". He has shown that the body wall over the lung vibrates much more than other parts of the body — 30 dB more motion than the head surface, from 300 to 1000 Hz in salamanders and 200 to 2500 Hz in lizards. The lateral body walls in lizards were more responsive than their eardrums to frequencies below 1250 to 2000 Hz. Furthermore, he has shown that the peak response for lizards corresponds to the resonant frequency of a Helmgholtz resonator with the same dimensions as their lungs, meaning that small animals respond to higher frequencies than large animals.

By carrying out the experiment on salamanders that have lungs — such as the newt and tiger — and on those that do not, namely the redback and dusky, he has proved that the vibrometer is measuring vibrations originating in the lungs and not just general body movement. When he filled the lungs with oxygenated saline, the response of the body wall was subdued, only to reappear when the lungs were again filled with air.

More than 30 years ago it was suggested that the lungs serve an auditory purpose in snakes. In the course of more than four years of work Hetherington has measured the brain responses to sound in some amphibians and has shown that their hearing is dependent on a clear pathway from the lungs through the respiratory cavities into the inner ear cavity. The precise pathway from the lungs to the

hearing receptors has not yet been established, and Hetherington hopes to accomplish this in future studies.

9. Answer the following questions:

Where could a better understanding of limb regeneration lead to?
What does Mr. Simon think of tissue and bone regeneration?
What was the unforeseen result of his experiments?
What techniques are being used now by Simon's group?

10. Render the text "Computed Tomography".

Topics for discussion:

Regeneration and developmental processes.
Different gene activities.
New studies in the field of human wound healing.

LESSON TWO

OPTOACOUSTICS MOVES CLOSER TO THE CLINIC (part I)

Pre-text exercises

1. Read the following for pronunciation:

target ['ta:git]	malign [mə'lain]
tiny ['taini]	malignant [mə'lignənt]
diagnose [ˈdaiəgnəuz]	benign [biˈnain]
diagnosis [ˌdaiəgˈnəusis]	piezoelectric detector [paiˈi:zəuilˈektrik diˈtectər]
harness [ˈha:nis]	transducer [trænzˈdju:sə]
advantage [ədˈva:ntiʤ]	array [əˈrei]
disadvantage [ˌdisədˈva:ntiʤ]	acquire [əˈkwaiə]

2. Try to guess the meaning of the words in bold type. Study their usage.

damage *v.* – 1) cause physical harm to something, 2) have a bad effect on something or someone in a way that makes them weaker or less successful

"A detector needs to be ultrawideband and also very sensitive, because we can't use large amounts of energy or we will damage the tissue"; he said.

array *n.* – a group or collection of things, usually arranged so that you can see them all

The firm is developing patented optoacoustic imaging systems that use such an array.

malignant *adj.* – (of diseases) harmful to life

It was suspected that one tumor was malignant and the other benign.

target *n.* 1) an object, person, or place that is deliberately chosen to be attacked, 2) a result, such as a total, which you aim to achieve

Optoacoustic imaging involves irradiating a target with a laser and detecting acoustic waves.

available *adj.* able to be used or can easily be bought or found

Some research groups believe the method will be available in hospitals by 2004.

advantage *n.* 1) something that helps you to be better or more successful than others, something useful, helpful or likely to bring success

One of the main advantages of optoacoustic imaging is that it can be used for diagnosis.

range *n.* 1) a number of things which are all different but of the same general type, 2) the limits within which amounts, quantities, ages, etc can vary, 3) the distance within which something can be seen or heard

One must be able to detect optoacoustic waves within a very wide range of ultrasonic frequency.

3. Give the English for following:

злокачественная опухоль, доброкачественный, испытание, подтверждать, преимущество, недостаток, вызывать подтверждение, сходный, глубина, достичь ч.-л., диапазон, частота, датчик, давать возможность, средний.

4. Give derivatives of the following words:

detect, radiate, deep, indicate, apply.

OPTOACOUSTICS MOVES CLOSER TO THE CLINIC (part I)

What do you do if you have one imaging technique that gives you good resolution but poor contrast, and another that gives you good contrast but poor resolution? Combine the two and the best of both worlds. This is the principle behind optoacoustic imaging, which harnesses the good contrast attainable with optical imaging with the high resolution of acoustic or ultrasonic techniques.

Other techniques have disadvantages. For example, x-ray imaging uses ionizing radiation that can cause damage, while ultrasound has poor contrast because different biological tissues are acoustically similar. Purely optical imaging techniques are inadequate because tissue severely scatters light, limiting the depth of imaging resolution.

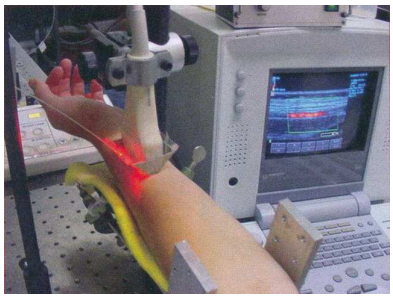


Fig. 2. Optoacoustic imaging, or laser-induced ultrasound, can be used to image objects close to the skin.

One of the main advantages of optoacoustic imaging is that it can be used for diagnosis. It not only images a tumor, but also indicates whether it is malignant

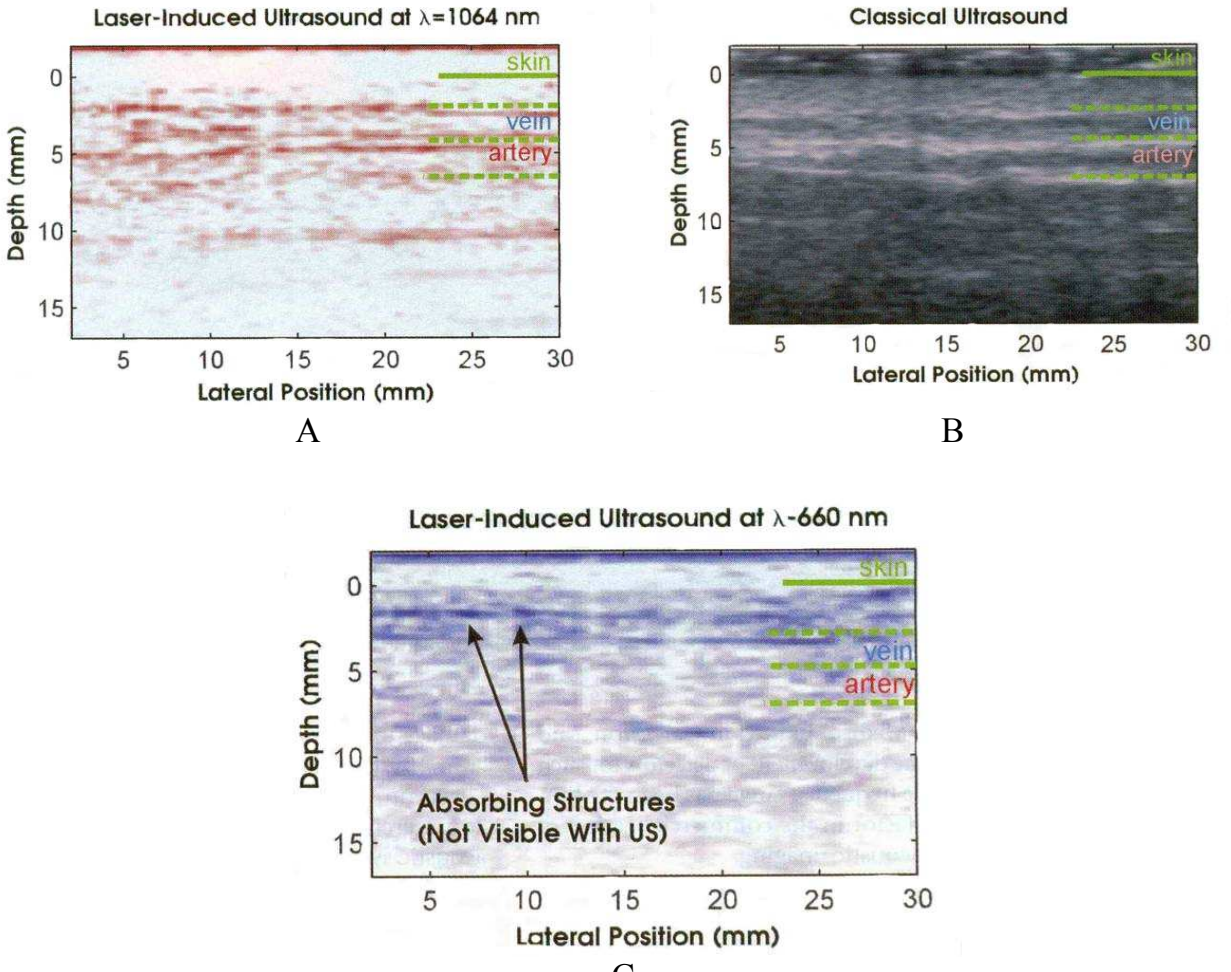
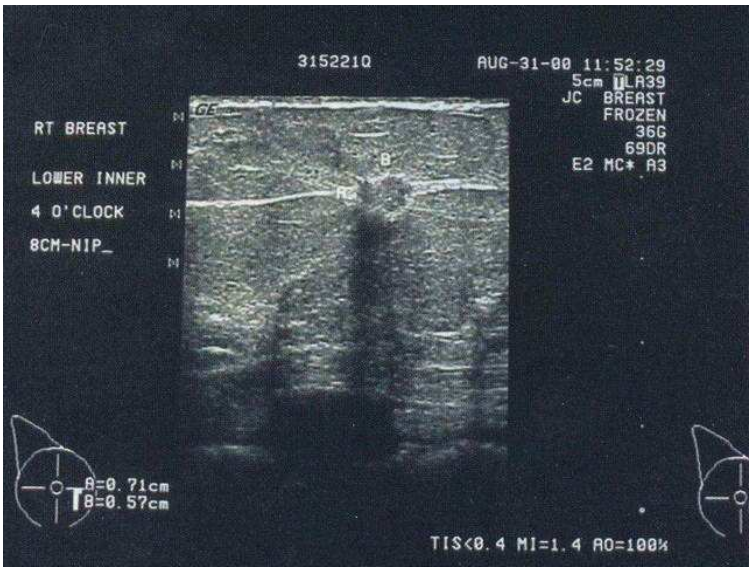


Fig. 3. Optoacoustical imaging of a human forearm using a wavelength of 1064 nm (A) shows more artery contrast than ultrasound along (B). Optoacoustic imaging with a wavelength of 660 nm shows stronger vein signals than ultrasound (C).

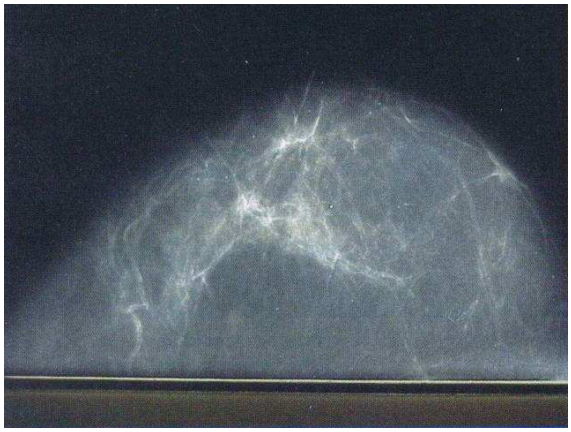
or benign. Similarly to optical imaging, the wavelength of light determines the main molecular targets in tissue. For most medical applications of optoacoustic imaging blood is the target. Unlike in optical imaging, the spatial resolution is de-

fined by the wavelength of resulting ultrasound. The bandwidth of ultrasound detectors is a limiting factor in this technique, because to achieve higher resolution and visualize relatively large objects at once, one must be able to detect optoacoustic waves within a very wide range of ultrasonic frequency.

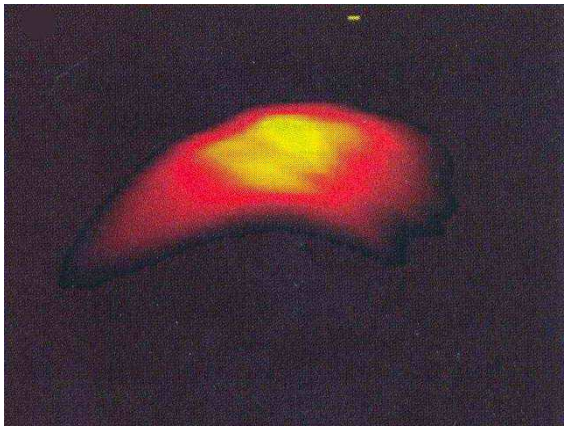
Although optoacoustic techniques need specialized ultrasound detectors, the development of which has proved a challenge, they do not require difficult and expensive cooling to reduce thermal noise as do optical detectors. Ultrasonic waves are detected by piezoelectric crystal to convert the acoustic waves to an electronic signal.



A



B



C

Fig. 4. This had a ductal carcinoma measuring 6x7 mm, with its central core 11 mm beneath the breast surface as seen in the ultrasound and x-ray images (A, B). C shows the contrast achievable with optoacoustic imaging. Virtually all the visible features come from the tumor along. The yellow dash above the image shows the position of the single optical fiber illuminating the breast. Multiple illumination sites (as are planned in the commercial system) will yield an image with greater tumor detail.

The technique identifies tumors from the pressure waves produced in tissue within an ultrawide range of ultrasonic frequencies between 20 kHz and 100 MHz,

depending on the tumor's type, size and depth. Thus, acoustic devices must be ultrawideband to detect low and high frequencies simultaneously.

One researcher in this field, Alexander Oraevsky said that the development of detectors for such a wide frequency range has been the limiting factor in the commercialization of optoacoustic imaging.

"A detector needs to be ultrawideband and also very sensitive, because we cannot use large amounts of energy or we will damage the tissue," he said.

In 1998, he started a company called Laser Sonix Technologies to develop a commercial prototype of a laser optoacoustic system using an ultrawideband acoustic transducer array in close partnership with Fairway Medical Technologies in Houston. It is developing patented optoacoustic imaging systems that use such an array.

With this detector, Oraevsky has developed a system that can achieve 0.5 mm spatial resolution and can detect tumors 6 to7 cm deep (Fig. 1). This, he said, enables him to image an entire breast, because the average distance from the surface to the center of a breast is less than 7 cm.

In a recent trial involving 11 patients who were all known to have tumors, he was 100 percent successful in finding them. "We were particularly pleased with one case where a female patient had a small tumor in each breast," he said. "It was suspected that one tumor was malignant and the other benign."

Words and word-combinations to be remembered

target	цель
tiny	крошечный
diagnose	ставить диагноз
disadvantage	недостаток
to scatter light	рассеивать свет
to visualize	делать видимым
damage	v. повреждать, n. повреждение, шум
to reduce thermal noise	уменьшить тепловой шум
malignant	болезнетворный, злокачественный
benign	доброкачественный
blood content	состав крови

Exercises

1. State the part of the following words pointing out the word building elements. Give their Russian equivalents:

malign — malignant — malignantly — malignity
able — ability — enable

attain — attainability — attainable — attainment
identical — identify — identification — identity
notice — noticeable — noticeably
oxygen — oxygenate — oxygenous
attest — attestant — attestation —attester(or)
deep — deepen — depth

2. Arrange the words given in A and B in pairs of synonyms

A	advantage	B	testify
	attest		harm
	believe		preference
	damage		disperse
	research		limit
	cause (n.)		reason
	demonstrate		use
	scatter		show
	restrict		investigate
	apply		think

3. Arrange the words given in A and B in pairs of antonyms

A	involve	B	rich
	male		benign
	poor		behind
	malignant		exclude
	before		different
	similar		reduce
	increase		high
	low		female

4. Combine the words in bold type with those in brackets. Translate the combination into Russian

tumor (small, malignant, benign)
branch of (science, technology, medicine, knowledge)
to evolve (a new theory, a scheme, a method, a solution to a problem, a solution to a plan)
expensive (equipment, fuel, instrument, device)

5. Translate the following sentences paying attention to Infinitive Constructions.

- UV micro-irradiation has been shown to break one or both strands of DNA.
- They tested the system's ability to produce double – strand DNA breaks in the nuclei of human cells.
- To visualize the damage they fixed and immunostained cells after irradiation.
- Brightness and ability to be expressed in genetically engineered cells have inspired scientists to develop microscopy techniques.
- This enables the user to excite some more fluorescent dyes.
- Detection of the optoacoustic waves also has proved to be a challenge for the scientists.
- The scientist did not buy the whole-imaging system because he wanted the flexibility to perform several tasks and to add components as necessary.
- To test the technique, the researches imaged samples of yellow fluorescent protein.
- Micro CT (computed tomography) allows you to image an optically volume with excellent resolution.
- This allows them to determine how long it takes for the ion channel to open and for equilibrium to be re-established between its closed and open-channel forms.
- It causes ion channels to open and produce an electrical current.
- The techniques allow researchers to measure the current.
- The cells seem to be guided by an attractive signal.
- These properties allow various factors to alter the orientation of the molecules.
- A technique using liquid crystals as an optical amplification medium could enable an ordinary light microscope to show structural features and biochemical interactions occurring on cell surfaces.
- The researchers hope this will allow them to use liquid crystals as an amplification medium for imaging biological cells.

6. Read the text and state the main ideas in 5-6 sentences either in English or in Russian:

To detect small tumors and those that are more than 7 cm below the skin, he is working on using gold nanoparticles as contrast agents. He is developing them with a sharp optical absorption peak at any desirable wavelength in the near-infrared. The optical absorption coefficient of optimally designed metal nanoparticles could be more than 1000 times stronger than absorption of those made of any organic molecules.

The nanoparticles can also be used therapeutically. A molecule conjugated with nanoparticles can selectively bind to the surface of cancer cells; one particle

can carry many antibodies or peptides that selectively target a variety of cancer cells. Other molecules attached to a nanoparticles (toxin) can serve as a cells. After a time, all nanoparticles would be cleared from circulation and only those selectively attached to tumors would remain.

While Oraevsky is concentrating on imaging and diagnosing tumors, his former colleagues at the University of Texas have continued their optoacoustic research in a different direction. Rinat Esenaliev, associate professor and chairman of the department of anesthesiology, have turned their attention to the real-time monitoring of blood oxygenation levels in seriously ill patients, for example, a patient who has been in a car accident.

7. Complete the following statements:

- Optoacoustic imaging can be used to image…
- Acoustic devices must be ultrawideband to detect…
- The bandwidth of ultrasound detectors is a limiting…
- One must be able to detect optoacoustic waves within…
- Ultrasonic waves are detected by…
- Purely optical imaging techniques are in adequate because tissue severely scatters…
- The spatial resolution is defined by the wavelength of…
- It was suspected that one tumor was malignant, and the other…
- Benign tumors have relatively normal levels of…

8. Give answers to the following questions:

What must be done to get both good resolution and good contrast?
What are the advantages of optoacoustic imaging?
What is a limiting factor of this technique?
How can ultrasonic waves be detected?
What kind of detector is needed?

9. Speak on the topic of the text “Optoacoustics moves closer to clinic”

10. Write an annotation on this text.

Topic for discussion:

Use of optoacoustical devices in medicine

LESSON THREE

OPTOACOUSTICS MOVES CLOSER TO THE CLINIC (part II)

Pre-text exercises

1. Read the following for pronunciation:

Invasion [in ‘veizən]	
trauma ['trɔ:mə]	simultaneous [ˌsiməl’teinjəs]
life-threatening illness [‘laif ‘θretniŋ ’ilnis]	yield [ji:ld]
brain injury [’brein ’indʒəri]	robust [rəu’bʌst]
high accuracy[’hai 'ækjurəsi]	

2. Try to guess the meaning of the words in bold type. Study the use of these words.

trauma *n.* 1) a very unpleasant and upsetting experience, 2) technical injury

A group of scientists has invented a two-wavelength optoacoustic system for blood oxygenation measurements of patients with life-threatening illness including traumatic brain injury.

monitor *v.* 1) carefully watch and check a situation in order to see how it changes or progresses over a period of time, n. 2) a piece of equipment that receives and shows information about what is happening inside someone’s body.

The system monitors blood in a large central cerebral vein inside the skull.

penetrate *v.* enter something or pass through it, especially when this is difficult

The scientists have found that near-infrared radiation penetrates sufficiently through the skull.

accuracy *n.* 1) the ability to do something in an exact way without making a mistake, 2) the quality of being correct or true

The results demonstrate that the system is capable of blood oxygenation measurements with high accuracy.

confident *adj.* 1) sure that you can do something or deal with a situation successfully, 2) very sure that something is going to happen or that you will be able to do something (not before noun)

Prough, confident that the method is safe, is planning to begin human trials.

injury *n.* physical harm that is caused by an accident or attack

We have seen no evidence to suggest that our technique will result in skin injury.

cause *v.* make something happen

We irradiate the object under investigation with a 6-ns-pulsed laser, causing a small temperature change.

3. Give the English for the following:

проникать с точностью, измерение, уверенный, испытание на человеке, определить, высокая чувствительность, облучить объект, вызвать изменения, улучшить, другой подход, одновременно.

OPTOACOUSTICS MOVES CLOSER TO THE CLINIC (part II)

Although pulse oximetry systems are standard for measurement blood oxygenation from the fingertip, monitoring cerebral blood oxygenation — one of the most important parameters in patients with conditions like head trauma or who are undergoing cardiac surgery — isn't so easy. Blood oxygenation of less than 50 percent may cause brain damage, other complications or even death. If it falls to this level, doctors know to begin treatment immediately.

The purely optical-based method of pulse oximetry won't work in the brain because the tissues between the probe and the brain are too thick. Moreover, purely optical techniques do not have the resolution that is required to accurately measure venous blood oxygenation in the brain. Thus, this monitoring task requires invasive procedures such as inserting a catheter in the jugular vein or drilling a hole in the patient's skull.

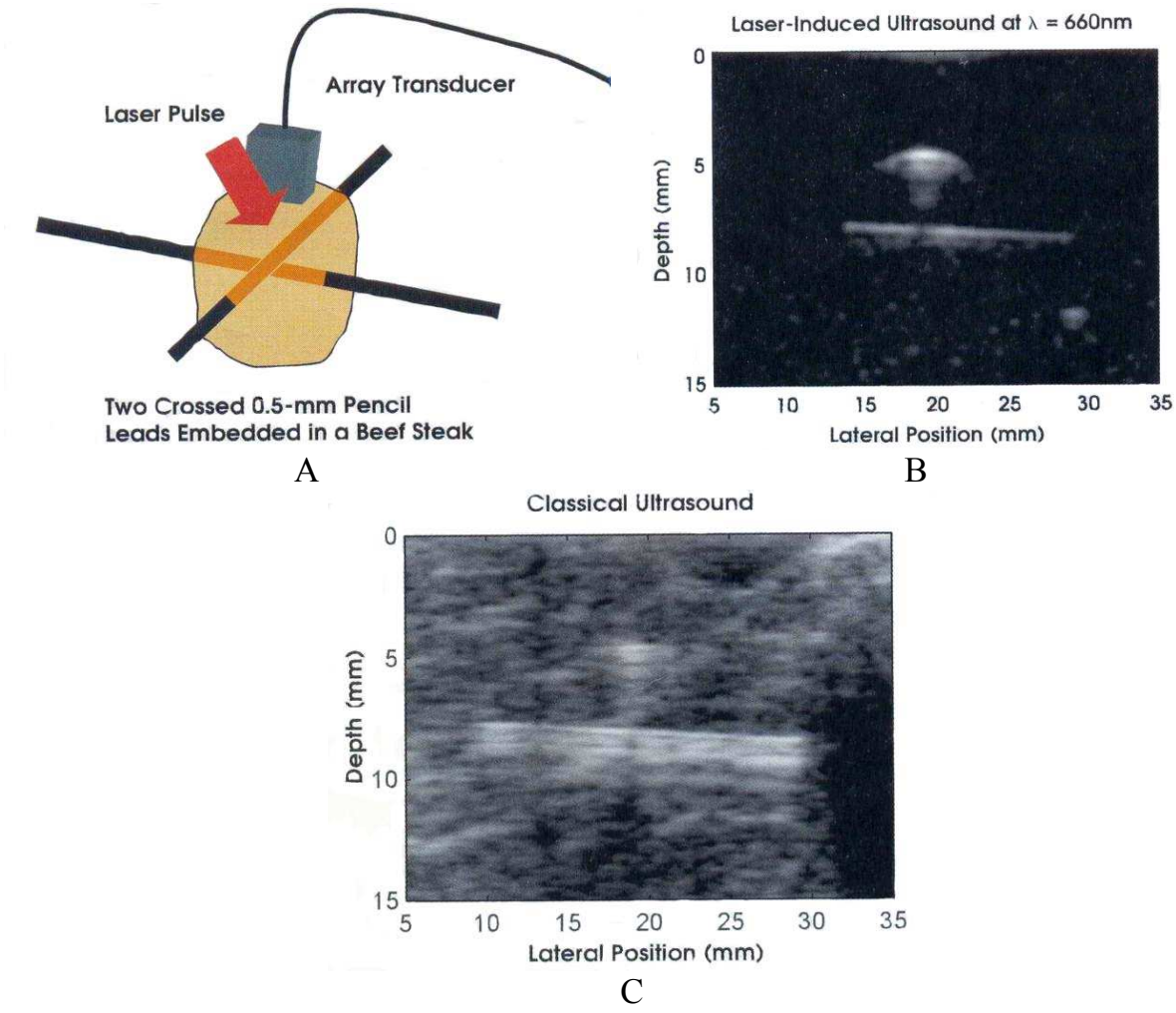


Fig. 5. When imaging two perpendicular graphite sticks embedded in a steak (A), optoacoustic imaging (wavelength = 660 nm) (B) produces an image with contrast superior to that from classical ultrasound (C).

Esenaliev, Prough and their colleagues Oraensky and Massoud Motamedi have invented a two-wavelength optoacoustic system that noninvasively monitors oxygenation levels in veins of patients who have life-threatening illnesses, including traumatic brain injury. It has nanosecond Nd. YAG and alexandrite lasers and a specially designed optoacoustic probe.

The system monitors blood in the superior sagittal sinus, a large central vein inside the skull. The scientists have found that near-infrared radiation penetrates sufficiently through the skull. They tested the system in vitro in sheep blood with experimentally varied oxygenation and total hemoglobin concentration. “Our results demonstrated that the system is capable of blood oxygenation measurements with high accuracy, despite variation of total hemoglobin concentration,” Esenaliev said.

These results suggest that the two-wavelength optoacoustical technique can be used for patients with different or charging hemoglobin concentration such as may happen during infusion of blood-free fluids or as a consequence of hemor-

rhage. Esenaliev and Prough, confident that the method is safe, are planning to begin human trials. “The laser energy we use is low, and the pulses are intermittent,” Prough said. “We have seen no evidence to suggest that our technique will result in skin injury.”

Martin Frenz’s group in Switzerland has developed an optoacoustic system for determining vascularization in the skin, an important factor in skin grafts, for example(Fig. 2-4). Its real- time imaging system is based on a Schlieren transducer, a sensitive device that detects pressure gradients with high resolution and relatively high sensitivity.

“We irradiate the object under investigation with a 6-ns-pulsed laser, causing a small temperature change,” Frenz explained. “This object, which is buried deep inside highly scattering media, then sends out an acoustic wave, which propagates to the tissue surface and from there into a liquid-filled cuvette put on the surface of the sample. We image the pressure-induced refractive index changes in this liquid and use this data to reconstruct the image of the object.”

The whole process takes about 50 ms and provides a real-time imaging technique with a resolution of 30 μm. “If we move the object, the reconstructed image moves, too,” Frenz said.

Detection of the optoacoustic waves also has proved to be a challenge for him and his colleagues. In other studies, they have investigated piezoelectric and optical detectors as well as using standard ultrasound detector systems. “We used a standard ultrasound imaging system as a detector with the ultrasound switched off. Instead of the ultrasound, we used a laser to irradiate the sample. This gave excellent results with better contrast than ultrasound alone. We have been able to show that standard ultrasound systems can be improved upon,” he said.

Imarx Therapeutics in Tucson, Ariz, is taking a different approach to imaging. It owns a patent for a system that applies both light and ultrasonic waves, in parallel, to the tissue and detects both, effectively performing optical and ultrasound imaging simultaneously. “Using acoustic waves combined with light has its advantages,” said Evan Unger. “Ultrasound can be used to create a base image, and optical information can be overlayed, creating an image with both anatomic and functional, biochemical and molecular information.”

The ultrasonic waves can be used to create an acoustic mirror inside the tissue to improve the reflection of light, and the mirror can vibrate the tissue to create interference patterns.

This technique should be relatively inexpensive and yield a robust image. “Additionally, we can combine optical and acoustic energy therapeutically in photosonodynamic therapy,” Unger said.” Certain photoactive compounds can be activated by ultrasound energy (sonodynamic therapy), activation by light and sound energy is synergistic to enable treatment of deeper-seated neoplasms, for example.” But a commercial system for treating deep tumors with optoacoustic technology is still away off.

***Notes*:**

sagittal *мед.* – сагитальный
sinus – пазуха, свищ
vascularization *мед.* – прорастание кровеносных сосудов, васкуляризация
jugular vein – шейная вена
a consequence of hemorrhage – последствие кровотечения
invasion – начало заболевания

Active words and word-combinations to be remembered

patient *adj., n*	терпеливый, пациент
trauma	травма
to undergo surgery	перенести операцию
to cause	вызвать, быть причиной
complication	сложность, осложнение *мед.*
treatment	лечение
brain	мозг
life-threatening illness	болезнь, угрожающая жизни
penetrate(through)	вводить, проникать
high accuracy	высокая точность
consequence	последствие
to intermit	прерваться
the object under investigation	исследуемый объект
simultaneous	одновременный
to overlay	покрывать

Exercises

1. State the part of speech of the following words pointing out the word building elements. Give their Russian equivalents:

invasion — invasive — noninvasion
intermit — intermittence — intermittent — intermittently
measure — measurable — measurably — measureless — measurer — measurement
complicate — complicative — complication — complicacy

2. Arrange the words given in A and B in pairs of synonyms

A	opaque	B	exclude
	include		resemble
	accept		hide
	differ		weak

	expose		transparent
	scatter		reject
	strong		collect

3. Say it in English.

вызвать изменения, начать лечение, требовать процедуру, внутри черепной коробки (черепа), проникать в, испытывать систему, последствия кровотечения, приводить к повреждению кожи, восстановить изображение объекта, дать отличные результаты, различный подход к чему-либо, обнаружить что-либо, одновременно, создать образ, улучшить отражение света

4. Translate the sentences paying attention to the Passive Voice

- This information reveals which genes were conserved through evolution.
- Because current sequencing methods work only with pieces much shorter than a genome, DNA must be cut up into many small sections.
- Each section is fragmented and tagged to identify the end base. The fragments are separated by size, and the tags are read.
- The companies are being talked with about developing applications and new sampling protocols for the technique.
- Methods for conducting co-called optical biopsies are being investigated at the University of Geneva School of Medicine.
- A compact system for optical fiber-based in vivo imaging has yet to be realized because it is difficult to send the necessary ultrashort laser pulses through the fiber.
- The other employs technology based on laser-induced fluorescence imaging that was developed by fellow researcher Moon S Kim - then working for NASA – to evaluate vegetation health.
- Until recently, machine vision systems which traditionally have been used for inspecting man-made products, were considered impractical for assessing food.
- Chen expects manufacturers will come forward after technology has been tested in a processing plant.
- After a time, all nanoparticles would be cleared from circulation and only those selectively attached to tumors would remain.
- The laser light is channeled to pick up and move living cells under the microscope.

5. a) Read the text and state the main ideas in 5-6 sentences either in English or in Russian:

MRI improves detection of acute coronary syndrome

Magnetic resonance imaging (MRI) could improve detection of acute coronary syndrome in emergency departments, say researchers from the National Heart, Lung and Blood Institute and Suburban Hospital. They estimate that chest pain prompts more than 5 million people to visit emergency departments of hospitals each year, and about 2 percent of these patients are suffering myocardial infarction but are discharged because the problem goes undiagnosed. In these cases patients' risk – adjusted mortality rate may double.

Because electrocardiograms and initial troponin levels sometimes do not detect acute myocardial infarction and unstable angina, the researchers evaluated the diagnostic ability of cardiac MRI in 161 patients who showed symptoms of myocardial ischemia but had negative electrocardiograms.

b) Read the second part of the text and answer the following question:
What can MRI predict?

Diagnostic MRI

They administered the contrast agent gadolinium and a 1.5-T scanner from General Electric with a cardiac phased-array receiver coil to examine regional contractile function, perfusion and viability.

Three cardiologists analyzed wall motion, delayed gadolinium hyperenhancement and perfusion on images. Quantitative analysis also was performed to measure left ventricular wall thickness and signal intensities. In addition, patients were diagnosed using conventional tests, and statistical analysis was used to determine if MRI provides diagnostic value over these clinical parameters.

Results, published in the February issue of *Circulation*, showed that MRI predicts acute coronary syndrome better than conventional tests and provides additional independent diagnostic value. It was more sensitive than electrocardiogram, initial troponin level and the TIMI (trombolysis in myocardial infarction) risk score, and more specific than abnormal electrocardiograms for detecting acute coronary syndrome, including myocardial infarction and unstable angina.

6. Give questions to which the following statements might be answer:

- They tested the system in vitro in sheep blood with experimentally varied oxygenation and total hemoglobin concentration.
- The system is capable of blood oxygenation measurements with high accuracy.
- The nanoparticles can also be used therapeutically.
- Other molecules attached to a nanoparticle (toxin) can serve as a drug that kills cancer cells.
- They have turned their attention to the real-time monitoring of blood oxygenation levels in seriously ill patients.
- They irradiate the subject under investigation with a 6-ns-pulsed laser.

- The whole process takes about 50 ms.
- If we move the object, the reconstructed image moves too.

7. Give full answers to the following questions:

What have scientists found?
What can you say about the results of the investigation?

8. Review the article “Optoacoustics moves closer to the clinic”

9. Write an annotation on the article.

10. Topics for discussion:

The progress of optoacoustic imaging.
The application of optoacoustic imaging medicine.

LESSON FOUR

IMAGING ADVANCES IMPROVE NEUROSURGERY (part I)

Pre-text exercises

1. Read the following for pronunciation:

surgery [ˊsə:dʒəri]
neurosurgery [ˌnjuəro(u)ˈsə:dʒərˌi]
brain's interior ['breinz int'iəriə]
ultimately ['ʌltimitli]
eliminate [i'limineit]
in conjunction with [in kə'dʒʌŋkʃən wið]
image-guided therapy ['imidʒ 'gaidəd'θerəpi]
variety [vəˊraiəti]
resume [ri'zju:m]

2. Try to guess the meanings of words in bold type. Study the use of these words.

collaboration *n.* the act of working together with another person or group to achieve something, especially in science or art

Many of the developments in interoperation imaging and 3-D visualization have come out of Boston – specifically, out of a collaboration between Brigham and Women's Hospital and Massachusetts Institute of Technology in neighboring Cambridge.

swelling *n.* an area of your body that has become larger than normal, because of illness or injury

shrinking *n.* an area of your body that has become smaller in amount, size or value

Changes in blood pressure during brain surgery often lead to swelling or shrinking of the brain.

interior *n.* the inner part or inside of something

Since the early 1990s, advances in technologies have provided surgeons with increasingly useful information about the brain's interior.

avoid *v.* 1) do something to prevent something bad from happening, 2) deliberately stay away from someone or something, 3) deliberately not to do something, especially because it is dangerous, unpleasant

Now surgeons can even get information to help them avoid brain areas associated with speech and motor function.

ultimately *adj.* finally; in the end

And ultimately these technologies may help to eliminate any remaining dependence on the human eye.

in conjunction with working, happening or being used with someone or something else

One of the first and perhaps most significant of these technologies was the MRI scanner, which researchers designed in conjunction with engineers from 9E Medical System.

resemble *v.* look like, or be similar to, someone or something

MRI scans can reveal the exact location of a tumor, even when it is hidden by healthy tissue or itself resembles healthy tissue.

resume *v.* start doing something again after a pause or interruption

He added that intraoperative scans have led surgeons to resume tumor resection "countless times."

3. Give the Russian for the following:

healthy tissue, blood pressure, swelling and shrinking of the brain, 3-D, advances in technologies, real-time, gain information, collaboration, in conjunction with, a large vertical gap, resection.

4. Give derivatives of the following words:

depend, operate, direct, provide, relate.

IMAGING ADVANCES IMPROVE NEUROSURGERY(part I)

Imaging is changing the way physicists think about and perform neurosurgery. As recently as 10 years ago, the outcome of procedures such as tumor excision depended largely on what the human eye could see. Preoperative images provided some guidance, but physicians had to rely on what was visible as the surgery progressed. If a tumor was partially hidden behind healthy tissue, for example, they run the risk of leaving some of it behind. Also, changes in blood pressure dur-

ing brain surgery often lead to swelling or shrinking of the brain, compromising the usefulness of preoperative images.

Fig. 6. In 1993, working in collaboration with GE Medical System, a team of researchers at Brigham and Women's Hospital and at MIT introduced an intraoperative MR scanner designed to allow access to patients while they are inside the magnet. Because the scanner offers real-time images of a patient's anatomy, it can help account for shifts in the brain's positron during neurosurgery.

Much of this has changed with the emergence of intraoperative imaging and three-dimensional visualization. Since the early 1990s, advances in technologies such as MRI and image processing and display have provided surgeons with increasingly useful information about the brain's interior. The first advance allowed real-time updates of a tumor's position, and now surgeons can even gain information to help them avoid brain areas associated with speech and motor function.

Researchers are working to advance minimally invasive therapy by developing high-technology operating suites in which pre- and intraoperative images are integrated with instrument tracking systems, 3-D visualization and robotics. By coregistering the various technologies and summating many of the procedures, they will further improve accuracy in neurosurgery and, ultimately, may help to eliminate any remaining dependence on the human eye.

Many of the developments in intraoperative imaging and 3-D visualization have come out of Boston — specifically, out of a collaboration between Brigham and Women's Hospital and Massachusetts Institute of Technology in neighboring Cambridge. One of the first, and perhaps most significant of these was the Signa SP intraoperative MRI scanner, which researchers designed in conjunction with engineers from GE Medical Systems. This 0.5-T whole-body scanner has a large vertical gap in the middle to provide surgical access to the patient while he or she is inside the magnet. Previously, MR imaging during surgery wasn't possible without moving the patient out of the operating room, which can be especially dangerous when the skull is already open.

The researchers introduced the intraoperative scanner in 1993 to address the limitations of the human eye during surgery, said Ferenz Jolesz, director of the MRI division and the image guided therapy program at Brigham and Women's Hospital, who came up with the idea for the scanner in the late 1980s. MRI scans

can reveal the exact location of a tumor, even when it is hidden by healthy tissue or itself resembles healthy tissue. Through real-time updates, the scanner can portray deformations caused by the swelling or shrinking that often follows craniotomy.

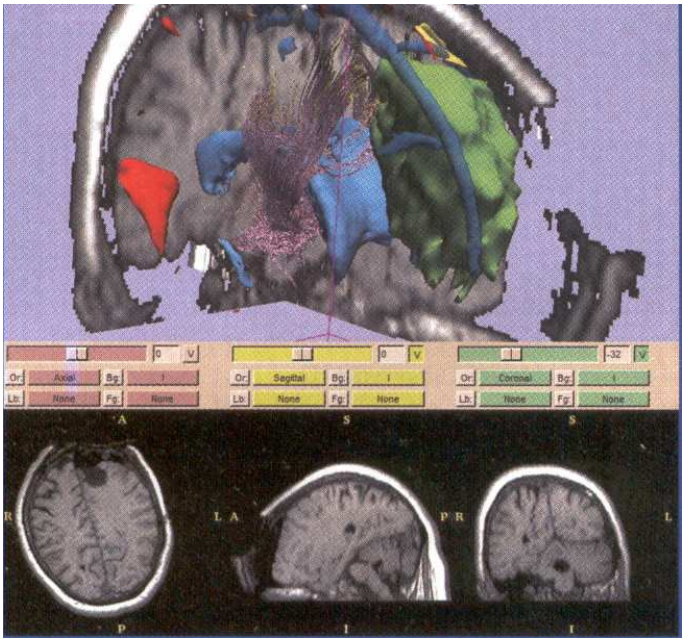


Fig. 7. Researchers have developed 3-D visualization systems that employ information obtained with other modalities and with instrument tracking systems to augment the real-time information offered by interventional MR scanners. For example, the 3D Slicer incorporates preoperative information from functional MRI and diffusion tensor imaging. Mathematical models ensure that the preoperative images adjust to changes tn the brain's position during neurosurgery.

This scanner, along with a handful of others developed more recently, has contributed to a variety of procedures over the past 10 years, including a number of applications in neurosurgery. For example, because it provides real-time, cross-sectional scans, and thus allows surgeons to update maps of the anatomy during surgery, intraoperative MRI has aided doctors in tumor biopsy and resection. With these applications, noted Ligil Samset, a researcher with the Interventional Centre at the National Hospital of Norway, which installed a Signa SP in 1996, "it increases accuracy and eliminates problems related to brain shift." He added that intraoperative scans have led surgeons to resume tumor resection "countless times," even after they had judged the tumor to be completely resected based on its appearance in microscope.

In addition, intraoperative scanners have assisted physicians around the world in performing tumor ablations via laser cooling or heating delivered through a fiber optic needle. Imaging during these procedures is essential because cooling or heating beyond the boundaries of the tumor might damage normal tissue, but cooling or heating too little can leave some of the tumor behind. Because MR images thermal changes inside the body as well as anatomic structures, intraoperative scanners are uniquely qualified to monitor thermal and cryoablations.

***Notes*:**

cranium ['kreinjəm] – pl. – nia – череп
craniotomy – трепанация черепа
ablation – удаление, ампутация

Active words and word-combinations to be remembered

collaborate	сотрудничать
avoid	избегать
ultimately	в конечном счете, в конце концов
in conjunction with	совместно с…, в сочетании с…
to resemble	напоминать
swell	набухать, опухать
shrink	сжиматься
eliminate	устранять, исключать
resume	а) получать, брать обратно, б) возобновлять, продолжать
tumor resection	удаление опухоли
a handful of	горсть, пригоршня
portray	описывать, изображать, представлять

Exercises

1. State the part of speech of the following words pointing out the word-building elements. Give their Russian equivalents:

excise — excision
visible — invisible — visibility — visibly
part — partial — partially — partibility — partible
shrink — shrinkable — shrinkage
health— healthful— healthy — healthfulness — healthless — unhealthy

2. Arrange the words given in A and B in pairs of synonyms

A	swift	B	discriminate
	distinguish		rapid
	decide		purpose
	aim		conclude
	recognize		accurate
	exact		acknowledge

3. Arrange the words given in A and B in pairs of antonyms

A	swift	B	generalize
	distinguish		contradict
	agree		slow
	emit		absorb
	gain		shrinking
	peculiar		lose
	exact		common
	complete		rough
	swelling		partial

4. Combine the words in bold type with those in brackets. Translate these combinations into Russian.

precise (measurements, meaning, definition, knowledge)
essential (task, difference, condition, results, role)
relevant (problems, detail, facts, information)
reliable (information, source of information, device, measurements)

5. Translate the sentences paying attention to different functions of "that".

- Insects do not have lungs, but some types breathe with air exchange rates similar to those in humans.
- The research revealed that some insects compress and expand tracheal tubes in the head and thorax, causing a 50 percent volume exchange, which is similar to that in humans during moderate exercise.
- But that distinction isn't necessarily permanent.
- The problem is that the intensity of the evanescent beam falls off so rapidly that only 1 Mm away from the interface, it is more than a thousand times less.
- Because the Rab proteins in the vesicles and those that remained on the Golgi apparatus both fluoresced, it was difficult to separate signals coming from the vesicles from those coming from the Golgi apparatus.
- Three-dimensional paths and statistics of vesicles moving along those paths can then be extracted.
- That he declined to take part in this conference surprised everybody.
- This situation differs from that for ordinary particles.
- That we use countless machines today needs no proof.
- A tachyon that was losing energy by interacting with matter would speed up.

- It was in the field of radiowaves and electronics that the development ran parallel with that of industry.
- Thus the ideal emitting surface e = 1 would also be an ideal absorbing surface. That is, all the radiation incident on the ideal absorbing surface would be absorbed and none would be reflected.

6. Read the text and state the main ideas in 5-6 sentences either in English or in Russian:

Despite the many advances afforded by these scanners, researchers and physicians have not been content with the two-dimensional MR images that they produce, as these are difficult to read unless one is trained to do so. Thus, researchers have developed visualization systems that employ data acquired with other modalities, instrument and probe localization and 3-D rendering techniques to enhance the real-time information provided by the interventional MR scanner.

In Boston, the Surgical Planning Lab is to develop the 3D Slicer, a software package that integrates a variety of approaches to image-guided medicine to create a virtual environment to assist the neurosurgeon.(The Slicer is available to download from the Surgical Planning Lab's Web site.)

On its own, the software package facilitates automatic registration of data obtained with multiple modalities, semiautomatic segmentation of structures such as vessels and tumors, and generation of 3-D models of the patient's head. When integrated with the interventional MR scanner at the hospital, it allows the surgeon to update these models throughout the procedure, thus accounting for shifts in the position of the brain.

The Slicer begins with a preoperative MR scan obtained with a standard (noninterventional) 3-T magnet, which offers much higher resolution than the 0.5-T magnet used for intraoperative imaging. It uses the 2-D images from this scan to reconstruct a 3-D model of the patient's head that also incorporates information obtained with other modalities that are useful for surgical navigation purposes: Diffusion tensor imaging shows how nerve bundles travel through the brain, while functional MRI reveals the areas of the brain that are involved in speech and motor tasks.

7. Ask questions to which the following statements might be the answer.

- Preoperative images provided some guidance.
- Physicians had to rely on what was visible as the surgery progressed.
- Changes in blood pressure during brain surgery often lead to swelling or shrinking of brain.
- This scanner has contributed to a variety of procedures over the past 10 years.

- Intraoperative scanners have assisted physicians around the world in performing tumor ablations via laser cooling or heating.
- A soft package integrates a variety of approaches to image-guided medicine to create a vertical environment to assist the neurosurgeon.

8. Complete the following statements:

- Brain surgeons have relied largely on …
- New approaches are making surgery…
- Changes in blood pressure during brain surgery often lead to…
- Advances in technologies have provided surgeons with useful information about …
- Now surgeons can gain information to help them avoid brain areas associated with …
- The various technologies may help to eliminate any remaining dependence on …
- The scanner can portray deformations caused by …

9. Give answers to the following questions:

What are new approaches in brain surgery making?
What has changed with the emergence of intraoperative imaging and 3-D visualization?
Which deformation can the scanner portray?
Is it possible now for surgeons to resume tumor resection “countless times”?
What helps physicians in performing tumor ablations?

10. Reproduce the text “Imaging Advances Improve Neurosurgery”

11. Write an annotation on this text.

Topics for discussion:

Preoperative images.
New approaches in brain surgery.
3 – D visualization systems.

LESSON FIVE

IMAGING ADVANCES IMPROVE NEUROSURGERY (part II)

Pre-text exercises

1. Read the following for pronunciation

deficit [ˊdefisit]
cortex [ˈkɔ:təkʂ]
eloquent [ˈeləkwænt]
unique [juˈni:k]
incision [inˈsiʒ(ə)n]
suites [swi:ts]
angiography [ændʒiˈɔgrəfi]
excision [ekˈsiʒən]
automatic [ɔ:təˈmætik]
guidance [ˈgaidəns]
catheter [ˊkæθitə]
radiologist [reidiˈɔlɔdʒist]
exquisite [ˈekskwizit]
dynamic [daiˈnæmik]

2. Try to guess the meanings of words in bold type. Study the use of these words.

spare *v.* prevent someone from having to experience something difficult or unpleasant

The surgeon needs to make treatment decisions that spare the cortex and the supporting tissue.

unique *adj.* being the only one of its kind

Each person's brain layout is unique.

goal *n.* something that you hope to achieve in the future; aim

The goal (aim) is to provide as much information as possible.

track *v.* move a film or TV camera away from or towards a scene in order to follow the action that you are recording

To track changes in the brains position during surgery the researchers at Brigham devised a way to adapt this information to the 0.5-T scan.

provide *v.* produce a useful result, opportunity etc.

The intraoperative data can provide extra information to guide the surgical decision making.

precise *adj.* used to emphasize that something happens exactly in a particular way or that you are describing something correctly and exactly

By knowing the precise coordinates of a patient's anatomy in magnetic space robots are increasingly helping to make up for the limitations of the hand.

verify *v.* state that something is true

The robot allows the doctor not only to point and click where he wants it to go, but also to verify in real time that it's going there.

shortage *n.* a situation in which there is not enough of something that people need

There is a shortage of experienced doctors that do needle-based biopsies and ablations.

3. Give the English for the following:

беречь, щадить, лечебные рекомендации, облегчать, помогать, способствовать, речь, опухоль, доступ, хирург, мозг, уникальный, следить, точность, нехватка, кровеносные сосуды, представлять информацию, замещать, говорить на том же языке.

4. Give the Russian for the following:

damage to the functional areas, to take care to avoid something, to make treatment decisions, to spare the cortex, boundary, to preserve the significant areas, to track changes, to maintain the high resolution, to devise a way , to guide the surgical decision making, to develop high-tech operating suites, to perform these procedures, to navigate a catheter through a vast array of blood vessels

IMAGING ADVANCES IMPROVE NEUROSURGERY (part II)

Even as interventional MRI takes hold in the operating room, though, researchers are working to develop high-tech operating suites to advance in minimally invasive therapy — ultimately enabling physicians to perform such procedures with much more precision. In the imaging sciences program at the National Institutes of Health Clinical Center in Bethesda researchers and physicians have already introduced " the operating room of the future," in which several imaging

modalities, a magnetic instrument tracking system, 3-D visualization and robotics are merged, their Cartesian coordinates commingled, either mechanically, in magnetic space, or with mutual information-based software.

Here, physicians can co-register x-ray and rotational angiography with computed tomography, MR and ultrasound for a host of minimally invasive procedures. Rotational angiography provides 3-D images of iodine dyes injected into the catheters through which these procedures are performed, but without anatomic guidance.

"Imagine trying to navigate a catheter through a vast array of blood vessels without knowing where you're going specifically," said Brad Wood, an interventional radiologist in the imaging sciences program. The group has added the tool of displaying a previously acquired CT scan of the area in question while navigating through that vessel. "You're getting exquisite anatomic detail," he said. One can also fuse images obtained preoperatively with other modalities, such as positron emission tomography scans, and dynamic or functional MRI, which provide information about metabolism and function, for example.

Of the recent advances in image-guided surgery, the use of robots is perhaps the most promising — that is, the most likely to lead to improved accuracy in neurosurgery. "I used to say that surgery is based hand-eye coordination," Jolesz said. "Now I realize that both have limitations and should be replaced with advanced technology." By opening up the inner reaches of the anatomy, imaging has gone some way toward addressing the limitations of the eye. By knowing the precise coordinates of a patient's anatomy in magnetic space, for example, robots are increasingly helping to make up for the limitations of the hand.

In the image guided procedure room in Bethesda, a robot is attached to a stereotactic frame used in many imaging modalities and is registered with the Cartesian coordinates of the CT scanner. "It speaks the same language, knows the same software platform," Wood said. Thus, it can assist in precise "point and click" positioning and repositioning of needles. To be sure, in a 2003 study of needle placement accuracy, it scored much higher than any of the physicians in the National Institutes center.

The National Institutes group plans to begin using a robot clinically early this year. Ultimately, doctors will be able to click on a tumor in a CT scan displayed on a computer screen, and the robot will determine the ideal angle and depth of entry and then insert the needle. "The doctor can sit at a console and drive the needle," Wood said. "The robot allows him not only to point and click where he wants it to go, but also to verify in real time that it's going there."

Many of the research efforts in image guided minimally invasive therapy are geared toward widespread implementation of such therapy. In Europe, members of Aris*Ing, a fledgling consortium devoted to the advancement of minimally invasive therapy through intraoperative imaging and augmented reality visualization, are focused on how to make imaging technologies available to those who do have the training and experience to operate them. To this end, said Samset, who coordinates the consortium's activities, they plan to develop 3-D visualization tools that work across modalities so that physicians will need only to interact with user-

friendly software packages that incorporate data sets from each of the modalities. Similarly, they hope to encode knowledge about a variety of procedures from experts in the field. Physicians will be able to access that knowledge through embedded help functions. In some cases, the software will even be able to stop the physician if he is about to do something wrong.

Wood agrees that facilitating translation of the technology to the community should be one of the primary objectives of such efforts. “There’s a shortage of experienced doctors that do needle-based biopsies and ablations,” he said. “This is a way to have more people do more procedures like this better. This is part of our public health mission.”

***Notes*:**

cortex (лат.) (pl. cortices) – кора головного мозга
incision location – место разреза
excision boundaries – границы удаления чего-либо
to maintain the high resolution – поддерживать высокую разрешающую способность
to determine the ideal angle and depth of entry – определить нужный угол и глубину проникновения

Active words and word-combination to be remembered

to result in *v.*	кончаться, иметь результат
to access *v.*	проходить
unique *a.*	уникальный
guidance *n.*	руководство
to spare *v.*	щадить, беречь
to track *v.*	прослеживать
to verify *v.*	проверять, подтверждать
shortage *n.*	нехватка, недостаток
to facilitate *v.*	облегчать, способствовать
to provide *v.*	обеспечить
to preserve *v*	охранять
to inject *v.*	вводить
main *a.*	главный
set-up *n.*	система, структура
to make a decision	прийти к решению
to devise a way	изобрести способ
to be injected into something	быть введенным куда-либо
the area in question	область, о которой идет речь
to be replaced with something	быть замененным на что-либо

Exercises

1. Arrange the words given in A and B in pairs of antonyms

A	software	B	outer
	damage		improve
	vast		usual
	inquire		hardware
	unique		width
	soft		small
	depth		rigid
	before		answer
	inner		after

2. Arrange the words given in A and B in pairs of synonyms

A	replace	B	accurate
	precise		certain
	sure		substitute
	damage		injury
	vast		extensive
	attach		fasten
	evolve		develop

3. Combine the words in bold type with those in brackets. Translate the combinations into Russian

perform (an experiment, test, procedure, analysis)
shortage of (experienced doctors, qualified workers, food, good, weapons, soldiers)
angle (acute, right, obtuse, ideal)
develop (business, memory, mind, mineral resources, an organization, an attack, tools)
mission (peace, goodwill, public health)
boundary (natural, artificial, land, excision)
provide (meals, military aid, an opportunity, information, conditions)

4. Say it in English:

- Опухоль находится поблизости от этой области.
- Хирургу необходим доступ к опухоли.
- Во время операции необходимо оберегать кору головного мозга.

- Чтобы проследить за изменениями во время хирургического вмешательства, ученые разработали для этого специальную методику.
- Робот будет определять идеальный угол и глубину проникновения иглы.
- Сейчас наблюдается нехватка квалифицированных врачей в этом центре.

5. Translate the following sentences paying attention to Gerund.

- Understanding this process would be beneficial to future studies of exocytosis and to the improvement of artificial respiration technology.
- After trying various expensive instruments, Nakata decided to modify the geometry of his total internal reflection inverted microscope by adjusting the angle of incidence of the excitation beam.
- By analyzing the data with custom software, they identified several specific optimal wavelengths for detecting defects.
- Prior to its initial fission, the Drosophila embryo goes through stages of clearing and clouding caused by the distribution of lipid droplets throughout the cytoplasm.
- It also can be used as a quick method to classify developmental mutants in the Drosophila embryo by generating intensity profiles.
- Besides providing insight into motor protein behavior, the method is proving useful for tracking other cellular behavior.
- They also are planning to develop simulations of motor protein activity that can be linked to the clearing and clouding behavior of lipid droplets in the embryo.
- The global measurements are critical for verifying the validity of the simulation and for confirming their understanding of transport mechanisms.
- Stippling involves executing a series of small dots to compose an image.

6. Translate into English using the active vocabulary.

- Теория динамических систем без дифференциальных уравнений может представить основные особенности поведения исследуемой системы
- Высокое качество лучевого лечения с применением современных технологий возможно только при наличии современного радиотерапевтического комплекса.
- Полученные данные позволяют подтвердить мнение о негативном влиянии геомагнитных возмущений на пациентов с таким заболеванием.
- Формирование изображения является наиболее важным технологическим этапом измерительного процесса.

- Они разработали методику распознавания влияния магнитных возмущений.
- Нехватка квалифицированных специалистов одна из важнейших проблем в этой области.
- Некоторые способы получения диагностических изображений постепенно заменяются радионуклеидной диагностикой.
- В этом случае кроме процесса, который рассматривается, можно определить и его временные параметры, также имеющие диагностическое значение.
- Трудно наблюдать за всеми этими процессами одновременно.

7. Say whether the following statements are true, if they are not, correct them.

- Setting up a mathematical framework can't provide extra information to guide the surgical decision making yet.
- Incision locations and excision boundaries can preserve the significant areas where possible.
- Researchers have already introduced "the operating room of the future."
- With such equipment physicians can't co-register x-ray and rotational angiography with computed tomography for invasive procedures.
- Rotational angiography provides only 2-D images.
- There are a lot of experienced doctors that do needle-based biopsies and ablations.
- In any cases, the software will even be able to stop the physician if he is about to do something wrong.
- They hope to encode knowledge about a variety of procedures from experts in the field.

8. Read the text and state the main ideas in 5-6 sentences in English *(ж. «Мед. Физика» №3 2004, стр 86)*

9. Answer the following questions:

What way did the researchers devise to track changes in the brain's position during surgery?

What can you tell us about "the operating room of the future"?

What can physicians co-register x-ray and rotational angiography with?

What is new on robotic surgery?

How does a robot operate?

When and how does the National Institutes group plan to begin using a robot clinically?

Why should facilitating translation of the technology to community be one of the primary objectives?

10. Complete the following statements:

- The surgeon needs to make…
- Each person's brain layout is…
- The goal is to provide as much…as possible.
- Setting up a mathematical framework can provide extra…
- According to Mr. Joleser surgery is based on…
- A robot is attached to a stereotactic…
- The doctor can sit at a console and drive a…
- They hope to encode knowledge about a variety of procedures from…
- In some cases, the software will even be able to stop the physician if he is about to do something…

11. Look through the main text and reproduce it.

12. Write a summary of the text.

Topics for discussion:

Combining Modalities
Robotic Surgery

LESSON SIX

DIGITAL DETECTORS HEAD OUT OF THE LAB AND INTO THE CLINIC

Pre-text exercises

1. Read the following for pronunciation

colleague [ˊkɔlig]
initial [iˈniʃəl]
vigorous [ˈvigərəs]
promise [ˈprɔmis]
processing[ˈprousesiŋ]
archive [ˈa:kaiv]
retrieve [riˈtri:v]
alleviate [əˈli:vieit]
quality [ˊkwɔliti]

2. Try to guess the meanings of words in bold type. Study the use of these words.

vigorous *adj.* strongly and very healthy

It is surprising that 100 years after the discovery of the x-rays, the area is still vigorously developing.

handling *n.* 1) the way in which a problem or person is treated or dealt with 2) the act of picking something up or touching or feeling it with your hands

For years advances in detector technology have promised greater image quality and made data handling easier.

promise *n.* 1) a statement that you will definitely do something or that something will definitely happen 2) sign that something or someone will be good or successful

That promise is now moving out of the laboratory and into the clinic.

reduce *v.* make something smaller or less in size, amount or price

This metal grid is used to reduce scattered x-rays.

lower *v.* make smaller

Digital radiography has the potential to lower these costs dramatically by saving on image storage, archiving and retrieval.

alleviate *v.* make something less painful or difficult

Some clinics are moving toward digital picture achieving and retrieval systems to alleviate the problems associated with manual filing.

implement *v.* take action or make changes that you have officially decided should happen

It is impossible to implement PACS without moving to digital radiography.

acquire *v.* 1) buy or obtain something, especially something expensive or difficult to get, 2) to learn or develop knowledge, skills by your own efforts

It does not make sense for hospitals to acquire digital images if they don't have an easy way to store and transmit them.

capture *v.* 1) get control of a place that previously belonged to an enemy by fighting for it, 2) to succeed in showing or describing a situation or feeling using words or pictures

One traditional measure of image quality quantifies the ability of an x-rays exposure to capture both fine anatomical features and larger structures.

3. Give the English for the following:

захватывать, пленка, размер, осветить, мягкая ткань, собрать информацию, суммировать, улучшать работу, затраты, первоначальная стоимость

4. Give the Russian for the following:

grain size, an x-ray exposure, fine details, commercial digital detectors, advantage, quality, signal-to-noise ratio, to make sth visible, to discern, background noise, to manipulate the contrast and brightness

DIGITAL DETECTORS HEAD OUT OF THE LAB AND INTO THE CLINIC

In November 1895, Wilhelm Konrad Röntgen discovered a form of electromagnetic radiation immediately realizing their diagnostic value that he thought his colleagues would think he had investigated the properties of this radiation that he called x-rays. In fact, 1896 saw more than 1000 papers published on the subject.

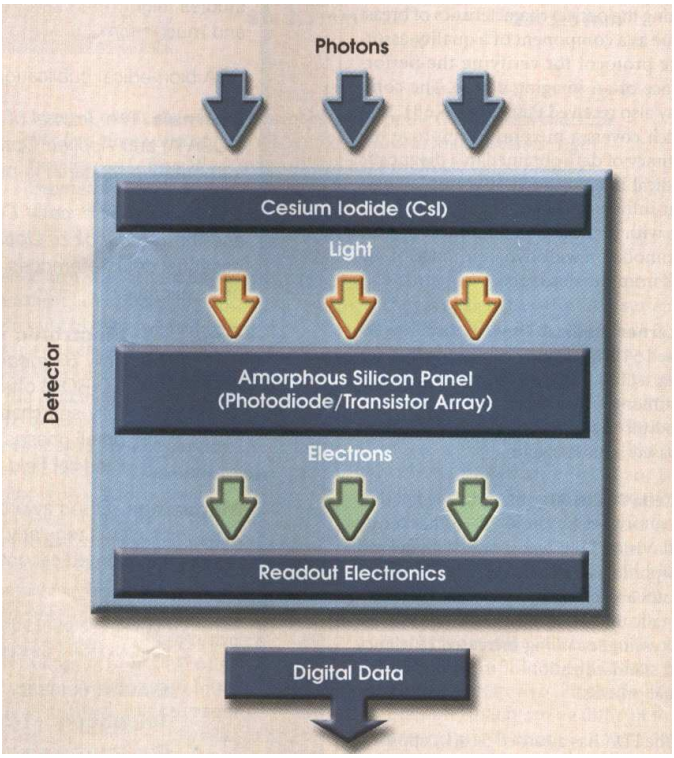


Fig. 8. Amorphous silicon flat panel detectors first convert incident x-rays to visible light with a cesium-iodide scintillator. A silicon photodiode collects the visible photons and an electronic charge transfers them to a silicon thin-film transistor for readout by low-noise electronics.

Given the rapid pace of the initial discoveries surrounding x-rays, in a 1996 essay commemorating the anniversary of Röntgen's discovery Gottfried Landwehr wrote, "It is surprising that 100 years after the discovery of x-rays, the area is still vigorously developing. This is mainly caused by the development of new and very powerful x-ray sources and by improved x-ray detection methods."

For years, advances in detector technology have promised greater image quality and made data handling easier. That promise is now moving out of the laboratory and into the clinic. According to the US Department of Energy, more than 300,000 x-ray units, including specialty instruments such as dental x-ray equipment, are in use in the US. Most use a Bucky, which is a metal grid used to reduce scattered x-rays, with a scintillator to convert x-rays to visible photons and a cassette containing a 17 × 14-in, sheet of film. An x-ray instrument typically has two or three grids to image the patient in different orientations.

The traditional x-ray detector is cheap, but processing is expensive. A calculator program found on the Web site of GE Healthcare of Waukesha, Wis., estimates that the Facility, materials and labor for film processing using a chest x-ray machine would add up to an annual cost of about $50,000. Digital radiography has the potential to lower these costs dramatically by saving on image storage, archiving and retrieval. Radiology departments using film x-rays must maintain physical files for images and must have personnel for handing the retrieval, processing and distribution of the developed films. However, some clinics are moving toward digital picture archiving and retrieval systems (PACS) to alleviate the problems as-

sociated with manual filing. But with radiographic exams accounting for two-thirds of all diagnostic images, it is impossible to implement PACS without moving to digital radiography.

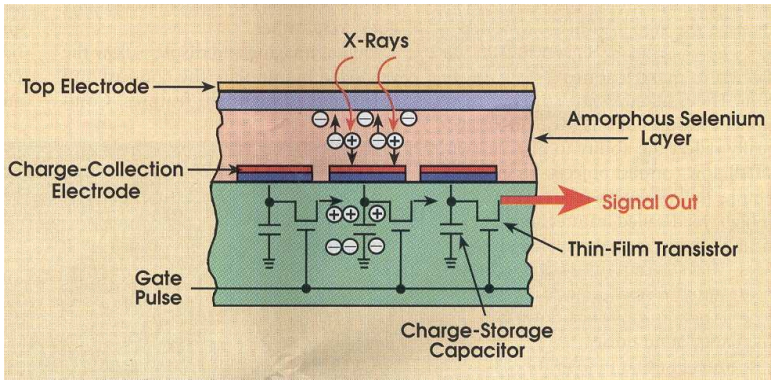


Fig. 9. One type of detector uses a layer of amorphous selenium over an amorphous thin-film transistor readout, which allows x-rays to be directly converted to a digital signal.

Antonio Garcia has just completed a report titled "World Digital Radiography Markets," which claims that digital radiography machines, instruments that use CCDs or flat panel detectors to produce digital x-rays, make up about 1 percent of the installed base in the US. That number is expected to double by the end of 2004, but, Garcia noted, "most of the digital radiography machines will be in place in the top three or four hundred flagship medical centers, while smaller hospitals will continue to use traditional screen-film units."

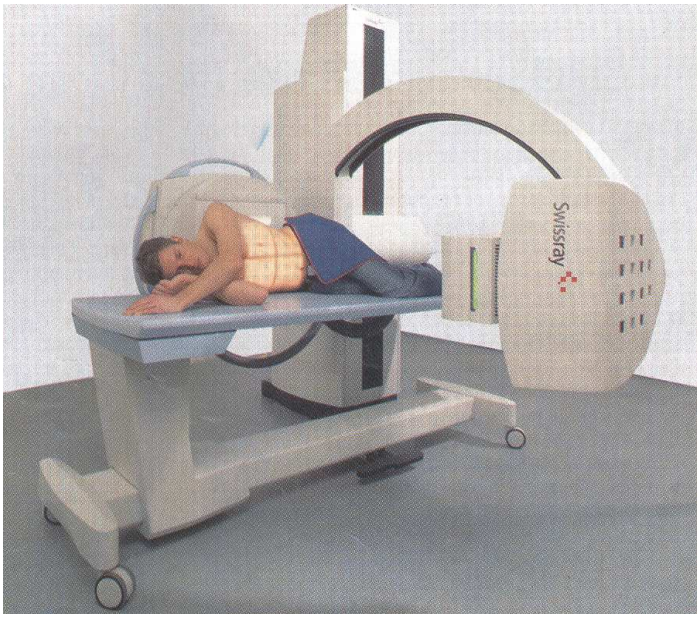


Fig. 10. A cesium-iodide scintillator, 10x reducing optics and Kodak CCDs with overlapping field provide another method for detecting x-rays. To take advantage of the speed of the detector, the system may be automatically and rapidly configured for different x-ray exposures.

Smaller hospitals with fewer than 500 beds or so, are not as likely to be implementing PACS, and, he said, it doesn't make sense for hospitals to acquire digital images if they don't have an easy way to store and transmit them. Garcia has found that radiologists tend to be comfortable with soft-copy reading from display terminals, "but the referring physicians still want the hard copy to review," which doesn't help with cost savings.

***Notes*:**
diagnosis [daiəg'nousis] (pl. diagnoses) – диагноз
to make out a diagnosis – поставить диагноз

Active words and word-combinations to be remembered

vigorous *a.*	сильный
handling *n.*	разделывание, обращение
promise *n., v.*	обещание, перспектива; уверять
reduce *v.*	снижать
lower *v.*	снижать
alleviate *v.*	облегчать
implement *v.*	обеспечивать выполнение
acquire *v.*	приобретать, достигать
capture *v.*	захватить
initial *a.*	начальный
processing *n.*	отработка
retrieve *v.*	реабилитировать, восстанавливать
quality *n.*	качество
to make something visible	делать видимым
to manipulate the contrast and brightness	влиять на контраст и яркость
to image something in different orientations	отображать что-либо с различных углов зрения

Exercises

1. State the part of speech of the following words pointing out the word-building elements. Give their Russian equivalents:

drama — dramatic — dramatically — dramatics
process — processing —procession — processional — processionist
discover — discoverer — discovery
main — mainly

convert —converter — convertibility — convertible
exceed — exceedingly — excess — excessive
equip— equipment

2. Arrange the words given in A and B in pairs of synonyms

A	rapid	B	first
	initial		energetic
	vigorous		to name
	movement		possible
	to call		to restrict
	to explore		fast
	probable		motion
	pattern		to examine
	to limit		example
	to emerge		to appear

3. Arrange the words given in A and B in pairs of antonyms

A	broad	B	to vanish
	to emerge		unusual
	conventional		frequent
	rare		disadvantage
	advantage		narrow
	to freeze		to disobey
	to obey		real
	false		to melt

4. Combine the words in bold type with those in brackets. Translate the combinations into Russian

various (things, people, kinds, examples, equipment, devices, reasons)
to practise (jumping, running, swimming, making experiments)
exact (time, description, answer, measurement, arrangement, sum, address)
plenty of (time, equipment, money, food, air, paper)
treatment (cruel, medical, thermal, new)
beyond (one's help, hope, one's understanding)
to handle (documents, device, information, a problem, the affair)
restricted (application, publication, diet, data)
to exclude (a mistake, new war, causes of war, all possibility of doubt)
to alleviate (pain, sorrows, sufferings, one's quilt)

5. Translate into Russian paying attention to the Nominative with the Infinitive.

- That number is expected to double by the end of 2004.
- Smaller hospitals with fewer than 500 beds or so are unlikely to possess such equipment.
- Neither resolution nor the signal-to-noise ratio by itself turns out to be a good measure of detectability.
- Nature appeared to be quite symmetrical after all.
- Such nuclei seem to fall rather neatly into two categories.
- This situation does not seem to have any physical meaning.
- Radium is known to be very radioactive.
- This relation turned out to define the center of mass of the particles.
- The positively charged particles called ions, proved to have masses of atomic size.
- Heat was thought to be a material substance.
- This device is sure to help us.
- The data happened to be very interesting.
- Yellow is said to contain the greatest amount of white.

6. Read the text and state the main ideas in 5 – 6 sentences in English.

Of course, cost saving means little if the image isn't good enough for diagnosis. But digital radiography appears to excel here as well. One traditional measure of image quality quantifies the ability of an x-ray exposure to capture both fine anatomic feature and larger structures. The grain size for film, which is related to the resolution limit, can be less 500 nm, while digital detectors have pixels on the order of 100 μm. It would seem that film could image finer details than digital detectors, but most physiologically interesting features tend to be between 0.16 and 0.5 mm, well within the region of good resolution for all commercial digital detectors. The apparent advantage of film is reduced already, but there is a more important factor that tips the balance toward digital detectors.

Another traditional metric for image quality, the signal-to-noise ratio, measures how much x-ray energy must be delivered to make features visible on the film. The problem is that the two traditional measures of image quality do not really reflect the ability to discern small, low-contrast objects; for example, the resolution of x-ray film is high, yet detailed features are difficult to extract from the analog images. That's because the signal-to-noise ratio for small objects is very low — details get washed out by the background noise.

It turns out that neither the resolution nor the signal-to-noise ratio by itself is a good measure of detectability, but combining the two gives a measure of the observer's ability to detect objects. This new measurement is higher for digital detectors than for film, reflecting the ability to discern small features with digital imaging. But the advantage of digital radiography goes even further.

7. Read the text and state the main ideas in Russian:

Digital imaging and display allow the reader to manipulate the contrast and brightness to highlight features. Combined with the high dynamic range of digital detectors, this enables the investigation of soft tissue and dense bone in the same exposure. Because digital detectors can detect fine details with less background noise, the same information can be gathered with a lower patient dose. Digital images also make it easy to use automated feature detection.

Renaud Maloberti, manager of global radiography for GE Healthcare, a manufacturer of digital detector-based systems, summarized the advantages: "Digital radiography offers improved work flow, increased productivity, better image quality and reduced patient dose, and it opens the gateway to advanced applications."

With all these advantages, why haven't digital systems swept through and replaced all the film system? Price is one barrier. A digital system costs three to four times that of a film system. Proponents of digital technology argue that the operating expenses of digital instruments make for a significantly lower cost of ownership, but initial price is still a factor. The argument for lower cost of ownership gets even stronger when considering integration with PACS, possibilities for teleradiology and possible automated detection. So institutions carefully evaluating the total cost will find that digital systems compare favorably with screen-film systems.

8. Give answers to the following questions:

What does digital radiography offer?
What was discovered in November 1895?
Why is the area connected with the x-rays still vigorously developing?
What potential does digital radiography have?
What systems are many clinics moving toward? And Why?

9. Complete the following statements:

- In November 1895, Wilhelm Conrad Röntgen discovered …
- Soon Röntgen investigated …
- It is surprising that 100 years after the discovery of the x-rays, the area is still … developing.
- For years, advances in detector technology have promised greater image …
- Advances in detector technology have made data handling …
- An x –ray instrument typically has two or three grids to image the patient in …
- The traditional x-ray detector is cheap but processing is …

10. Correct the false statements:

- Digital radiography does not have any potential to lower the costs of data processing.
- Many clinics don't want to possess such systems to alleviate the problems associated with manual filing.
- Digital radiography can't offer better image quality.
- Interest to the development of new powerful x-ray sources is not connected with medicine.
- In 1896 only several papers were published on x-rays.
- An x-ray instrument usually has about five grids to image the patient.
- The traditional x-ray detectors are rather expensive.

11. Render the text in English

Диагностическое изображение (diagnostic image) – изображение, отражающее внешний вид или внутреннее строение исследуемого участка тела человека, на основании которого можно получить сведения о состоянии исследуемых органов или систем организма, необходимые для вынесения диагностического заключения об их состоянии. Диагностическое изображение часто получают при использовании электромагнитных излучений в разных частотных диапазонах, в том числе и в невидимых участках оптического спектра. Так же возможно получение диагностических изображений с использованием проникающих, либо свободно распространяющихся в органах или тканях организма физических полей и излучений, генерируемых(испускаемых) вне или внутри организма. Возможно получение диагностических изображений за счет регистрации какого-либо физического агента, возникающего в исследуемом объекте в результате внешнего воздействия. Регистрация первичной информации, необходимой для построения диагностического изображения, производится вне тела пациента или в его естественных полостях. При этом важно отметить, что в любом случае происходят физические изменения какого либо физического параметра, характеризующего органы и ткани, которые находятся в области измерений. Получаемая информация имеет чисто физический характер, для которого необходимо установить связь со свойствами самих органов и тканей, их строением и составом. Только в этом случае возможна медицинская интерпретация полученных данных.

12. Speak on the topic of the main text.

13. Write an annotation on this text.

LESSON SEVEN

DIGITAL DETECTORS HEAD OUT OF THE LAB AND INTO THE CLINIC (continued)

Pre-text exercises

1. Read the following for pronunciation:

artifact['a:tifækt̬]	perpendicular[ˌpə:pən'dikjulə]
incident ['insidənt]	efficiency [i'fiʃənsi]
	dual [djuəl]

2. Try to guess the meanings of words in bold type. Study the use of these words:

feature *n.* a part of something that you notice because it seems important, interesting or typical

Radiologists must be certain that any feature detected in this new format is truly an indication of trauma or disease.

artifact *n.* an object such as a tool, weapon, that was made in the past and is historically important; false image

They must be sure that any feature detected in this new format is not an artifact of processing, lighting or magnification.

facility *n.* a special part of a piece of equipment or a system which makes it possible to do something

The capital costs of new instruments and facilities are such that the rate of adoption of digital radiography is the rate of replacement of existing instruments.

demagnify *v.* to make something much more smaller

A visible light image of a human torso can be demagnified with lenses.

under investigation the act of investigating something

X-rays must be collected, in an area at least as large as the anatomical area under investigation.

efficiency *n.* the quality of doing something well and effectively, without wasting time, money or energy

This detector has the best detective quantum efficiency of any existing digital detector.

3. Give the English for the following:

увеличивать, производить, быть уверенным, отличительная черта, цифровой, исследовательская лаборатория, установка, замена, источник, цифровые данные

4. Give the Russian for the following:

torso, nodule, facility, trauma, to focus, to demagnify, to involve, thickness, value, dual imaging, to fall into a trap, to offer higher resolution

5. Give derivatives of the following words:

discover, radiate, investigate, detect, calculate, visible

DIGITAL DETECTORS HEAD OUT OF THE LAB AND INTO THE CLINIC (continued)

Besides cost, radiologists must be certain that any feature detected in this new format is truly an indication of trauma or disease, and not an artifact of processing, lighting or magnification. They want proof that digital imaging is better, not just in a research lab or in esoteric calculations, but in real-world experiences, that real-world experience, gathered by early adopters of digital x-ray instrumentation, is building to the point where the consensus in the industry is, that the real digital revolution — in adoption of the new technology — is upon us today.

Thomas Umbel, senior vice president of marketing for Hologic Inc., a manufacturer of mammography instrumentation and a supplier of digital detectors to radiography OEMs, said, “Digital radiography holds the advantage over traditional radiography in every area except one — traditional radiography installations are already implemented. The capital costs of new instruments and facilities are such that the rate of adoption of digital radiography is the rate of replacement of existing instruments.”

Given that radiologists are ready to move to new technology, the logical question is: which digital technology should they adopt?

The physics of x-rays has driven the design of radiography instrumentation. It is nearly impossible to focus broad-spectrum x-rays. A visible light image of a human torso, for example, can be demagnified with lenses and imaged on 35-mm film. But because there are no efficient x-ray lenses, x-rays emitted from a point source and differentially absorbed by tissue must be collected in an area under investigation. A clinically useful and historically endorsed format is the 17 × 14 –in. general radiography x-ray standard.

Researchers at GE Healthcare realized that a new detector would need to meet or exceed film's image quality, provide manageable digital data and do it all in a thin, large format. They turned to amorphous silicon, with a cesium-iodide scintillator.

Digital detectors must convert incoming x-ray radiation to electrons, a technique that commonly involves an intermediate conversion to visible light. Cesium iodide activated with thallium converts incident x-rays to 565-nm light, which can then be detected with a silicon photodiode. X-ray absorption depends upon scintillator thickness, which can be optimized for specific applications. A thicker scintillator layer absorbs more x-rays but also tends to scatter light within the absorbing layer. To counteract the scattering, the cesium iodide is grown in needlelike structures perpendicular to the surface of the amorphous silicon photodiode array; light generated within a particular needle will be confined within that needle.

GE's detector is a 16-in.-square array of 200-µm-square photodiodes deposited on an amorphous silicon thin-film transistor. Maloberti said that the technology can be used for static applications, such as a chest x-ray, and for dynamic applications, such as cardiovascular imaging.

Although Maloberti stated that GE's detector has the best detective quantum efficiency of any existing digital detector, he noted that the true value goes beyond measurements of image quality. For example, the detector is designed to detect x-rays at the range of energies used in general radiography exams. It also is fast — capable of acquiring two images 100 ms apart. This allows it to perform dual energy imaging, for pixel-by-pixel comparison of absorption features at different x-ray energies. For an application such as lung cancer detection, the technique allows nodules typically hidden behind bone to be identified much more clearly. "This is something that can't be done with amorphous selenium detectors," he said.

Amorphous selenium has its own advantage, however. According to Umbel, it can be summed up in a single world: resolution. Hologic's general radiography detector is 17 × 14 –in. 139-µm-pixel array formed by a 1-mm-thick amorphous selenium layer deposited over an amorphous silicon thin-film transistor read-out. Amorphous selenium is a direct-detection material — a photoconductor that converts x-rays directly into electronic charge.

"There is electronic diffusion, as in any semiconductor," said Umbel, "but it's orders of magnitudes below the light scatter in a scintillator." Combine that with a proprietary method to funnel charge away from the nonconductive thin-film transistor pixel border and amorphous selenium has "a real advantage in image

quality," he added. "General radiography is not necessarily so demanding, but the advantage of selenium is really clear for mammography."

An additional advantage of the digital approach is the way it lends itself to being combined with other imaging modalities to give more information, Umber said. For example, anatomic information from an x-ray image can be combined with functional information from a PET scan to provide a more complete picture of the tissue of interest.

Both the cesium iodide/amorphous silicon and amorphous selenium methods have formats that mimic screen-film cassettes of traditional radiography. According to Rex Harmon, vice president of marketing at radiography instrument manufacturer Swissaray in Elizabeth, N. J., that's a mistake. "Some manufacturers fell into the trap of believing that, because a digital detector has to replace a cassette, it has to look like a cassette."

***Notes*:**

thallium [θælium] хим. – таллий
torso ['tɔ:sou] (pl. os [ouz]) – туловище

Active words and word-combinations to be remembered

magnify *v.*	увеличивать
nodule *n., мед.*	узелковое утолщение
facility *n.*	оборудование, приспособление
a point source *n.*	точечный источник
an approach *n.*	доступ
to hold the advantage over	иметь преимущество над…, использовать преимущество
the replacement of existing instruments	замена существующих инструментов
under investigation	исследуемый, изучаемый
order of magnitude	порядок величины
to fall into a trap	попасть в ловушку

Exercises

1. State the part of speech of the following words pointing out the word-building elements. Give their Russian equivalents:

install — installation

necessary — necessitate —necessarily — necessity
detect — detector — detection
value — valuable — evaluate
explore — explorer — exploration

2. Arrange the words given in A and B in pairs of synonyms

A	certain	B	illness
	disease		to estimate
	to value		besides
	different		to supply
	except		sure
	rate		plant
	installation		speed
	to provide		various

3. Arrange the words given in A and B in pairs of antonyms

A	to act	B	false
	true		to disconnect
	to connect		to disappear
	to appear		invisible
	externally		internally
	visible		to open
	to hide		behind
	in front of		to counteract
	to store		to disperse
	to magnify		to diminish

4. Combine the words in bold type with those in brackets. Translate the combinations into Russian

information (new, important, anatomical, functional)
to damage (a specimen, a control system, a house, the new equipment, somebody's reputation)
unique (ability in something, object, feature, solution for the problem, nature, TV system)
tissue (biological, living, organic, nerve, connective)
to collect (information, evidence, material on the problem, one's courage, thoughts, energy)
essential (feature, property, role, task, difference, condition, step)

reliable (evidence, source of information, device, measurements, firm)

5. Say it in English:

- Результаты этих опытов можно подтвердить этими теоремами.
- В 1895 г. Рентген открыл вид электромагнитной радиации.
- Они ищут доказательство, что цифровое изображение намного лучше.
- Этот детектор предназначен для обнаружения Х-лучей в диапазоне частот, используемых в радиографии.
- Данная информация может быть применена для получения более полной картины ткани, которая используется.
- Некоторые изготовители ошибаются, полагая, что цифровой детектор должен выглядеть как кассета.

6.Translate word combinations with the nouns used as attributes:

lung cancer detection –
image quality –
radiography instrument manufacturer –
image processing –
light transmission losses –
detector efficiency –
high – energy scattering –
field- theory models –
radio – wave propagation velocity –
high – frequency electromagnetic-wave trains –

7. Catch the meaning of the text and state the main ideas of it in Russian:

The introduction of the laser into medicine has made many surgeries less invasive and more accurate and has even led to procedures that couldn't be performed before. Laser requires a delivery system to transport the light to the surgical site. When laser surgery was first introduced, light delivery involved an articulated arm consisting of a set of tubes connected by joints and reflecting mirrors. Optical fiber designed for surgery has allowed the bulky articulated arm to be replaced with portable, easy-to-use probes that are more similar to surgical cutting tools.

Fiber has even allowed lasers to reach areas previously unreachable with traditional surgery via the working channel of an endoscope. But laser surgery poses a great many challenges for fiber optics that aren't present in other applications, such as telecom.

The fiber must first and foremost be save for both the surgeon and the patient, and it also must withstand sterilization, bending and the high laser power typically required for surgery. There are even more challenges for each specific operation.

8. Give questions to which the following might be the answer:

- The module, bigger than a flat panel, contains a scintillator and transfer optics.
- Digital radiography holds the advantage over traditional radiography in every area except one – traditional radiography installations are already implemented.
- I think, it is.
- A clinically useful and historically endorsed format is the 17×14 - in general radiography x-ray standard.
- This allows it to perform dual energy imaging.

9. Render in English:

Получение диагностических изображений производится в результате проведения физических измерений. Изображения формируются в соответствии с полученными данными о величине измеряемого физического параметра. Соответственно получение оптимальных по диагностическому значению изображений требует знания целого ряда физических и физико-химических свойств нормальных и патологически измененных тканей. В то же время, все изложенное выше подтверждает правомерность постановки сравнительных исследований возможностей разных методов получения диагностических изображений в распознавании патологических изменений различных органов и систем организма. Оптимизация самих методов получения такой информации, по всей вероятности кроется в исследованиях физических и физико-химических свойств органов и тканей.

10. Give answers to the following questions:

- What proof do radiologists want to get?
- What does digital radiography hold the advantage over?
- Does the rate of adoption of digital radiography mean the rate of replacement of existing instruments?
- With what help can a visible light image of a human torso be demagnified?
- What is an additional advantage of the digital approach?
- Why can anatomical information from an x-ray image be combined with functional one?

11. Complete the following statements:

Radiologists must be certain that any feature detected in this format is truly an indication of…
Radiologists are ready to move to…
It is nearly impossible to focus broad-spectrum…
A visible light image of a human torso can be demagnified with…
X-ray absorption depends upon scintillator…
Scintillator thickness can be optimized for…
True value goes beyond measurements of…
The detector is designed to detect…
The technique allows modules typically hidden behind…
Amorphous selenium has its own…
Anatomical information can be combined with…

12. Correct the false statements:

- General radiography is obligatory demanding.
- Combination of anatomical and functional information can't be used to provide a complete picture of the tissue.
- Some manufacturers are sure that digital detectors have to look like cassettes.
- They are sure they have the most efficient x-ray lenses.
- Traditional radiography installations have not yet implemented.
- Amorphous selenium can't be a direct-detection material.
- Photoconductors don't convert x-rays directly into electronic charge.
- GE's detector has the best detective quantum efficiency of any existing digital detector.

13. Review the main text.

14. Write an annotation on this text.

Topics for discussion:

The possibility of examining data from multiple imaging modalities.
Detector efficiency.

LESSON EIGHT

OCT DISTINGUISHES CANCER FROM PRECANCER

Pre-text exercises

1. Read the following for pronunciation:

distinguish [dis´tiŋgwiʃ]
sign [saiɲ]
optical coherence tomography (OCT) [kou'hirəns]
ophthalmology[ˌɔfθæl'molədʒi]
lesion ['li:ʒ(ə)n]

2. Try to guess the meanings of words in bold type. Study the use of these words:

distinguish *v.* be able to recognize and understand the difference between two similar things or people

The researchers are investigating the use of OCT to distinguish between pre-cancer and early-stage cancer.

sign *n.* an event, fact etc. that shows that something is true

There are often no signs of early bladder cancer.

rely on *v.* trust someone or something to do what you need or expect them to do

Doctors must rely on random biopsies.

diagnose *v.* find out what is wrong with someone or something especially what illness someone has, by examining them carefully

OCT may have moved a step closer to becoming a clinical instrument for diagnosing bladder cancer.

lesion *n.* 1) a wound, 2) a dangerous change in part of someone's body such as their lungs or brain, caused by injury or illness

There is a need to locate the lesion rather than take a random biopsy.

transmit *v.* 1) send or pass something from one person, place or thing to another, 2) send out electrical signals, messages by radio or other similar equipment

OCT can be performed with an endoscope by using its fiber optics to transmit and collect light.

3. Give the Russian for the following:

in the early stage, sign, OCT (optical coherence tomography), gastrointestinal tract; to distinguish, radiation sources, the primary source of scattering in cells

4. Give the English for the following:

полагаться на; болезни кожи; ультразвук; требовать; поверхность; инфракрасный свет; проникать на некоторую глубину в ткань; создать образ; передавать и собирать свет; взять биопсию

OCT DISTINGUISHES CANCER FROM PRECANCER

Bladder cancer — especially the type known as flat carcinoma — is difficult to detect in its early stages. As with most cancers, a biopsy is the gold standard for diagnosis and staging, there are often no outward signs of early bladder cancer, so doctors must rely on random biopsies of the lining of the bladder. As a result of research at State University of New York optical coherence tomography (OCT) may have moved a step closer to becoming a clinical instrument for diagnosing this type of cancer.

OCT instruments are being produced commercially for ophthalmology and have been used to diagnose diseases of the skin, blood vessels, gastrointestinal and respiratory tracts, and teeth. The researchers, led by Yingtian Pan at Stony Brook, are investigating the use of OCT to distinguish between precancer and early-stage cancer.

No existing technology, be it urine cytology, x-ray with intravenous contrast enhancement, magnetic resonance imaging or ultrasound, can provide the sensitivity and specificity required to detect and diagnose bladder cancer, Pan said. Current diagnostic techniques lack the vertical resolution to see below the surface of bladder wall. “Biomarkers may give some useful screening info,” Pan said, “but there is still a need to locate the lesions rather than take a random biopsy,” In these cases, OCT has a lot of potential for optically guided biopsy.

Essentially, OCT works like sonar with light. Infrared light, which penetrates a few millimeters into tissue, generates an image based on the way the light is scattered. OCT can be performed with an endoscope by using its fiber optics to transmit and collect light. Another advantage is that low-power lasers are much safer than other radiation sources, such as the standard x-ray.

The research, published in the Dec.2 issue of *Optics Express*, correlates the micromorphology shown in an OCT image with the actual tissue structures and has laid the groundwork for further analysis of the sensitivity and specificity of OCT in the bladder.

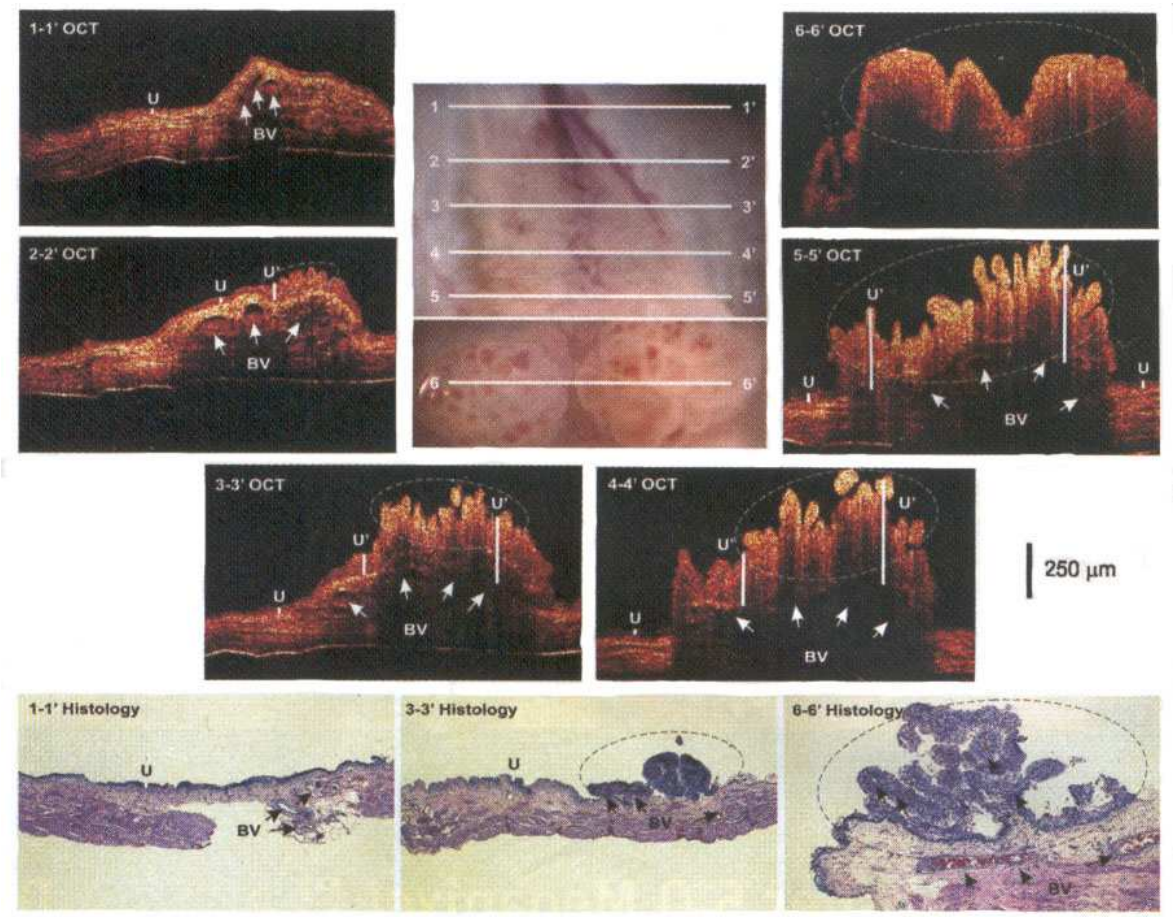


Fig. 11. Researchers have demonstrated that optical coherence tomography holds promise for detecting bladder cancer. The group's cancer model calculates backscattering based on the increase in cell nuclei density caused by cancer. This papillary carcinoma imaged at about 38 weeks after introducing a chemical carcinogen shows the difference between the edge of a large bladder tumor and the tumor itself. U: urothelium, U': abnormal urothelium; BV: blood vessel.

The group made extensive models of bladder lesions. They simulated the three stages of inflammation – edema, vasocongestion and inflammatory infiltration – by injecting water, blood and intralipid, respectively, into the lining of rat bladders. OCT detected different light-scattering and structural characteristics from the three stages. As inflammation becomes worse, the types of fluids that accumulate in an affected area of the bladder become more scatting, which obscures the view of deeper tissue structures in the bladder wall. To model the two stages of precancer (hyperplasia and dysplasia) and newly formed cancer (neoplasia), the researchers assumed that the nuclei are the primary source of scattering in cells. They created a mathematical model of the scattering and absorption based on changes in nuclei size and concentration process as seen in histological evaluation of tissue samples.

Typically, as an area becomes cancerous, the density of cell nuclei increases dramatically, which is the defining characteristic of neoplastic tissue. The model

indicated that the higher density would increase scattering. However, it indicated also that the changes in scattering might not be enough to allow the researchers to distinguish between hyperplasia and dysphasia. They compared scans of hyperplastic and neoplastic lesions with normal tissue. The hyperplastic lesion showed a 20 percent increase in scattering, and the neoplastic, 60 percent.

This work demonstrates the potential for confusing some types of inflammatory lesions with cancer. For instance, a lesion with severe swelling can look like hyperplasia. Likewise, a chronic inflammation with denuded urothelium (the lining of the bladder) or with some scarring and necrosis may look like early cancer. Improvements in theoretical modeling, creating a reference image of normal urothelium in the surrounding area or imaging the transition from a healthy area to a cancerous one may enhance the specificity of the technique.

The researchers plan to work on the theoretical models, to conduct animal and human studies, and to improve the illumination and detection systems. They must develop a grading system to count backscattering and its relation to the nucleated cell ratio for cancer detection. Pan said that he hopes to begin studies in humans to help develop this system. The group also has to implement a broader-band light source that will improve resolution, possibly by using a femtosecond laser that can resolve single cells and improve sensitivity.

He said that fluorescence in situ hybridization, usually combined with cystoscopy, can detect neoplastic cells or urothelial carcinomas in urine samples. However, pinpointing the location of the cancerous lesions depends on cystoscopy, which may have limited success with early flat carcinomas.

Photodynamic detection, relying on fluorescence from aminolevulinic acid (ALA), has demonstrated the potential to detect bladder cancers, including early urothelial carcinomas. Although fluorescence cystoscopy is quick, the technique requires that the ALA inserted into the bladder for a few hours before the procedure. The technique is sensitive and has good contrast, Pan explained, but it may suffer from problems caused by leaky but benign lesions that fluoresce. By combining it with OCT, his group could enhance the specificity and resolution for diagnosing early urothelial carcinomas.

He said that, although no clinical studies have been undertaken, the animal studies are encouraging because they can differentiate urothelial precancer from cancer, which no other method can do. Thick, invasive cancers would not image well, but surface cystoscopy can identify them. The system's value lies in early detection of flat bladder cancer.

***Notes*:**

gastrointestinal and respiratory tracts – желудочно-кишечные и дыхательные пути

ophthalmo [ˌɔfθælmou] - компонент сложных слов; в русском языке «офтальмо»

info – информация

carcinoma [ˌkɑ:siˈnoumə] – мед. раковое образование, карцинома
bladder – мочевой пузырь

Active words and word-combinations to be remembered

nucleus – nuclei *n.*	ядро – ядра
sign *v., n.*	отмечать, помечать; примета, признак, свидетельство
to rely on *v.*	полагаться на что-либо
blood vessels *n.*	кровеносные сосуды
to distinguish *v.*	разделять
to simulate something	мед. усиливать действие чего-либо
density *n.*	плотность
primary *a*	первичный
sample *n.*	образец
inflammation *n. –мед.*	воспаление
transition *n.*	переход, перемещение
to enhance the specificity	усилить специфичность
to undertake	предпринимать, брать на себя (определенное обязательство, функции и т.п.) гарантировать

E x e r c i s e s

1. State the part of speech of the following words pointing out the word-building elements. Give their Russian equivalents:

differ — different — indifferent — differentiate
solve — resolve —resolution
optic — optical — optically — optician — optics
radiance — radiant — radiate — radiator — radiation — radiative
extend — extensible — extensibility — extentially— extensional

2. Arrange the words given in A and B in pairs of synonyms

A	to offer	B	to furnish
	to provide		to invent
	to create		to permit
	to allow		opportunity
	occasion		to suggest
	to explain		to hide
	to expose		reason
	cause		to define

3. Arrange the words given in A and B in pairs of antonyms

A	to scatter	B	to doubt
	to switch on		to gather (collect)
	ineffective		to switch off
	to be sure		random
	difficult		valid
	low		easy
	constant		dark
	light		high

4. Combine the words in bold type with those in brackets. Translate the combinations into Russian.

characteristics (different, light-scattering, structural)
to require (clear statement, explanation, study, skill)
source of (information, knowledge, light, heat, energy)
approach (initial, special, theoretical, possible, scientific, primitive, simplified)
equipment (necessary, unique, suitable, technical, laboratory, test, modern, new, out-of-date)
loss (small, great, partial, serious, total)
advance (rapid, steady, recent, slow, industrial, remarkable)
proof (valid, satisfactory, convincing)
to transmit (light, heat, information, electric current, radiation, disease, infection)

5. Render in English:

В работе представлены результаты клинических исследований. Изучена зависимость амплитуды и формы пульсовой волны от показателей, характеризующих реологические свойства крови. Исследования проведены с использованием специально разработанной установки. Регистрацию пульсовой волны осуществляли с помощью датчика, представляющего собой автодинный высокочастотный (ВЧ) измеритель вибраций. Для анализа полученных данных была использована оригинальная программа обработки аналогового сигнала, позволяющая создавать файл данных, описывающий колебательное движение стенок сосудов.

В результате проведенных исследований показана возможность клинического применения неинвазивного способа контроля показателей, характеризующих реологические свойства крови, по параметрам пульсовой волны. Разработанный способ открывает перспективы для создания приборов неинвазивного мониторинга реологических свойств крови.

6. Find the Sentences with Passive Voice in Paragraph 2 of the main text and translate them into Russian

7. Translate into Russian paying attention to modal verbs with Perfect Infinitive:

- Pinpointing the location of the cancerous lesions depends on cystoscopy, which may have limited success with early flat carcinomas.
- Researchers from the University of Illinois may have founded an alternative to the dye marker.
- All the preparation for these experiments must have completed long ago.
- The gravitational energy must have gone into another form.
- While studying history at school you must have read that the art of building houses, palaces, bridges was known several thousand years ago.
- In some directions they might have been scattered off material with a random velocity toward us whereas in other directions the best-scattering surface may have been receding from us.
- Care must have been taken to use nonionic dyes.
- Test patterns of such images must have been broadcast and received.
- At bottom a voltage might have been established across the electrodes.
- Very massive stars that condensed when the galaxies must have become supernovas early, shortly after the Big Bang.
- These problems were predominantly technological and must have been solved.
- On the other hand, all the galaxies must have been tightly packed together no more than 10 billion years ago.
- The smaller gas clouds may have formed first and later collided and agglomerated into galaxies.

8. Read the text and state the main ideas in Russian:

Food Security: Machine Vision Systems Inspect Fruit

With growing concerns about the antimicrobial resistance of food-borne pathogens, huge increases in imported foods and the growing importance of food exports, government regulatory agencies are trying to beef up the safety of our food supply. Researchers from the Instrumentation and Sensing Laboratory at Agricultural Research Service, a division of the US Department of Agriculture, have developed two spectral imaging systems for inspecting fruit. The systems can detect fecal matter and defects such as bruises, cuts, abrasions and cracks that increase the likelihood that fruit will harbor harmful bacteria.

Lead researcher Yud-Ren Chen believes that the systems will also be able to examine vegetables for traces of fecal matter that may contain dangerous bacteria, such as E *coli* 0157:H7, which sometimes are missed by other screening methods.

One system adapts a reflectance imaging technique developed by the team to assess poultry. The other employs technology based on laser-induced fluorescence

imaging that was developed by fellow researcher Moon S.Kim — then working for NASA — to evaluate vegetation health.

Until recently, machine vision systems, which traditionally have been used for inspecting man-made products, were considered impractical for assessing food. The systems generally use reflectance or transmittance imaging to ensure that products are uniform and components are assembled correctly. Industrial products that have standard shapes and variety differ in color, texture, size, and shape, making machine vision inspection complex. The availability of powerful, yet relatively inexpensive, digital imaging devices, however, is helping to surmount obstacles posed by these natural variation.

The underlying principle is that the surfaces of contaminant- and disease-free apples reflect and fluoresce in a range of wavelengths, and that surfaces that fall outside this range might indicate contamination or disease. Researchers previously used multispectral imaging to determine these parameters, but this technique detects only three or four wavelengths and often requires a separate filter and camera for each. More recently, scientists have used hyperspectral imaging, which typically acquires 10 or more images each at consecutive, discrete, narrow spectral bands.

9. Read the text and state the main ideas in 5-6 sentences in English.

The system had two independent light sources — a quartzhalogen lamp and a set of UVA fluorescent lamps — which enabled reflectance and fluorescence imaging of whole apples. The spectrograph and an electron-multiplying CCD camera detected, reflected or emitted signals. Chen said that the components his team used are not unique and that other models would have worked as well.

The researchers used the system to determine which wavelengths could identify potential hazards. They scanned hundreds of apples, alternating the light sources to collect reflectance and fluorescence data. By analyzing the data with custom software, they identified several specific optimal wavelengths for detecting fecal matter and defects.

Because hyperspectral imaging is generally too slow or real-time imaging, they built two multispectral imaging systems for commercial use that incorporate these optimal wavelengths. One is a reflectance imaging system that uses customized three-cannel multispectral cameras from Duncan Tech of Auburn, Calif. A common aperture enables simultaneous capture of multispectral images with three separate CCD chips.

The other is a laser-induced fluorescence imaging system. Because the fluorescence quantum yields from agricultural products are relatively low compared with ambient light yields, Kim and biomedical engineer Alan Lefcourt used a gated intensified CCD camera. Capturing signals in short intervals at just the right moment — immediately after laser light impinges on the product — makes ambient light negligible.

His team is evaluating inspection of other types of fruits, including strawberries, honeydew melon and cantaloupe*. He noted that the systems have the poten-

tial to ensure the safety of imported fruits and vegetables and to maintain the quality of our farmers' produce.

* мускусная дыня

10. Correct the false statements:

- Bladder cancer is easy to detect in its early stages.
- A biopsy is not used for diagnosis of cancer.
- Doctors must not rely on random biopsies of the lining of the bladder.
- OCT is not becoming a clinical instrument for diagnosing this type of cancer.
- The researchers are going to start investigating the use of OCT to distinguish between precancer and early-stage cancer.
- Biomarkers can't yet give useful screening information.
- OCT has potential for optically guided biopsy.

11. Complete the following statements:

- The researchers simulated the three stages of…
- OCT detected different light-scattering and structural characteristics from…
- As an area becomes cancerous, the density of cell nuclei increases…
- They plan to work on the theoretical…
- The researchers want to conduct animal and…
- Mr. Pan says he hopes to begin studies in…
- Now they can differentiate urothelial precancer from cancer; which no other method…

12. Answer the following questions:

Which tomography distinguishes cancer from precancer?
Does this method offer sensitivity needed for early diagnosis?
What have the researchers demonstrated?
What do they plan to do?

13. Review the text "OCT distinguishes cancer from precancer."

14. Write an annotation on this text.

Topic for discussion:

Current diagnostic techniques.

LESSON NINE

CONDUCTIVE KERATOPLASTY

Pre-text exercises

1. Read the following for pronunciation:

incredible [in´kredəbl]	presbyopia [ˌprezbi'oupjə]
decipher [di'saifə]	myopia [mai'oupjə]
retina ['retinə]	hyperopia [haipə'oupjə]
cornea ['kɔ:niə]	adverse ['ædvə:s]
reciprocal [ri'siprək(ə)l]	numb [nʌm]
stroma ['stoumə] – pl stromata	denature [di:'neitʃə]
stria[straiə] – pl. striae [straii:]	speculum['spekjuləm] – specula ['spekjulə]

2. Try to guess the meaning of the words in bold type. Study the use of these words:

incredible *adj.* 1)too strange to be believed or very difficult to believe; 2) extremely good or extremely large

The eye is an optical system of incredible precision and resolution.

lens *n.* a piece of glass or substance like glass with one or both sides curved, for use in specticles, cameras, telescopes and other optical instruments

Most of the refractive performance of the eye is given by two of its parts: the cornea and the lens.

myopia *n.* inability to see things clearly that are far away

Myopes are nearsighted people.

hyperopia *n.* inability to see things clearly that are close

Hyperopes are farsighted people.

presbyopia *n.* (Greek for "aging eye") causes near vision to fade with age

Presbiopes tend to hold books at a distance in order to focus the fine print.

In the United States, 90 million people either have presbiopia or will develop it in the next ten years.

numb *v.* 1) make someone unable to feel pain or other sensations; 2) make someone unable to think, feel or react in a normal way

Prior to the procedure, the eye is numbed using drops of topical anesthetic.

de- [di:], [di] (prefix used with a verb) negative, reverse, opposite of

denature *v.* change natural properties

The heating produced by the applied RF current denatures tissue.

shrink *v.* become smaller

The heating shrinks the collagen fibers nearby the electrode.

access *n.* the way by which you can enter or reach a place

The lid speculum serves the purpose of keeping the eyelids wide open, to give the surgeon access to the treatment area.

3. Give the English for the following:

хрусталик, роговая оболочка (глаза), кривизна, приблизительно, увеличивать, уменьшать, близорукий, дальнозоркий, требовать, хирургическое оборудование, ток

4. Give the Russian for the following:

incredible precision, to refer to, myopia, hyperopia, presbyopia, to fade with age; to become dependent on, prior to the procedure, to use drops, to denature, to shrink, to cause, outside the field of vision

CONDUCTIVE KERATOPLASTY

The eye is an optical system of incredible precision and resolution. Most of the refractive performance of the eye is given by two of its parts: the cornea and the lens. Of the two, the cornea provides most of the eye's refractive power, about 70-80%. Therefore, eye conditions such as myopia, hyperopia, or presbyopia may be treated by reshaping the cornea. Assuming LeGrand's simplified eye model, a reasonable approximation for the focal distance of the eye is

$$f = \frac{R}{n-1} \tag{1}$$

where f is the focal distance, R is the curvature of the cornea, and n is the refractive index of the cornea. The literature gives $n = 1.336$ and, for a normal human eye, $R \approx 7.8$ mm. Thus, the focal distance of a normal eye is approximately 23.5 mm. Given that the number of diopters of a lens equals the reciprocal of the focal distance expressed in meters, a normal eye has about 42.5 diopters. By increasing or decreasing R, the number of diopters of any particular eye can be corrected. Myopes, people who are nearsighted, have a focal distance that is too short relative to the location of their retina. To correct myopia, the corneal surface should be made flatter (R is increased), so that the focal distance increases. Hyperopes, people who are farsighted, have a focal distance that is too long relative to their retina. To correct hyperopia, the corneal surface should be steepened (R is decreased). Presbyopia (Greek for "aging eye") causes near vision to fade with age, as the lens gradually loses its accommodation power, affecting most people by the age of 40 and everyone by the age of 51. As illustrated in Fig. 12, this results in close-range images being focused behind the retina, instead of directly on the retina. As a consequence, for example, presbyopes tend to hold books at a distance in order to focus the fine print. In the United States, 90 million people either have presbyopia or will develop it in the next ten years. Most of these patients become dependant on reading glasses to conduct activities such as reading the newspaper, using the cell phone, reading a restaurant menu, etc. Similarly to hyperopia, correction of presbyopia requires making the corneal surface steeper. Surgical procedures such as photorefractive keratomileusis (LASIK) have been developed to treat

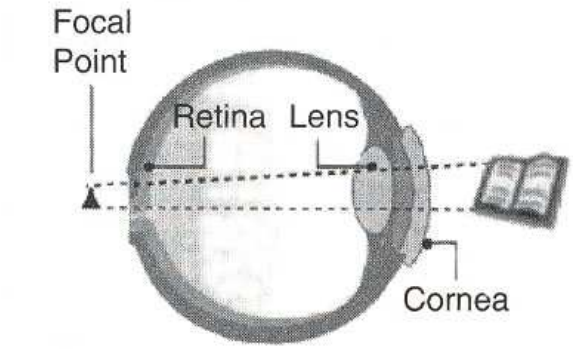


Fig. 12. Due to loss of lens accommodation, a presbyopic eye focuses nearfield objects behind the retina.

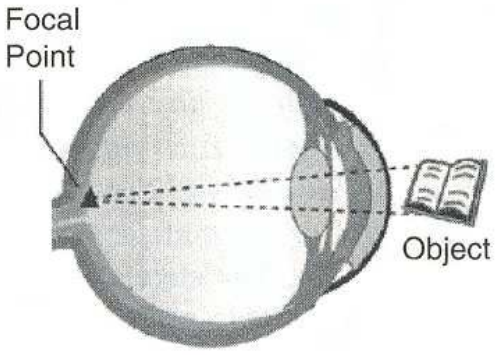


Fig. 13. By decreasing the local radius of curvature of the cornea, CK reduces the focal distance of the eye

myopia by flattening the cornea. These procedures involve cuts in the cornea and flattening of its deeper layers, operations that require precise laser systems. Until recently though, fewer surgical options were available to treat hyperopes and presbyopes. Particularly, presbyopes seem to be more risk adverse and would prefer

procedures that are less invasive than laser cutting. Conductive keratoplasty (CK) is a less-invasive surgical technique that uses radiofrequency (RF) currents to make the corneal surface steeper.

The goal of CK procedure is to produce minor corneal surface changes that result in a decreased local radius of curvature. As illustrated in Fig. 13, the focal distance of the treated eye is decreased and near-field objects become focused onto the retina.

Prior to the procedure, the eye is numbed using drops of topical anesthetic. ACK system delivers RF directly into the deeper layers of the cornea (the stroma) through a tipped electrode that is inserted at peripheral spots distributed in a circular pattern outside the field of vision. The heating produced by the applied RF current (the Joule effect) denatures tissue and shrinks the collagen fibers nearly the electrode. The local collagen shrinkage causes other fibers to stretch and striae to

Fig. 14. View of a CK probe carrying the RF electrode at its tip, shown next to a 7.0 suture.

form between treated spots. The peripheral tightening results in a decreased radius of curvature of the central cornea. Thereby, the focal distance is reduced and the patient's near vision improved. The RF voltage is applied between an electrode located at the distal tip of a disposable surgical probe and a lid speculum that acts as indifferent electrode. Shown in Fig. 14, the RF electrode has a diameter of 90 μm and a length of 460 μm. The lid speculum also serves the purpose of keeping the eyelids wide open, to give the surgeon access to the treatment area.

***Notes*:**

radius (pl. radii) – радиус
stroma (pl. stromata) – остов, основа
stria (pl. strial) – полоска, бороздка
speculum (pl. specula) – расширитель
in situ [in'saitju:] – на месте

Active words and word-combinations to be remembered

precision *n.*	точность, четкость
complete *a.*	полный, законченный
lens *n.*	линза, хрусталик глаза
cornea *n.*	роговая оболочка глаза
farsighted *a.*	дальнозоркий
nearsighted *a.*	близорукий
numb *v.*	вызывать онемение
denature *v.*	изменить естественные свойства
shrink *v.*	сокращать, сморщиваться, усыхать
harmful *a.*	вредный
foolproof *a.*	безопасный
decipher *v.*	расшифровывать
to reshape the cornea	изменять форму роговой оболочки
the refractive index of the cornea	показатель преломления роговой оболочки
close-range images	близкие изображения
to become dependent on something	стать зависимым от чего-либо
prior to the procedure	до операции
as a consequence	как результат чего-либо
to conduct activities	руководить деятельностью
to give somebody access to the treatment area	дать доступ к области лечения

Remember the following Latin and Greek words:

retina[‘retinə] – retinae[retini:] –сетчатка
hyperopia – дальнозоркость
myopia – близорукость
presbyopia[prezbi’oupjə] – старческая близорукость
keratoplasty – кератопластика, деформация роговицы

E x e r c i s e s

1. State the part of speech of the following words pointing out the word building elements. Give their Russian equivalents:

direct — director — direction — directional — directive
refract — refractive —refraction — refractor

simple — simpleness — simplicity — simplification — simplify — simply
shrink — shrinkage
access — accessible — accessibility — accession
apply — application —applicable — applicability
require — requirement
vary —variety — variation — various —variable — variability
distribute — distributor — distribution

2. Arrange the words given in A and B in pairs of synonyms

A	hold	B	use
	employ		moment
	separate		collect
	instant		keep
	assemble		divide
	average		mean

3. Arrange the words given in A and B in pairs of antonyms

A	bend	B	fast
	former		unlike
	gradual		straighten
	add		backward
	like		latter
	understand		war
	peace		misunderstand
	forward		subtract

4. Give the degrees of comparison of the following adjectives:

high, long, little, interesting, bad, large, difficult, good, useful, easy

5. Combine the words in bold type with those in brackets. Translate the combinations into Russian

cheap (edition, coat, food, joke, device, equipment)
to evaluate (a new discovery, a new book, one's abilities, a new scientific approach, the result of the experiments, the full significance)

explorer (prominent, famous, eminent, distinguished, outstanding, well-known, great)

6. Translate the following word combinations paying attention to the noun groups.

data acquisition system –
book reviews –
positron emission –
program committee –
population growth –
biomedical engineering design projects –
senior design project experience –
cost reduction –
Medicine and Biology Society –
long-term effects –

7. Translate into Russian paying attention to the Complex Object.

- The local collagen shrinkage causes other fibres to stretch.
- Everybody knows these scientists to carry out research in the field of bio-technologies.
- Everybody knows Mendeleev to have studied the properties of elements be-fore he arranged them in the table.
- Any metallurgist knows the properties of an alloy to depend upon the prop-erties of the elements it consists of.
- Radiolocation enables the pilot to determine the position of an airplane in the air.
- The decrease in the weight of the structure of the plane enables more pas-sengers to be carried.
- The magnetic field causes these particles to develop tremendous speeds.
- We consider these experiments to be very complicated.
- This would cause them to travel faster in the denser medium than in free space.
- They consider all the bodies to consist of atoms.
- This allows the lid speculum to serve the purpose of keeping the eyelids wide open.
- The CK procedure causes corneal surface to change slightly.
- Presbyopia causes near vision to fade with age.
- The surgeons believe patients to be treated effectively.

8. Read the text and state the main ideas in Russian:

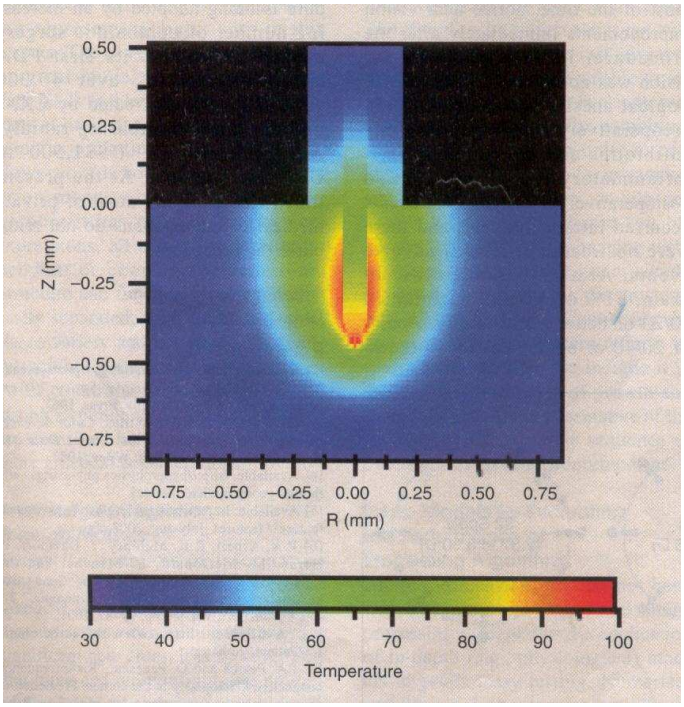


Fig. 15. Temperature profiles generated during CK, as computed by a finite-difference model.

Fig. 16 shows that the predictions of the numeric model correlate very well with birefringence results. Denatured tissue appears as a darker area surrounding

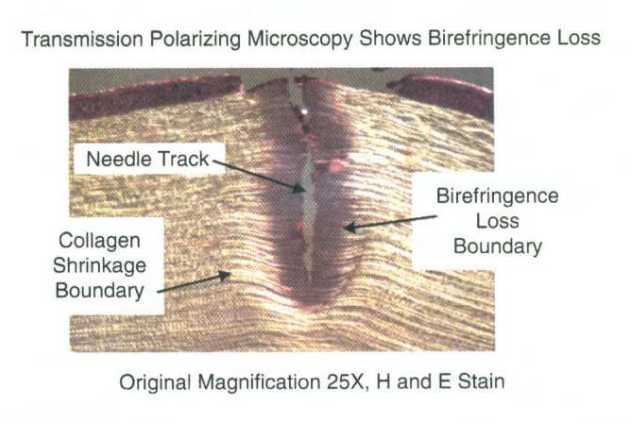


Fig. 16. Birefringence view of a leukoma produced by CK in a pig eye.

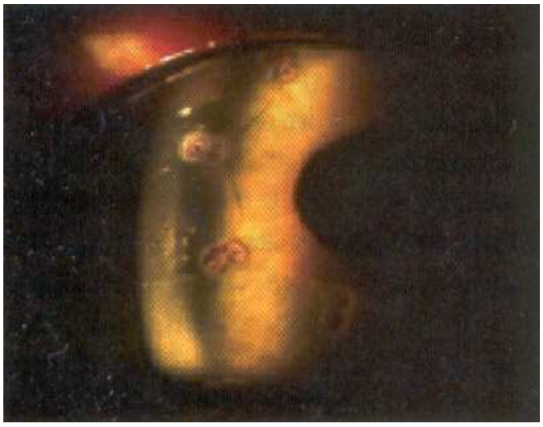


Fig. 17. Sit-lamp view of leukomas and striae formation following treatment.

the needle track and displays loss of birefringence. The image also reveals stretching of nearby collagen fibers. The human cornea is approximately 600 μm thick. It is important to note that the depth of the leukomas (i.e., the volume of denatured tissue), as shown in Fig. 15 and 16, is only about 80% of the corneal thickness. Consequently, damage to the endothelium (the one-cell-thick bottom layer of the cornea) is avoided. The track left by the electrode needle heals within several days.

Fig. 17 shows a slit-lamp postoperative view of a treated cornea. The treatment consisted of eight pairs of two RF deliveries. The pairs were evenly distributed on a circumference beyond the periphery of the pupil. Striae formed between adjacent treatment spots. The superficial after-treatment marks left on the cornea heal esthetically within several days and are not visible afterwards.

9. Read the text and state the main ideas in 5-6 sentences in English.

Clinical Outcomes

The CK procedure was approved by the Food and Drug Administration (FDA) for the treatment of hyperopia in 2002 and for presbyopia in March of 2004. A large clinical trial studied the effects of CK on 401 eyes and showed positive outcomes. To enroll in the study, patients had hyperopia levels between +0.75 D and +3.00 D. The treatment spot distribution varied based on the preoperative hyperopia level. Fig. 7 illustrates that to treat hyperopia levels between +1 D to 1,62 D, RF was applied at 16 spots evenly distributed on 6-mm and 7-mm circles around the optical zone. Given the sensitivity of vision acuity to deformations of the cornea, it was very important to deliver RF at precisely the places shown in the nomogram from Fig. 7. To help users achieve this goal, a hand-held corneal marker was used to mark the treatment spots onto the cornea with washable ink. The marker was first centered coaxially with the pupil center and then pressed gently onto the cornea. The RF probe was then sequentially inserted at spots required by the nomogram and RF delivered for 0.6 s. The entire procedure was conducted under a surgical microscope and lasted 3-5 min. The patients could, most of the time, notice near vision improvements immediately after the procedure. In most patients, far vision was not significantly affected. Topical anesthetics were delivered preoperatively. Topical ophthalmic antibiotics and nonsteroidal anti-inflammatory drops were applied postoperatively. No significant events occurred intraoperatively, and there were no treatment-related adverse events. At a 12-month follow-up exam, 51% of patients maintained 20/20 or better vision acuity. Acuity of 20/40 or better was measured in 91% of patients. Preoperatively, vision acuity was 20/40 or worse in 81% of patients. The long-term effects of the procedure are still being analyzed.

10. Complete the following statements:

- Most of the refractive performance of the eye is given by two of its parts…
- By increasing or decreasing R, the number of diopters of any particular eye can be…
- To correct hyperopia, the corneal surface should be…
- Presbyopia causes near vision to fade with…
- Most of such patients become dependent on reading glasses to…
- These procedures involve cuts in the…

- The focal distance of the treated eye is… and near-field objects become focused onto the…
- Prior to the procedure, the eye is numbed using drops of…

11. Answer the following questions:

What is our eye?
How can eye conditions be treated?
Is it possible to correct the number of diopters by increasing or decreasing the curvature of the cornea?
What is hyperopia?
How can myopia be corrected?
Is it possible to help hyperopes?
What does correction of presbyopia require?
What technique is CK (Conductive Keratoplasty)?
What is the goal of the CK procedure?

12. Speak on the topic of the text “Conductive Keratoplasty”

13. Write an annotation on this text.

Topics for discussion:

Treatment of our sight. (Correction of vision acuity)
Promising future for CK

LESSON TEN

POSITRON EMISSION TOMOGRAPHY IN MOLECULAR IMAGING (part I)

Pre-text exercises

1. Read the following for pronunciation:

isotope [ˈaisəutəup̩]	simultaneous [simlˈteiniəs]
mature [məˈtjuə]	coincidence [ˌkɔuˈinsidəns]
hasten [heisn]	enzyme [ˈenzaim]
annihilation [əˌnaiəˈleiʃən]	synthesis [ˈsinθisis]

2. Try to guess the meanings of words in bold type. Translate them into Russian:

mature v. 1) come or bring to full development or to a state ready for use ; 2) fully developed or grown

His character matured during these years.

After 25 years of experience PET has matured to the point where it brings out the delivery of personalized patient care.

poise [pɔiz] v. 1) be or keep balanced; 2) balance

PET is poised to help bring to fruition many of the promises of the postgenomic era.

hasten v. 1) move or act with speed; 2) cause to happen quickly or earlier

They hastened to tell him the good news.

Artificial heating hastens the growth of plants.

PET can do that in a variety of ways, including uncovering new information regarding the molecular basis of disease, by hastening the drug development process and by other ways.

annihilation v. complete destruction

The PET scanner detects the annihilation photons of positron decay irrespective of their source or chemical composition.

Scatter will result in the LOP no longer passing through the true annihilation location.

simultaneous adj. happening or done at the same time

It exploits the annihilation of positrons and electrons into simultaneous back-to-back 511 –keV photons.

coincidence n. happening at the same time, in the same period of time

Random coincidence occurs at high count rates where two photons from two different events are detected in coincidence.

require v. need, demand

The projection data required for tomographic reconstruction are obtained.

Advantages offered by that configuration would require further calibration and would introduce additional variables.

3. Give the English for:

чувствительность, физиология, повышенный интерес, одновременный, совпадение, требовать, уничтожение

4. Give the Russian for:

molecular imaging technique; personalized patient care; drug development process; annihilation photons; positron decay; optical system sensitivity; needed physical detector resolution; projection data; attenuation correction

5. Give derivatives of the following words:

sense, detect, emit, annihilate, respect, chemist, distribute, improve

6. Give antonyms of the following words:

particle, high, increase, after, patient, positive, move, give

POSITRON EMISSION TOMOGRAPHY IN MOLECULAR IMAGING (part I)

Because of the high sensitivity of radionuclide-based techniques for detecting cellular and molecular physiology, the fact that positron-emitting radionuclides are largely isotopes of biologically relevant atoms, that development of high-resolution positron emission tomography (PET) devices is an area of increasing interest to engineers and physicists, and because this technology is eminently translatable to the clinic, PET is becoming established as an invaluable—if not the premier—molecular imaging technique. After 25 years of experience with ^{18}F-fluorodeoxyglucose (FDG) and the synthesis of hundreds of positron-emitting radiopharmaceuticals, PET has matured to the point where it is poised to help bring to fruition many of the promises of the postgenomic era, perhaps the boldest of which is the delivery of personalized patient care. PET can do that in a variety of ways, including uncovering new information regarding the molecular basis of disease, by hastening the drug development process, and by enabling segregation of patients into appropriate treatment groups based on genetic polymorphism and phenotype—all noninvasively, and, therefore, in the most relevant, physiologic milieu.

PET is merely an in vivo analog of autography, a radionuclide-based technique used to study receptors, enzymes, transporters, organelles, and other aspects of cellular activity. The highest-resolution commercial PET scanner is based on a technique originally developed for autoradiographic equipment. The PET scanner detects the annihilation photons of positron decay, irrespective of their source or chemical composition. That complicates matters for PET, as discussed below, but helps explain why radiopharmaceutical synthesis is at the heart of PET and why synthetic chemists with an interest in imaging are currently in high demand at centers that perform molecular imaging research.

PET detects the distribution of positron-emitting radioisotopes in the body. It exploits the annihilation of positrons and electrons into simultaneous back-to-back 511-keV photons to achieve the nuclear imaging analog of X-ray computed tomography (CT). The positron is the positively charged antiparticle of the electron. Unstable nuclei that are proton rich may decay by positron emission. In the decay of a positron-emitting radionuclide, the positron comes to rest within several mm of the decay event and interacts with an atomic electron, yielding two photons that travel in (nearly) opposite directions. By detecting those photons in coincidence (within several ns), the projection data required for tomographic reconstruction are obtained. (Fig. 18). If two detectors are in coincidence, the assumption is that the positron was emitted along the line that connects them, referred to as the “line of response” (LOR).

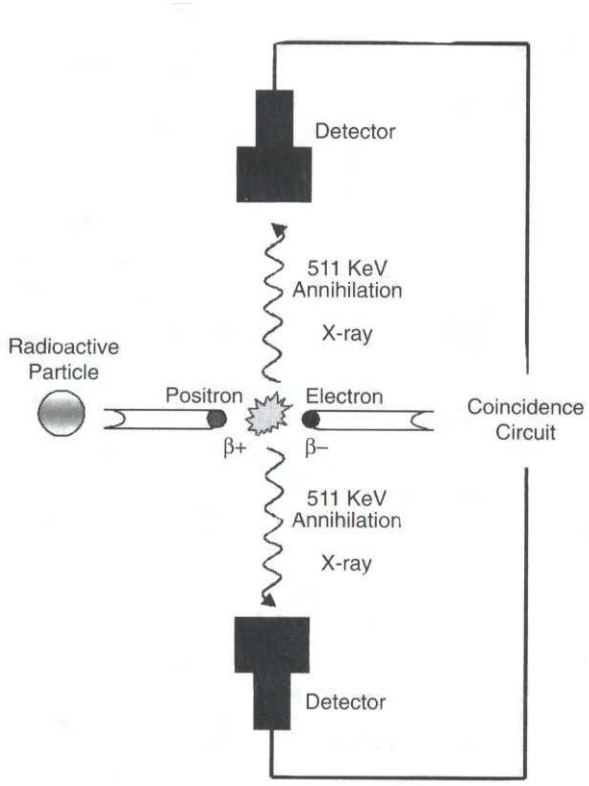


Fig. 18. Diagram showing the process of positron emission and annihilation. After a positron is emitted, it comes to rest within several mm of decay event and collides with an electron. Annihilation occurs, with the production of two 511-keV photons emitted at (nearly) 180 degrees apart. Photons are detected in coincidence (<8 ns) by paired detectors.

Detectors in PET imaging are usually small (4×4 mm - 7×7 mm) pieces of scintillator material, such as bismuth germinate, lutetium oxyorthosilicate (LSO), gadolinium xyorthosilicate, or sodium iodide. The first three are more commonly used due to their increased detection efficiencies for 511-keV photons. The efficiency of LSO in particular has enabled a significant increase in the speed with which PET data can be acquired. When an annihilation photon interacts with a detector, light is emitted and collected by an array of photomultiplier tubes (PMTs). By taking a weighted sum of the PMT signals, one can determine within which of the detector elements the event occurred, enabling reduction in detector size, thereby improving the spatial resolution of the system. State-of-the—art dedicated PET scanners are fullring systems (i.e., detectors situated a full 360˚ around the volume to be imaged). Advantages offered by that configuration are a) optimal system sensitivity, which is necessary to obtain high counting statistics to achieve the needed physical detector resolution; b) reduction of image artifacts due to tracer, organ, or patient motion; and c) absence of moving components (slip ring or rotating heads), which would require further calibration and would introduce additional variables. If sufficient LORs and angles are sampled, it is possible to reconstruct the three-dimensional, tomographic distribution of radiopharmaceutical.

The positron can move a substantial distance before colliding with an electron [Fig. 19(b); Table 1]. Furthermore, if the annihilation photons are noncolinear (i.e., off of 180˚from one another), the detected LOR would not correspond to the site of annihilation [Fig. 19(c)]. Two additional problems limiting resolution are Compton scatter and random coincidence. Scatter will result in the LOR no longer passing through the true annihilation location [Fig. 19(d)], while random coincidence occurs at high count rates where two photons from two different events are detected in coincidence [Fig. 19(e)] The LOR will not be representative of either event in that case.

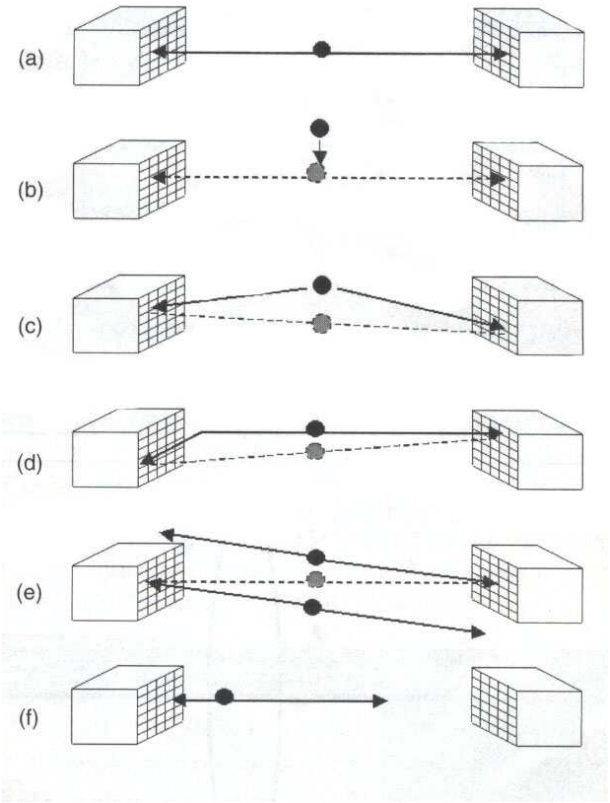


Fig. 19. Diagrams demonstrating true coincidence (a) as well as different possible sources of error in PET imaging, including (b) the difference between positron emission and annihilation location, (c) noncolinearity, (d) scatter, (e) false coincidence, and (f) attenuation effect.

Deep organs may experience a 50-fold attenuation in photon detection relative to those at the surface. The ability to correct the attenuation in PET relies on the fact that attenuation, and therefore coincidence detection of positron annihilation, are independent of the location along a given ray between opposite detectors. Since the amount of tissue traversed by the two photons is constant for each LOR, the correction factor for each LOR can be determined empirically by performing a transmission scan. Transmission scans using a ^{68}Ge source are accordingly performed to account for such geometrical distortions. The observed count rate obtained along each LOR during the actual scan is then divided by the attenuation factor. Attenuation correction is necessary for coregistration of PET images with

other modalities and for the application of semiquantitative measurements such as the standard uptake value (SUV). Furthermore, acquiring post-injection transmission scan or using iterative reconstruction methods, such as ordered-subset expectation maximum (OSEM), on both the emission and transmission scans may save time.

***Notes*:**

milieu [ˈmi:ljˑ] фр.– обстановка, окружающая среда
in vivo - внутри организма, в живом организме

Active words and word-combinations to be remembered

relevant atoms	рассматриваемые атомы
positron-emitting radionuclides	радионуклиды, испускающие позитроны
high-resolution positron emission tomography	позитронно-эмиссионная томография высокого разрешения
to mature	созреть; доводить до зрелости
to poise	удерживать в равновесии; уравновешивать
drug development process	процесс разработки лекарств
annihilation photons of positron decay	аннигиляция фотонов при распаде электронов
delivery	доставка, поставка, выработка
to hasten	спешить, торопиться, ускорять
irrespective of	независимый от
to acquire	приобретать, получать, достигать
sufficient	достаточный

Exercises

1. Combine the following words with those in brackets:

to require (attention, skill, explanation, clear statement)
statement (clear, familiar, necessary, important, contradictory)
appropriate (conditions, circumstances, words, devices, examples, way)
promising (discovery, student, method, application)
satisfactory (conditions, results, progress, way, theory, arguments, explanation)
substantial (contribution, aid, difference, progress)

2. Change the following according to the model.

the temperature of the sea – the sea temperature

the number of the room –
forecast of the weather –
an accident on the road –
parameters of order –
sensor of temperature –
diameter of a molecule –
photons of annihilation –
decay of a positron –
the location of annihilation –
detection of a photon –

3. Point out the nouns used as attributes (see the text, paragraph 1)

4. Give the degrees of comparison of the following adjectives:

bold, relevant, significant, high, sufficient, deep

5. Translate into Russian paying attention to construction "the…the…"

- The closer the coil is to the target tissue, the better the quality of the image.
- The stronger the absorption, the less the diffuse reflection.
- The greater the mass of an object, the greater is the force required to change its motion
- The more we come to know about space, the greater is our knowledge about our planet and ourselves.
- The smaller the velocity, the greater its scattering.
- In general, the narrower the wavelength range, you choose the sharper the filter's boundaries.
- When it comes to scientific imaging, the higher the resolution and speed, the better.

6. Read the following text and render it in Russian.

PET – CT

The recent advent of combined PET-CT scanners has revolutionized the clinical application of PET (Fig. 20). In addition to acquiring coregistered anatomical and functional images, a further advantage of the dual modality system is

the potential to use the CT images for attenuation correction of the PET emission data, eliminating the need for a separate, lengthy transmission scan. The use of the CT scan for attenuation correction not only reduces whole-body scan times by at least 40%, but also provides essentially noiseless attenuation correction factors compared to those from a standard transmission scan. PET-CT devices are now commercially available and are beginning to prove their clinical value, with objective improvements in diagnostic accuracy documented.

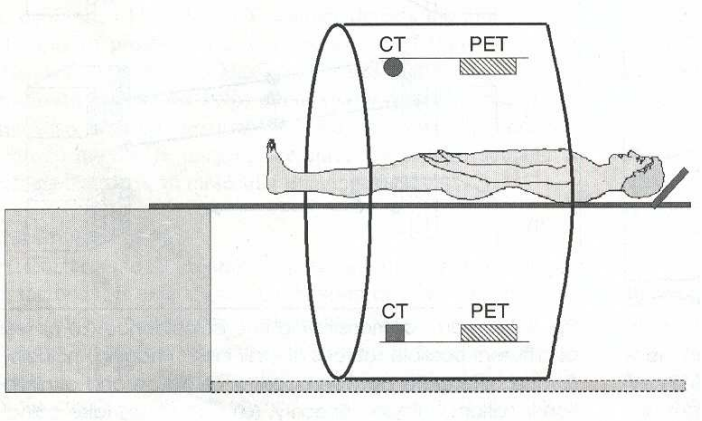


Fig. 20. Simplified diagram of a combined PET/CT scanner.

7. Read the following text and render it in English.

Tracer Principle

Specific activity is the amount of radioactivity per unit of mass and is a key consideration in radiopharmaceutical development. It is because PET radiopharmaceuticals can be synthesized in high specific activity that such compounds are designated radiotracers. Although it will not produce a pharmacologic effect or otherwise perturb the system under study, a radiotracer will follow the same pharmacokinetic pathway of the parent molecule from which it was derived and will provide quantitative information about that pathway. For that reason, the word *radiopharmaceutical* is somewhat of a misnomer, in that, these imaging agents by definition do not behave as pharmaceuticals, but rather as tracers of physiology. It is the *tracer principle* (i.e., the fact that high specific activity is required of new PET agents) that enables such compounds to be administered to humans with fewer restrictions and faster approval from the Food and Drug Administration (FDA) than most new drugs (Fig. 21). That principle also accounts, in part, for why the first applications of molecular imaging research have used PET.

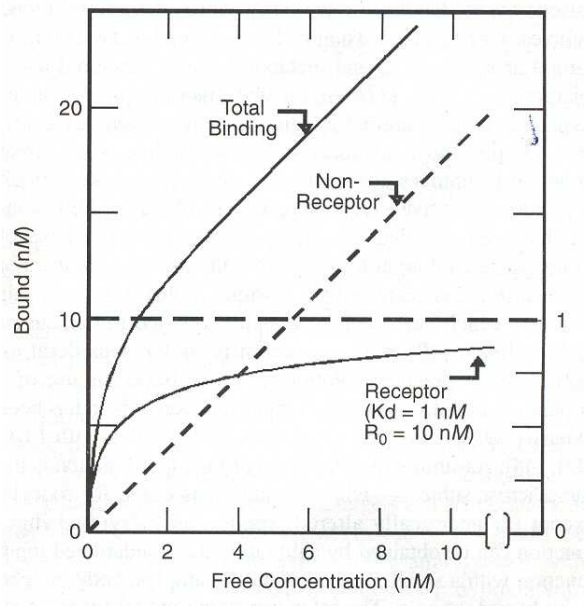


Fig. 21. binding curves for a hypothetical binding system including both high-affinity, limited-capacity (receptor) and low-affinity, high-capacity (nonreceptor) binding components. As ligand concentration increases, so does the contribution of nonreceptor binding to total binding. A radioligand must be administered in high specific activity – i.e., with minimal fractional receptor binding – to produce a clean signal devoid of nonreceptor interaction.

8. Translate the following text into English.

В настоящее время в связи с созданием лазерных автодинов на квантоворазмерных структурах появилась возможность проводить измерения микро - и нановибраций биологической ткани in vivo. Хорошие эргономические характеристики полупроводниковых автодинов позволяют закреплять всю измерительную систему на голове пациента, обеспечивая тем самым подвижность пациента и устраняя влияние произвольных движений головы на результат измерений. Разработанные ранее принципы регистрации и анализа сигнала полупроводникового лазерного автодина позволяют обеспечить получение абсолютных измерений амплитуд вибраций с точностью, недостижимой для известных электромагнитных преобразователей.

9. Complete the following statements:

- The development of high resolution positron emission tomography (PET) devices is an area of increasing interest to…
- PET is becoming established an invaluable-if not the premier-molecular imaging…
- Positron-emitting radionuclides are largely isotopes of biologically relevant…
- PET is a radionuclide-based technique used to study…

- The PET scanner detects the annihilation photons of…
- Synthetic chemists with an interest in imaging are currently in…
- The positron is the positively charged antiparticle of…
- When an annihilation photon interacts with a detector, light is emitted and collected by…

10. Correct the following statements.

- The positron is the negatively charged antiparticle of the electron.
- PET detects the appearance of positron-emitting radioisotopes in the body.
- Physicians with an interest in imaging are currently in high demand at centers that perform imaging research.
- The PET scanner detects the annihilation photons of positron decay respective of their source.
- If sufficient angles are sampled, it is possible to change the three-dimensional tomographic distribution of radiopharmaceutical.

11. Answer the following questions:

Could the promise of personalized patient care be reached fruition?
What can PET be used for?
What is the highest-resolution commercial PET scanner based on?
What does the PET scanner detect?
What are the advantages of detectors situated a full 360˚around the volume to be imaged?

12. Speak on the topic of the main text.

LESSON ELEVEN

POSITRON EMISSION TOMOGRAPHY IN MOLECULAR IMAGING (part II)

Pre-text exercises

1. Read the following for pronunciation:

initial [i´niʃəl]	sample ['sa:mpl]
kinetics [kai'netikʂ]	interfere [ˌintə'fiə]
qualitative ['kwɔlitətiv]	chromatography [ˌkrəumə'tɔgrəfi]

2. Try to guess the meaning of the words in bold type. Study the use of these words:

attribute *n.* quality considered to be naturally or necessarily belonging to a person or thing

Light is an attribute of day.

The ability to perform quantitative analysis is one of the major attributes of PET.

extract *v.* 1) take or get out (usually with effort), 2) obtain by force, 3) select or copy out words, examples, passages, etc (from a book)

Depending upon the physiology under study and the specific protocol, qualitative – and, perhaps, quantitative – information can be extracted from a PET study.

dimension *n.* measurement of any sort, (pl) size, extent.

Qualitative information is in the form of images that depict the disposition of radiopharmaceutical in three dimensions or four dimensions, in dynamic studies.

interfere *v.* break in (other person's affairs) without right or invitation

Please stop interfering in my business.

Tracer kinetic analysis enables correction for interfering metabolites to provide a true input function.

depict *v.* show in the form of a picture, describe in words

Many Mediterranean scenes are depicted in these photographs.

Images depict the disposition of radiopharmaceutical in three dimensions.

underlie *v.* form the basis of (a theory, conduct, behavior, doctrine)

These methods can provide a fairly detailed description of the underlying tracer kinetics.

robust *adj.* strong, active, fit, healthy

These methods are more robust and are widely used to study binding.

reverse *v.* 1) turn the other way round or up or inside out, 2) go in the opposite direction, 3) change the order or position of

- to reverse one's policy
- to reverse one's car into the garage

Their positions are now reversed: Tom is poor and Ben is rich.

These methods are used to study irreversible and reversible neuroreceptor binding, respectively.

undertake *v.* make oneself responsible for; agree, promise (to do sth),

Until recently, molecular imaging research has been undertaken in humans, nonhuman primates, and other animals.

3. Give the English for:

начальный, качественный, количественный, образец, извлекать, измерение, сильный (крепкий), количественный анализ, представлять, описание, получать, обратимый

4. Give the Russian for:

interfere, attribute, tracer, interpret, image, extract, qualitative analysis, apply, blood data, movement, irreversible, tissue, to image gene expression in vivo

5. Give derivatives of the following words:

depend, dispose, use, apply, resolve, quantity

POSITRON EMISSION TOMOGRAPHY IN MOLECULAR IMAGING (part II)

Depending upon the physiology under study and the specific imaging protocol, qualitative—and, perhaps, quantitative—information can be extracted from a PET study. The ability to perform quantitative analysis is one of the major attributes of PET, although quantitative methods are generally more complex than rou-

tine qualitative analyses. Qualitative information is in the form of images that depict the disposition of radiopharmaceutical in three dimensions (or four dimensions, in dynamic studies). Clinical studies tend to be interpreted using simple qualitative inspection of the image data. Semiquantitative studies are sometimes applied (e.g., through calculation of the SUV or use of a simplified kinetic model), and will prove useful in therapeutic monitoring if a validated standard can be adopted qualitative. Because PET studies use radiolabeled compounds delivered in tracer closes, tracer kinetic principles can be applied to obtain estimates of relevant, physiologic parameters in vivo. Tracer kinetic analysis of a region of interest (ROI) typically requires that blood samples be removed from the subject periodically throughout a dynamic study to a) obtain a blood curve of the tracer activity and b) enable correction for interfering metabolites to provide a true input function. The blood data (from radio-high performance liquid chromatography analysis) and the image data (from the PET scan) are initially represented as time-activity curves (TACs) that may be analyzed using compartmental or non-compartmental methods. Compartmental methods can provide a fairly detailed description of the underlying tracer kinetics and provide data in the form of rate constants that describe the movement of radiotracer among the compartments. Noncompartmental methods generally require fewer assumptions, involve the estimation of fewer parameters, and so provide correspondingly less information regarding radiotracer disposition. However, noncompartmental methods are more robust and are widely used to study irreversible and reversible neuroreceptor binding, respectively.

Until recently, molecular imaging research has been undertaken in humans, nonhuman primates, and other animals large enough to provide a meaningful signal on a clinical scanner. Because clinical scanners are almost always in use during prime time and because rodents have become relatively easy to manipulate genetically, there has been a drive to produce dedicated small-animal PET systems. Also driving small-animal PET has been the desire to image gene expression in vivo, as reviewed previously and discussed elsewhere in this issue,

Site-selective tracer development has long been the unique domain of radionuclide imaging, mainly because of the high sensitivity of PET (n*M* to p*M*). For example, in drug development, receptor-based agents enable either direct (labeled drug) or indirect (receptor occupancy) pharmacokinetic determination of drug candidates. Scaling that process from humans to small animals, even with new high-resolution scanners, is no easy task. Quantitative treatments of that scaling have been undertaken, the main principles of which will be covered here. First, one must realize that even with dedicated animal scanners, the amount of tracer given to an animal must, in general, be comparable to that given to a human. That is because the resolution voxel for the animal is much smaller than that for the human, yet the amount of tracer must be delivered to that voxel for the statistical precision of measurement of activity in that voxel to be the same as for the human. Derivative from that is the issue of the need for very high, specific radioactivities for receptor-based radiotracers given to small animals.

***Notes*:**

in vitru – в пробирке

Active words and word-combinations to be remembered

attribute n.	свойство
depict v.	изображать, описывать
underlie v.	лежать под чем-либо; лежать в основе
extract v.	выжимать, вырывать
dimension n.	измерение, величина, объем
robust adj.	здоровый, сильный
dedicate v.	посвящать
undertake v.	предпринимать
reverse v	перевертывать, отменять
the physiology under study	изучение физиологии
to provide something in the form of	создавать в форме

Exercises

1. Give the part of speech of the following words pointing out the word-building elements. Give their Russian equivalents.
to prefer—preferable—preference
to suspect—suspicion—suspicious
to clarify—clarity—clarification
to respect—respectability—respectable—respecter—respectful—respectfully—respectfulness

2. Arrange the words given in A and B in pairs of synonyms

A	obtain	B	use
	chief		evaluate
	routine		measurement
	dimension		main
	apply		regular

3. Arrange the words given in A and B in pairs of antonyms

A	detailed	B	dear
	finite		common
	transfer		submerge
	lose		boundless
	expensive		find
	emerge		transport

4. Find sentences with modal verbs and translate them (paragraph 1)

5. Read the last sentence of paragraph 2 and translate it paying attention to the subject.

6. Translate the following paying attention to
A) the elliptical construction
- An instrument based on this near-infrared optical technique, if successful, could be used.
- Although simple, experiments of this kind should considerably enlarge our knowledge of this often mysterious plasma.
- When in doubt about the meaning of a word, look it up in the dictionary.
- A mass of gas, no matter how small, will completely fill the container.
- No matter how complicated this problem is expected to be finally solved.
- Objects fall at the same speed whatever their weight.
- When visible, sunspots are the most interesting objects on the solar surface.

B) Perfect Continuous Tenses.
- Scientists have been measuring fluorescence lifetime to determine the environment around fluoraphores for more than 30 years.
- They have been producing images using these instruments for about 10 years.
- The researchers have been exploring ways to more fully grasp the function and structure of ion channels.
- We've been using variable wavelength lasers for 20 years.
- If you looked at the machines people had been using up to 1950, you would certainly notice at a glance that they were rather crude and imperfect as compared to the ones available today.
- For a long time Röntgen had been experimenting with the Crookes tube before he discovered a new kind of rays.

7. a) Read the text and express the main ideas in 4-5 sentences in Russian.

A New View of Lymphocyte Movement in Vivo

To gain a better understanding of how T-and B- cells travel, researchers from the University of California, have used two-photon microscopy to image the natural behavior of the cells in intact mouse lymph nodes.

The researchers took purified mouse T- and B-cells, labled them with green and red fluorescent dyes and injected them into the tail veins of recipient mice. They then isolated the lymph nodes—where T-cells are formed —and used two-photon microscopy to image the cells at depths of up to 350 μm where the lymphocytes are influenced by natural, local environmental factors. Using tim-lapse 3-D

imaging, they tracked the locomotion of “unprovoked”-and B-cells, and T-cells responding to antigenetic challenge.

Their results revealed some inherent differences in the way T-and B-cells patrol lymph tissue. They described these differences by assigning cells a “mobility coefficient,” which characterized their average displacement as a function of time. T-cells showed a higher motility coefficient because they moved at almost twice the velocity of B-cells, and with a much wider, more skewed distribution. The research also showed that T-cells enlarge significantly when antigenically challenged, and either form tight, stationary clusters or more together in swarms.

b) Read the text and express the main ideas in 2-3 sentences in English

Optical Society of America 2002 Annual Meeting and Exhibit, and Laser Science

The optics in biology and medicine division of the society will sponsor symposia on topics such as advances in microscopy and coherent imaging, and optical nanodiagnostics, including chips, capsules and microelectromechanical systems. Invited speakers will discuss multidimensional microscopy using reference structure tomography, single-molecule detection by micropolimer optoelectromechanical system, and the use of nanoparticles probes for the recognition and detection of biomolecules.

8. Render in English

Введение новейших технологий лучевой терапии, реализуемых с помощью современного радиотерапевтического комплекса, позволило определять точную локализацию, размеры и конфигурацию опухоли. Создавать дозные распределения, максимально точно соответствующие опухолевой мишени, обеспечивать воспроизведение условий облучения при многократных сеансах. Все это является основой гарантии качества лучевой терапии, залогом улучшения результатов лечения онкологических больных. Высокие дозы, доставленные в планируемые объемы, вкупе с другими методами лечения онкологических больных – хирургическим вмешательством и химиотерапией – позволяют добиться высокой выживаемости больных с первой-третьей стадиями заболеваний; выживаемость больных после лечения достигает 50-70%.

9. Say whether the following statements are true, if they are not, correct them.

- Qualitative and quantitative information can be extracted from a PET study.
- The ability to perform quantitative analysis is the only attribute of PET.
- Clinical studies are interpreted using complex qualitative inspection of the image data.

- Semiquantitative studies will prove useful in therapeutic monitoring if a validated standard can be adopted.
- Until recently, molecular imaging research has been undertaken only in nonhuman primates.

10. Complete the following statements.

- Compartmental methods can provide a fairly detailed description of …
- Noncompartmental methods are widely used to …
- In drug development, receptor-based agents enable either direct or indirect …
- Scaling this process from humans to small animals is no …
- Clinical scanners are almost always in use during …
- Rodents have become relatively easy to manipulate …
- Driving small-animal PET has been the desire to image …
- Site-selective tracer development has long been the unique domain of radionuclide imaging, mainly because of …

11. Answer the following questions:

How can qualitative information be extracted from a PET study?
In what form is this qualitative information?
How are clinical studies interpreted?
What can compartmental methods provide?
What are noncompartmental methods used for?
Why has site-selective tracer development long been the unique domain of radionuclide imaging?
What are the main principles of quantitative treatments of scaling?

12. Speak on the topic of the main text

LESSON TWELVE

NEAR INFRARED OPTICAL APPLICATIONS IN MOLECULAR IMAGING

Pre-text exercises

1. Read the following for pronunciation:

fluorescence [fluə´resns]	viability [ˈvaiəbiliti]
spatial [ˈspeiʃəl]	graft [gra:ft]
quantitative [ˈkwɔntitətiv]	perfusion [pəˈfj:ʒ(ə)n]
conceptual [kənˈseptjuəl]	simultaneously [ˌsiməlˈteinjəsli]
commercialize [kəˈmə:ʃəlaiz]	threshold [ˈθreʃhəuld]

2. Try to guess the meanings of the words in bold type. Study the use of these words:

regard *n.* – 1) respect for someone or something; 2) formal attention or consideration that is shown towards someone or something; 3) relating to a particular subject; 4) relating to something just mentioned

NIR fluorescence imaging technology applications in humans differ in several regards from conventional imaging technologies.

distinct *adj.* – 1) clearly different or belonging to a different type, 2) something that is distinct can clearly be seen, heard, smelled.

The first is that NIR imaging instrumentation falls into two distinct classes.

complementoary *adj.* – serving to complete.

diverse *adj.* – very different from each other.

Within each group, a diverse set of complementary approaches are used to optimize conditions such as spatial resolution, signal-to-noise ratios, location of imaging.

constraint *n.* – 1) something that limits your freedom to do what you want; 2) control over the way people are allowed to behave.

This approach does not work for NIR imaging given the different constraints of body parts in terms of size and optical properties.

viability *n.* – capable of existing, developing and surviving.

The other system has been initially applied for the evaluation of viability of coronary artery bypass grafts.

implement *v.* – carry something into effect, realize, accomplish. Implementation – realization, accomplishment

Importantly, multichannel systems allow the implementation of mini arrays of several injected probes for greater in vivo target assessment.

interrogate *v.* – ask someone a lot of questions for a long time in order to get information.

It is difficult with many imaging modalities, including MRI, CT, PET and ulrasound to interrogate more than one parameter simultaneously.

3. Give the Russian for:

two distinct classes, diverse set, complimentary approaches, to optimize conditions, to excite and detect fluorescence, the region of interest, to evaluate the human skin surface, to evaluate viability, to provide different means

4. Give the English for:

обычные технологии, компьютерная томография, отношение сигнала к шуму, оптические свойства, болезнь, подобный чему-либо, возбуждать, видимый диапазон, длина волны, многоканальная система, привести к…, применимый

5. Give derivatives of the following words:

image, combine, reflect, add, detect, attract, sense

NEAR INFRARED OPTICAL APPLICATIONS IN MOLECULAR IMAGING

NIR fluorescence imaging technology application in humans differs in several regards from conventional imaging technologies, such as magnetic resonance imaging (MRI), computed tomography (CT), and photon emission tomography (PET).The first is that NIR imaging instrumentation falls into two distinct classes: those instruments that provide surface weighted reflectance images and those in-

struments that reconstruct light based on diffuse optical properties. Within each group, a diverse set of complementary approaches, reflected in instrumentation design, are used to optimize conditions such as spatial resolution, signal-to-noise ratios, degree of quantitation of signal, or location of imaging. In general, a one-size-fits-all approach does not work for NIR imaging, given the different constraints of body parts in terms of size and optical properties, the different ways one can approach the target tissue within the organ, and the expected diseases that one hopes to target within these organs. Additionally, both classes of instrumentation for NIR imaging are much less expensive than the high-capital imaging systems mentioned previously.

Surface fluorescence reflectance imaging systems, conceptually similar to epifluorescence microscopy, excite and detect fluorescence from the same surface and are technically the easiest systems to construct. Filtered broadband or laser, excitation light is diffused across the region of interest. Fluorescent light is filtered and recorded with a cooled charge coupled device (CCD). Several companies have made systems for evaluating the human skin surface, but often these systems are designed for imaging in the visible range to evaluate autofluorescence or the presence of photodynamic therapy agents,. However, two companies have commercialized intraoperative surface reflectance NIR systems. These systems have exciters and detectors outside of the body. In one system, the device is ceiling mounted, and the focus of use is for tumor resection. The other system has been initially applied for the evaluation of coronary artery bypass grafts using flow and perfusion detected by an NIR dye.

Whole animal surface fluorescence reflectance systems, a precursor for human systems, have allowed the optimization of probes for evaluating molecular events in vivo prior to their human use. Moreover, such systems, combined with molecularly targeted probes, are means for testing novel pharmaceuticals in vivo, which is a major bottleneck in drug discovery. Overall, small animal reflectance systems have the advantage of ease of animals, and straightforward data analysis. Even early systems could detect subpicomole amounts of fluorochromes, making optical imaging very attractive in terms of sensitivity. Photon flux is typically on the order of tens of microwatts to a few milliwatts per square centimeter at the tissue surface. Imaging signal from a depth of 5-10 mm is readily achieved with reflectance systems. The systems are not intrinsically quantitative for tissue fluorochrome concentration but can provide somewhat quantitative data when imaging fluorescence that is near a surface.

An advancement in surface reflectance imaging has been the introduction of multiple independent wavelengths in the NIR. Multichannel imaging is of particular use in recording multiple enzymatic targets in vivo or using one of the NIRF channels for calibration purposes. Whereas it is difficult with many imaging modalities, including MRI, CT, PET, and ultrasound to interrogate more than one parameter simultaneously, optical imaging lends itself to such multiplexing of even complex molecular information secondary to the ease of separating wavelengths of light. Using a system that robustly separated excitation and emission light from green fluorescent protein and two independent NIR wavelengths of light, we dem-

onstrated the ability to monitor multiple gene expressions simultaneously and independently. Fig. 2 shows such an example of an optical marker gene and a smart probe that reports on protease activity. Signal linearity and NIR light depth detection threshold are similar to the single channel systems. Importantly, multichannel systems allow the implementation of mini arrays of several injected probes for greater in vivo target assessment. Such multiparametric molecular analysis may result in better sensitivity and detection compared with single parameter molecular evaluation. Each subgroup of disease will likely have several targets that would help define the imaging mini array most suited for characterization. These multichannel techniques are applicable for both subsurface imaging and imaging of deeper tissue using tomographic approaches.

***Notes*:**

NIR – near infrared resonance
MRI – magnetic resonance imaging
CT – computed tomography
PET – photon emission tomography

Remember the abbreviations given above

Active words and word-combinations to be remembered

regard *n.*	взгляд, отношение
distinct *adj.*	отличительный
diverse *adj.*	разнообразный
complementary *adj.*	дополнительный
approach *v., n*	подходить, доступ
constraint *n.*	принуждение
viability *n.*	жизнеспособность
graft *n.*	1) прививка; трансплантант; 2) лоскут живой ткани для пересадки; 3) операция пересадки ткани
perfusion *n.*	перфузия
acquisition *n.*	приобретение, овладение, поступление, сбор данных *(процесс)*
precursor *n.*	предшественник, предвестник
implement *v.*	исполнять
interrogate *v.*	задавать вопрос
target *v., n*	целиться, цель
intrinsic *adj.*	присущий, существенный
a few milliwatts per square centimeter	несколько милливатт на кв. см.
to be of particular use	использоваться в особом случае

Exercises

1. State the part of speech of the following words pointing out the word-building elements. Give their Russian equivalents.

interrogate—interrogation—interrogative—interrogatively—interrogator
viable—viability
perfuse—perfusion
acquire—acquirement—acquisition—acquisitive
implement—implementation
distinct—distinction—distinctive—distinctively

2. Arrange the words given in A and B in pairs of synonyms

A	distinct	B	dear
	use		divide
	provide		apply
	some		give
	expensive		different
	separate		several

3. Combine the words in bold type with those in brackets. Translate the combinations into Russian

to differ from (conventional imaging technologies; magnetic resonance imaging; computed tomography; theory; the previously obtained results)
to evaluate (viability of; molecular events in vivo; fluorescence; the results; the discovery; the importance of)
additional (data, explanation, amount, information, calculation, time, help, problem)
similar (plans, instruments, schemes, properties, shapes, ideas, characteristics, ways, methods)
distinct (pronunciation, ideas, shapes, approaches, possibilities, classes)
conventional (scheme, condition, pattern, technique)

4. Give the degrees of comparison of the following adjectives:

complicated, expensive, attractive, easy, great, high, small, good

5. Translate the following noun groups into Russian:

- NIR fluorescence imaging technology application
- animal surface fluorescence reflectance systems
- tissue fluorochrome concentration

- multiple gene expression
- rapid data acquisition
- drug-development process
- high-resolution positron emission
- NIR light depth detection threshold

6. Translate the following sentence into Russian paying attention to the functions of “that”:

The first is that NIR imaging instrumentation falls into two distinct classes: those instruments that provide surface weighted reflectance images and those instruments that reconstruct light based on these diffuse optical properties.

7. Translate into Russian paying attention to the clauses joined asyndetically.

- One of the main advantages of using PET to measure molecular interactions is the spatial resolution it offers.
- Properties of steel depend also on heat treatment the metal has been subjected to.
- This is the principle the mercury thermometer is based upon.
- Should the falling body stop, all friction would disappear.
- Should this technique be successful, the next step will be the development of a targeted-hybrid-contrast delivery agent for specific disease treatment.
- In the case we are considering the average current remains unchanged.
- The properties of this quantum-mechanical fluid are revealed by the radiation it emits.
- The difficulties one encounters when trying to connect facts and theory come from two sources.
- Had you a more delicate instrument than the compass, you could recognize smaller electric or magnetic charges at greater distances.
- Should an electrically neutral atom attain an additional electron, the negative charges would predominate, resulting in a negative ion.

8. Read the text and express the main ideas in Russian.

The push in medical imaging technology across the entire electromagnetic spectrum is driven in part by the desire to obtain earlier and more accurate assessment of disease presence, disease course, and efficacy of disease treatment. As part of this expansion in imaging capabilities, a great deal of interest and enthusiasm have been generated by in vivo imaging in the NIR region of the electromagnetic spectrum. Advances in imaging hardware and algorithm development, combined with advances in exogenously administered fluorescent imaging probes, have allowed the rapid expansion of the range biological processes that can be interrogated noninvasively with NIR light . These processes, which are fundamental to normal tissue function and which are often altered early in disease states and early

in treatment response, may be used to help us reach our goal of more accurate and earlier assessment of illness. In this review, a range of the technologies that have been employed and that are in various stages of development will be examined, followed by a look at what biological events are targeted by some of the NIR IMAGING PROBES. Example disease applications may provide a view at how NIR imaging will be used clinically to evaluate disease-modifying molecular events in vivo. While much of the work described here was performed or tested in rodents, translation to humans is expected on all of these fronts.

9. Read the text and express the main ideas in 4-5 sentences in English.

NIR light offers two primary advantages over light in the visible spectrum for imaging. The first advantage is that, in biological tissues, NIR light has much lower absorption than visible light; information from deeper structures may be obtained. At even longer wavelengths, in the infrared region, photons are more greatly absorbed by water than are NIR photons. Hence, the NIR region of the electromagnetic spectrum provides a window of opportunity with tissue penetration on the order of 10-15 cm under certain conditions. The second advantage of NIR light compared to visible wavelengths is the lower autofluorescence that is present at these wavelengths. While autofluorescence may be useful in delineating disease it increases the background one must overcome when looking for signal derived exogenously administered molecularly targeted fluorochromes. NIR fluorescence imaging has also benefited over the last few years from an increase in the literature and that are available commercially, giving investigators a greater range of building blocks from which to construct molecularly selective imaging probes.

10. Say whether the following statements are true if they are not, correct them.

- NIR fluorescence imaging technology applications in humans do not differ from conventional ones.
- These multichannel techniques are applicable only for subsurface imaging.
- Each subgroup of disease will likely have only several targets that wouldn't help define the imaging mini array most suited for characterization.
- Multiparametric molecular analysis may result in worse sensitivity and specificity of disease characterization.
- Multichannel imaging is of particular use in exciting multiple enzymatic targets in vivo.

11. Complete the following statements:

- Both classes of instrumentation for NIR imaging are much …
- Surface fluorescence reflectance imaging systems excite and detect …

- Filtered broadband or laser excitation light is diffused across …
- Fluorescent light is recorded with …
- These systems have exciters and detectors outside of …
- These systems are designed for imaging in the visible range to evaluate…

12. Give questions to which the following statements might be the answer:

- Both classes of instrumentation for NIR imaging are much less expensive.
- Several companies have made systems for evaluating the human skin surface.
- Fig. 2 shows such an example of an optical maker gene.
- We demonstrated the ability to monitor multiple gene expressions simultaneously and independently
- Yes, it is.
- Yes, they could.

13. What do the following abbreviations mean?

- NIR
- MRI
- CT
- PET
- CCD

14. Answer the following questions:

How do NIR fluorescence imaging technology applications in humans differ from conventional ones?
What are complementary approaches used to optimize?
Are devices used for NIR imaging expensive or not?
What advantages do small animal reflectance systems have?
Where is multichannel imaging used?
What results can multiparametric molecular analysis give?

15. Speak on the topic of the text.

16. Write an annotation on the text.

LESSON THIRTEEN

AUGMENTED REALITY MOVES CLOSER TO USE IN SURGERY

Pre-text exercises

1. Read the following for pronunciation:

augment [ˊɔ:gmənt]
x-way vision ['ekswei'viʒn]
pathology [pə'θɔlədʒi]
image-quidance system ['imidʒ'gaidəns'sistim]
transparent [træns'pɛərənt]
synchronize ['siŋkrənaiz]
entire [in'taiə]
anchor ['æŋkə]
via ['vaiə]
virtual ['və:tjuəl]

2. Try to guess the meanings of the words in bold type. Study the use of these words:

augment *v.* increase the value, amount, effectiveness of something
Augmented reality moves closer to use in surgery.

via *(prep.)* 1) traveling through a place on the way to another place; 2) using a particular person, machine to send something
They are linked via Internet connection to exchange registration information.

transparent *adj.* something that is transparent allows light to pass through it so that you can see the things through it
The video display as opposed to a semitransparent display was chosen for this reason.

entire *adj.* used when you want to emphasize that you mean all of a group, period of time, amount etc.0
The entire image is about 0.1 second behind real time.

anchor *v.* 1) fasten something firmly so that it cannot move; 2) provide a feeling of support or safety for someone

The virtual structures superimposed on the screen are always rigidly anchored to the image.

clamp *n.* a piece of equipment for fastening or holding things together

They use a sterilizable MR marker frame and a head clamp with the reflective registration markers.

fringe *n.* the part of something that is farthest from the centre

The surgery is done in the fringe field of MR magnet.

crude *adj.* 1) offensive or rude; 2) not developed to a high standard or made with great skill; 3) in natural or raw condition before it is treated with chemicals; 4) done without attention to detail

The device can be used for brain biopsies, which the surgeon characterizes as the simplest and most rational use, although he thinks it is still too crude to use in more complicated cases.

3. Give the Russian for:

augmented reality; to avoid damaging nerves; relevant information; 3-D data; a constantly changing viewpoint; to plan a surgical approach; valid; heavy and bulky; the current pace of miniaturization; complicated cases

4. Give the English for:

задержка, прозрачный, матовый, через, возможность, увидеть сквозь кожу и кости кровеносные сосуды, на экране, собирать необходимую информацию, для практических целей, всё изображение

AUGMENTED REALITY MOVES CLOSER TO USE IN SURGERY

Of all Superman's powers, the one that surgeons might covet the most is x-ray vision. The ability to see through skin and bone to locate pathology or to avoid damaging nerves, blood vessels or other delicate tissues would be a tremendous advantage in planning and performing surgery.

Many systems have been developed to help surgeons "see" through patients, from fluoroscopic C-arms to computed tomography and magnetic resonance (MR) scanners. Conventional image-guidance systems show the medical imaging data on a screen, with the image of the interventional instrument moving through it. These systems work well for many procedures, but none can collect and show all of the relevant information. The surgeon, for all practical purposes, ends up operating on the image on the screen.

According to Frank Sauer, researchers have been working on a different approach, called augmented reality, in which relevant anatomical structures are ren-

dered in 3-D on a computer. They are superimposed onto a view of the patient, either with a semitransparent screen through which the surgeon can see the operation site or with an opaque screen (or screens) showing a real-time video image of the site with the relevant images superimposed. In the more realistic systems, the superimposed image remains true to its actual location when viewed from different perspectives.

The prototype system that Sauer's team is developing has head-mounted display which has an opaque high-resolution monitor in front of each eye. A GP-KS1000 camera is mounted above each eye to provide a stereoscopic view of the surgical site. The cameras are focused to about arm's length, and the signal from each is fed to the corresponding eye screen.

Using a head-mounted display with forward-looking cameras makes for an intuitive setup — where the user looks is what appears on the screen. But superimposing 3-D data from an imaging data set in the correct location from a constantly changing viewpoint can be a problem. For any system in its "true" position, even in two dimensions, both data sets must be oriented to the same geographic location points, a process called registration. For the Siemens prototype, a third camera is mounted on the headpiece and surrounded by a ring of infrared LEDs.

The surgical workspace is framed with a number of retroreflective optical markers to provide information for registration and tracking. The system is calibrated and the information merged with the imaging data. The left eye and tracker cameras feed to an SGI 540, and the right eye camera feed to an SGI 320. Both computers are linked via Ethernet connection information and remain synchronized, and each provides an augmented video view of its corresponding screen.

Sauer said that the video display, as opposed to a semitransparent display, was chosen for one reason — the virtual structures superimposed on the screens are always rigidly anchored to the image. The video refresh rate is the standard 30 Hz, and the tracker camera is genlocked to the image cameras, so the system has registration information for every frame. Analysis occurs rapidly, and the system synchronizes the video and graphics so that the virtual image is always locked into the correct location in the image. The entire image is about 0.1 second behind real time. The problem with the semitransparent screen on which virtual images are displayed is that the field is in real time, and the images are constantly struggling to catch up, thus either swimming or creating jitter.

Gregory J.Rubino, a neurosurgeon who working with the Siemens group, found that the short delay with the Siemens prototype was not a problem and said he adapted to it easily. Now in private practice in Maryland, he also said that the original virtual structures were semitransparent shading, but they later were depicted as colored wire frames, which he found better. The system can download data directly from the imaging console, and the user can create wire-frame models of the significant structures from the data for insertion into the augmented view.

Sauer said the initial development is geared toward neurosurgery. For planning a surgical approach, the neurosurgeon can usually use preoperative images. But once the skull is opened, tissues shift, and the preoperative data is no longer valid. To deal with this, the Siemens group worked out a system to calibrate the

visual registration to updated MR data in the interventional MR suite. They use a sterilizable MR marker frame and a head clap with the reflective registration markers. After calibrating preoperatively the patient can be moved in and out of the magnet for image updates, which are immediately incorporated into the system.

As a prototype, it is still undergoing development. The 2-kg headpiece, for instance, is too heavy and bulky for a long surgical case. Sauer said they have seen units as light as 340 g, but those units don't have the resolution necessary. Given the current pace of miniaturization, it shouldn't be too long before a usable headpiece can be adapted.

Rubino said the device could be used immediately for brain biopsies, which he characterized as the "simplest and most rational use," although he thinks it is still too crude to use in more complicated cases. "But I think with further development, it could actually replace the operating microscope, which is a very valuable tool," he said.

There are some areas in which he would like to see improvement, in addition to the bulk and size of the headpiece. He said there is need to tie the virtual images, especially the deeper-lying ones, to the real video image, but without cluttering up the screen with a lot of irrelevant or distracting information. He said this is more a graphics than a scientific issue. He also would like to see more magnification in the system. According to Sauer, the cameras currently have fixed optics, with digital zoom available.

Rubino envisions using chemical and functional imaging with MR and other modalities to locate structures of interest. "I think it's a great technology. I think three to five years down the road it might be very clinically useful. It brings all the best technology together in a way that can really help maximally utilize the information."

Sauer said the next step is clinical testing, which the group hopes to have under way within a year.

Active words and word-combinations to be remembered

augment *v.*	увеличивать
via *(prep.)*	через
transparent	прозрачный
opaque	светонепроницаемый
entire	целый
jitter *n.; v.*	дрожание изображения; нервничать
delay *n.*	задержка
insertion	вставка
clamp.	зажим, скоба
fringe	край
crude	сырой, необработанный, грубый

issue	исход, результат, итог
merge	поглощать, сливаться
anchor	скреплять

Exercises

1. a) State the part of speech of the following words pointing out the word-building elements. Give their Russian equivalents.
preoperative; visual; stereoscopic; bulky; modify; immediately; valuable; modality; analyze; clockwise

b) Give derivatives of the following words
magnify; length; discriminate; continue

2. Arrange the words in bold type with those in brackets and translate the combinations into Russian

to exchange (opinions, ideas, books, greetings, information)
expensive (education, equipment, apparatus, fuel, service)
to damage (tissue, a control system, a house, the new equipment)

3. Arrange the words given in A and B in pairs of synonyms

A	obtain	B	regular
	chief		measurement
	routine		get
	dimension		main
	estimate		use
	apply		evaluate

4. Arrange the words given in A and B in pairs of antonyms. Match the word on the left with its opposite on the right

A	break	B	ban
	analysis		pull
	push		find
	lose		synthesis
	finite		agree
	refuse		cheap
	expensive		boundless
	allow		build
	destroy		repair

5. Translate the following sentences paying attention to the construction “it is (was) … that (who)…

- It is a neurosurgeon who can use preoperative images.
- It is the nucleus that carries a charge of positive images.
- It is this system that can download data directly from the imaging console.
- It was Mr.Rubino who could use this device immediately for brain biopsies.

6. Translate the following sentences paying attention to -ing forms.

- By examining the returning signals researchers can detect such cancer-driven changes.
- The photons travel up to a meter, moving from point to point in a random walk.
- From the data, company researchers derived a normalized standard deriva-tion of both hemoglobin concentration and oxygen saturation by dividing the standard deviation of the data by the difference between the maximum and minimum.
- At varying distances this image of a leg has the same stipple density with different point sizes.
- Optimazing the laser and fluorescence emission collection could drop this figure up to 10.000.
- They believe that using this approach they will be able to reduce their in-vestment in equipment.
- Understanding how membrane ion channels work is paramount to compre-hending the electrical function of cells.
- After perfecting the technical aspects of the technique for gramicidin, the re-searchers plan to apply it to understand the formation of other types of ion channels.
- Cell sorting is performed by breaking up the stream of cells into droplets.
- Omitting an area can be frustrating and inefficient whereas exposing the same area repeatedly may cause thermal damage.
- Choosing an appropriate fluorophore pair is not as easy as it sounds.
- Aimed at treating farsightedness, the laser heats the cornea through two con-centric rings of eight simultaneous sports of energy.
- One of the challenges in lasik surgery is cutting the cornea.
- By having green, red and yellow wavelengths readily available, oph-thamologists can tailor treatment to the patient.
- The technique may eventually lead to the ability to follow environmental changes of specific proteins by watching for changes in the refractive index.

7. Find the sentence with the Passive Voice, translate it (see paragraph 2)

8. Render the text into Russian

Scanning Laser Aids Capillary Electrophoresis

DNA analysis based on electrophoretic separation is a laboratory standard and courtroom star. In the customary capillary approach, DNA fragments are replicated and fluorescently tagged. They are placed in a capillary tube and a voltage is applied. The charged fragments travel down the capillary and separate according to their respective charge/mass ratios. As they pass a detection window, a laser shines on the streaming flow and induces fluorescence, providing DNA information. Similar separations can be done for proteins.

Now researchers at Los Alamos National Laboratory in New Mexico have developed an electrophoretic separation technique that employs a liquid core waveguide and potentially offers a number of advantages.

"Theoretically, the fluorescence trapping using an optical waveguide should give us two to three times higher efficiency than using external detectors," said José A.Olivares, a staff scientist at Los Alamos.

9. Render the text into Russian

PET/CT Combines Benefits of Imaging Techniques

When biological tissue is diseased, it undergoes biochemical as well as structural changes. Positron emission tomography (PET) detects biochemical changes, and computed tomography (CT) scans provide important information about tissue structure. Radiologists are now realizing that the telltale changes associated with several diseases might be easer to detect with a combination of these two imaging techniques.

Several groups presented the results of their PET/CT research at the annual meeting of the Society of Nuclear Medicine in Los Angeles in June. A number of possible applications of the technology are being explored, from diagnosing cancer, for which the Food and Drug Administration originally approved a number of indications, to predicting hardening of the arteries.

A research team from the University of Pittsburgh Medical Center's radiology department has been investigating the possibility of using method to detect lesions in patients with ovarian or cervical cancer. The group, which includes David Townsend and DR. Todd Blodgett, noted that many previous ovarian or cervical cancer patients had negative CT or ultrasound scans, despite presenting a marker in the blood that is indicative of recurrent malignancy. The researchers decoded to conduct combined PET/CT scans on these patients to see if they could detect any cancerous lesions.

They examined 15 ovarian carcinoma patients using a CT scanner and a PET/CT scanner. In 12 of the women, PET/CT revealed lesions that CT alone did not. The researchers also looked at 11 patients with cervical carcinoma; PET/CT identified additional lesions in five.

Townsend said that it is often difficult to distinguish between healthy and cancerous tissue based on CT alone, particularly in areas where tissue is dense. "While CT can detect the structural changes, you may in fact see a hot spot with PET without seeing any abnormality on CT."

The "hot spot" that he referred to is the uptake of fluorodeoxyglucose, a commonly used PET radiopharmaceutical that is taken up by tissue with an increased rate of glucose metabolism. This increase in activity may signify cancer, but also can result from a variety of other causes, such as inflammation or infection.

For instance, researchers from Johns Hopkins University School of Medicine in Baltimore believe that the uptake of fluorodeoxyglucose in the aortic wall may be an early sign of atherosclerosis, or narrowing of the arteries from the buildup of cholesterol plaques.

10. Say if the following statements are true, if they are not, correct them.

- Only two systems have been developed to help surgeons "see" through patients.
- Conventional image-guidance systems can't show the medical imaging data on a screen.
- The surgeon, for all practical purposes, can't end up operating on the image on the screen.
- Relevant anatomical structures are rendered in 2-D on a computer.
- In the more realistic systems, the superimposed image remains true to its actual location when view only from one perspective.
- The surgical workspace is framed with one retroreflective optical marker to provide information for registration and tracking.
- Both computers are linked via Ethernet connection to store registration information.
- Analysis of registration information occurs slowly.
- The entire image is about an hour behind real time.
- The original virtual structures are opaque shading.

11. Complete the following statements:

- Many systems have been developed to help surgeons "see" through patients…
- Conventional image-guidance systems show the medical imaging data on a screen…
- The surgeon ends up operating on the images on the screen…
- They are superimposed onto a view of the patient…
- Analysis doesn't occur slowly…
- The system can download data directly from the imaging console…
- Nobody can be moved in and out of the magnet for image updates…

- It shouldn't be too long before a usable headpiece can be adapted…
- The device was used immediately for brain biopsies…
- Several groups presented the results of their research at the annual meeting in Los Angeles…

12. Discuss these questions:

What systems have been developed to help surgeons "see" through patients?
What do conventional image-guidance systems show?
Why was the video display chosen for surgery?
What are the results of Gregory Rubino's research?

13. Speak on the topic of the text

14. a) Suggest titles for each paragraph of the text so that you have a detailed plan of the text.
b) Develop the titles into topic sentences.
c) Write a summary of the text.

LESSON FOURTEEN

OPTICAL TECHNIQUE GUIDES CARDIAC PROCEDURE

Pre-text exercises

1. Read the following for pronunciation:

heart [ha:t]	bypass [ˈbaipɑ:s]
sequence [ˈsi:kwəns]	executive [igˈzekjutiv]
coherence [kəuˈhiərəns]	diameter [daiˈæmitə]
muscle [ˈmʌsl]	superluminescent [ˈsju:pəlu:miˈnesnt]

2. Try to guess the meanings of the words in bold type. Study the use of these words:

clog *v.* block or become blocked with dirt, grease, etc – so that movement, flow of liquid, etc is difficult or prevented

Don't clog your memory with useless factors.

Clogged arteries that supply blood to the heart muscle are the main cause.

supply *v*. provide people with something that they need or want, especially regularly over a long period of time

Arteries supply blood to the heart muscle.

undergo something v. unpleasant that happens to you

More than 1.6 million people in the US underwent surgical procedures in 1999, according to the American Heart Association.

relieve *v.* 1) reduce someone's pain or unpleasant feelings; 2) make a problem less serious

Surgical procedures help to relieve problems with the blood supply to human hearts.

obstruct *v.* 1) block; 2) try to prevent someone from doing something by making it difficult for them

A total blockage obstructs the doctor's view of the artery path.

perforate *v*. make a hole in something

Trying to open a blockage blind increases the chances that the catheter will perforate the artery.

guide *v.* help someone from doing something by making it difficult

A stand-alone system guides the catheter and warns the operator when the wire approaches the arterial wall.

steer *v.* control the direction something is going

Radiopaque dye is injected to reveal the outline of the artery and the angled tip is turned to steer the guide wire.

tip *n.* 1) the end of something, especially something pointed; 2) area where unwanted waste is taken and left

The company is testing a second-generation product, called safe-cross, which uses safe-steer technology with a special tip and controlled radio-frequency energy to cut through blockage.

calcify *v.* become hard or make something hard, by adding lime

Older blockages can calcify making them resistant to penetration with the guide wire alone.

seek *v.* (seek –sought – sought) 1) look for; 2) try to achieve or get something

The company has not sought approval for neurologic use.

3. Give the Russian for:

clogged arteries, to bypass blockages, angled tip, optical coherence reflectometry, remotely guided angioplasty, to increase changes, a flexical coated glass fiber

4. Give the English for:

изделия первого поколения, затвердевать, луч, ультразвуковой датчик, доступный, болезнь сердца, лекарство, сердечная мышца, подача крови, проникать

5. Give derivatives of the following words:

bulk, improve, able, part, obstruct, perforate

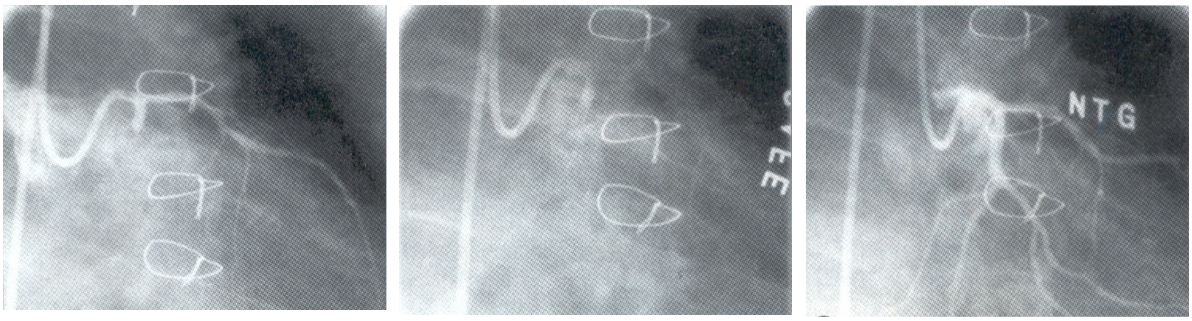
6. Using the prefix “un” – give antonyms to the following adjectives and translate them:

kind, just, satisfactory

OPTICAL TECHNIQUE GUIDES CARDIAC PROCEDURE

Heart disease is a leading cause of death and disability in the industrialized countries of the world, and clogged arteries that supply blood to the heart muscle are the main cause. Although diet, exercise, lifestyle changes and new drugs can treat heart disease, for many people surgery becomes the only option.

More than 1.6 million people in the US underwent surgical procedures to relieve problems with the blood supply to their hearts in 1999, according to the American Heart Association. One of the most widely used techniques to open or bypass blockages is to thread a catheter backward up the aorta and into the coronary arteries, where it can penetrate the blockages. This works well when the artery is only partially blocked, but a total blockage obstructs the doctor’s view of the artery path. Trying to open a blockage blind increases the chances that the catheter will perforate the artery.



A B C

Fig. 22. A sequence of x-rays shows the Safe-Cross catheter/guide wire in a totally blocked coronary artery. Radiopaque dye (and the catheter) shows up as white. (A) The obstructed artery is the short whitish vertical segment with the blunt end in the center of the image. The blockage is invisible but present , because the dye flow is stopped. It is impossible to see where the artery goes past the blockage. (C) The artery is open and dye is flowing into the branches past where the obstruction was.

One company has taken advantage of recent advances in fiber optics to develop a stand-alone system to monitor the progress of the wire that guides the catheter and to warn the operator when it approaches the arterial wall. He can then turn its angled tip and continue through the blockage.

IntraLuminal Therapeutic Inc. of Carlsbad, Calif., has developed a system using optical coherence reflectometry and proprietary software, which can be used with a standard-size guide wire and tip. John Neet, executive vice president and

chief technology officer, said the system needed a flexible, coated glass fiber that would maintain polarization and fit inside a coronary guide wire that is 355.6 µm in diameter. He said acrylic-coated fibers are too thick, but a polyimide-coated fiber with an outside diameter of 152.4 µm fit the bill. In addition, the polyimide-coated fiber is stable up to 3000˚C, so it can be easily sterilized.

Typically, when a surgeon inserts a catheter, it and the guide wire show up on a x-ray and are guided to the openings of the diseased coronary arteries by fluoroscopy. Radiopaque dye is injected to reveal the outline of the artery, and the angled tip is turned to steer the guide wire. Optical coherence reflectometry allows the doctor to determine which direction to go.

Neet explained that the technology is similar to optical coherence tomography, except that, instead of building an image, it examines a single point in real time. A beam of low-coherence light from a superluminescent LED with a near-infrared output centered at 1.300 nm splits, with half the beam going down a reference arm, where a mirror reflects it. The other half goes down the fiber, which looks out the angled end of the guide wire like a headlight. The fiber collects reflected and backscattered light and transmits it back, where it recombines with the reference beam in an interferometer that scans at 10 Hz.

Proprietary software analyzes the signal from the interferometer and displays the results as an X-Y graph. The materials that block arteries have values considerably different from the arterial wall, and Neet said it is relatively easy to tell if the tip is headed toward the wall or through the obstruction. Once the guide wire gets through the blockage, standard procedures such as balloon angioplasty or stent placement can be done.

Fig. 23. This image shows a blocked coronary artery in a pig's heart after a 355.6-µm guide wire passed through the blockage. The arrow at the top right points to the arterial wall, while the two arrows at the bottom point to the holes created by the wire in an occluded porcine coronary left anterior descending artery.

The 1.300-nm wavelength allows visualization 0.5 to 0.75 mm ahead of the tip, Neet said, and the resolution is less than 30 μm, well below what is possible with ultrasound. No ultrasound transducer is small enough to fit inside a guide wire, in any case.

IntraLuminal's first-generation product, called Safe-Steer, recently received clearance from the Food and Drug Administration for use in the US. It has been available for some time in Europe. The company is testing a second-generation product, called Safe-cross, which uses Safe-Steer technology with a special tip and controlled radio-frequency energy to cut through blockages.

Older blockages can calcify, making them resistant to penetration with the guide wire alone, and the radio-frequency energy makes a hole large enough to pass the wire, Neet said. The cutting energy is interlocked with the optical coherence reflectometry to prevent its use too close to the arterial wall. He said the device can treat obstructed arteries in other parts of the body also, such as the kidneys or legs. The company has not sought approval for neurologic use.

Remotely guided angioplasty using a wire and catheter, where the only incision is a small hole in an artery in the groin, is clearly less invasive than the next most common alternative, coronary artery bypass graft surgery, where the chest cavity is opened. This new technique may allow more patients to undergo the less traumatic angioplasty procedure and get back on their feet more quickly.

***Notes*:**

remotely guided angioplasty – быть управляемым на расстоянии

Active words and word-combinations to be remembered

clog *v.*	препятствовать
relieve *v.*	облегчать, ослабить
thread *n., v.*	нить, пронизывать
obstruct *v.*	преграждать, создать препятствие
perforate *v.*	просверливать, перфорировать, пробивать отверстие
undergo procedures	принимать процедуры
chest cavity	грудная полость
to be similar to something	быть подобным чему-либо
insert *v.*	вставлять
calcify *v.*	превращать в известь, отвердевать
steer *v.*	управлять рулём, руководить, направлять
blind	слепой
bypass *v.*	обходить, не принимать во внимание
groin	пах

Exercises

1. Give examples using the following prefixes:

re-; pre-; post-; over-; under-

2. Arrange the following words in bold type with those in brackets and translate the combinations into Russian

to undergo (procedures, an operation, suffering, a great change)
unique (solution for the problem, place, description, ability in something, opportunity)
to waste (fuel, an opportunity, time, money, energy, a chance)
tissue (biological, living, organic, nerve)
remote (place, future, ages, prospect, idea, analogy)
relevant (details, information, problem, remarks)
to obstruct (a road, the traffic, a view, the light, a sound, a person to do something)
to relieve (problems, cough, somebody's mind, the pressure)
to steer (a car, a ship, one's way, a steady course, a country to peace)

3. Arrange the words given in A and B in pairs of synonyms

A	link	B	substitute
	desire		dear
	replace		waste
	expensive		wish
	lose		bond

4. Translate into Russian paying special attention to different forms and functions of the participles.

- It can be a painstaking, time-consuming process when performed by hand.
- When plotted against biopsy results, the normalized standard deviation showed a correlation to normal tissue, benign tumors and in situ and invasive carcinoma.
- When using these dyes to stain and sort viable cells, there is concern that highpower pulses by UV light might damage cells.
- When observed in different area, the action in the newly illuminated region would be immobile at first but would begin to move after two or three minutes.

- It just provides the physician with an accurate view of the muscle's thickness which, if carefully examined, can indicate heart disease.
- When having measured fluorescence, the large tumor showed a much higher intensity than the small one.
- The fluorophores which fluoresce at a low intensity when attached to the nanoparticles, can be "activated" when separated from it, causing their fluorescence intensities to increase significantly.
- Newton, having introduced the concept of force into mechanics applied this concept to help explain the cause of the motions of the planets around the sun.
- The particles thought to propagate the gravitational force should also be massless.
- Compared with a beam of light a beam of electrons has not only a short wavelength but also a large amount of energy.
- Having made these observations they restricted the discussion to considerations totally within the bounds of the general theory of relativity.

5. Translate the following noun-groups into Russian:

executive vice president –
chief technology officer –
balloon angioplasty –
second-generation products –
coronary artery bypass graft surgery –
standard-size guide wire –

6. Read the text below and
a) find the answers to these questions:

What has PET in connection with FDDNP, a new chemical marker, enabled researchers to see for the first time?
What did the experiments in Los Angeles show?
What does PET measure?

PET Uncovers Fist Signs of Alzheimer's Disease

Positron emission tomography (PET), in combination with FDDNP, a new chemical marker, has enabled researchers to see for the first time in living patients the amyloid plaques and tangles indicative of Alzheimer's disease. Although no one is sure exactly how or why these plaques form, they are widely considered hallmarks of the early stages of the disease.

Experiments at the University of California's School of Medicine in Los Angeles showed that Alzheimer's patients ranging from 62-85 years old exhibited unusually high concentrations of the FDDNP tracer molecule in the memory centers of the brain. Prior to the study, viewing these brain lesions was possible only after a patient had died.

The researchers conducted the procedure on nine patients and seven control subjects. Each patient was positioned in a PET scanner and given an injection of FDDNP in the arm. Immediately afterward, a series of scans of varying duration were performed, some lasting up to 20 minutes.

"The signal was highest in Alzheimer cases in the brain's centers where we know from autopsy studies that the plaques and tangles accumulate," said Dr. Gary Small, a professor of psychiatry at the university and co-author of paper that appeared in the January issue of the *American Journal of Geriatric Psychiatry.* The signal also correlated with memory performance, with a higher signal seen in more impaired performance, he said.

The technique marks the first time that PET scans have been used to evaluate what is thought to be the cause of the disease, rather than to track its progression. Pioneered by Michael E. Phelps, another researcher at the university, PET measures the concentration of positron-emitting radioisotopes within the tissue of living subjects.

b) translate the first sentence of paragraph 5 of the text above paying attention to the Infinitive Construction.

7. Before you read the text, look at the sentences and see if you can guess the missing words. Then find the answer to the question in the text below.

- For years researchers have used a number of … in the hope of detecting Alzheimer's disease.
- The most immediate benefit of the technique may come in early diagnosis and … trials in the next few years.
- This may offer a more accurate approach to early…

What does this technique mark?

For years, researchers have used a number of techniques in the hope of detecting Alzheimer's, including magnetic resonance imaging, genetic screening and, more recently, PET in combination with APOE-4. Despite these advances, the initial diagnosis could be made only after significant pathological changes had occurred within the brain.

One of the biggest hurdles was finding a suitable chemical marker that was both nontoxic and able to pass through the so-called "blood-brain barrier." EDDNP, which was first synthesized five years ago, is hydrophobic, meaning that it avoids watery areas of the body. It was also attracted to those hydrophobic central areas of the plaques and tangles — making them easy to identify in a PET scan.

The most immediate benefit of the technique may come in early diagnosis and drug trials in the next few years.

"One of the problems with Alzheimer's disease is that by the time we diagnose the disease clinically, it's too late," said Jorge R. Barrio, professor, of medical and molecular pharmacology and principal investigator at the university. "If we can identify patients at risk earlier on, we have a better chance at successfully treating the disease."

"This may offer a more accurate approach to early diagnosis and will assist with drug discovery," Small said. "New drugs often aim to clear out the plaques and tangles. Scientists now can see if the drug works in a few samples before deciding to test it in large samples."

According to Barrio, a number of such drugs are now in the pipeline at leading pharmaceutical companies.

8. Fill the gaps in the sentences below with a suitable proposition from this list:

on, as, of, for, to, in, in, in, to, from, through, for, for

- Clogged arteries supply blood … the heart muscle.
- Heart disease is a leading cause of death and disability … the industrialized countries of the world.
- … many people surgery becomes the only option.
- One company has taken advantage … recent advances in fiber optics.
- A coronary guide wire is 355.6 μm … diameter.
- This technology is similar … optical coherence tomography.
- Proprietary software analyzes the signal … the interferometer.
- Proprietary software displays the results … an X-Y graph.
- Once the guide wire gets … the blockage, standard procedures, can be done.
- It has been available … some time in Europe.
- The device can treat obstructed arteries … other parts of the body.
- The company has not sought approval … neurologic use.
- This new technique may allow more patients to get back … their feet more quickly.

9. Say whether the following statements are true, if they are not, correct them.

- This new technique may allow more patients to undergo the more traumatic angioplasty procedure.
- The company has sought approval for neurologic use.
- Older blockages never calcify.
- The radio-frequency energy can't make a hole large enough to pass the wire.
- The company is already testing a fifth-generation product called safe-cross.
- Any ultrasonic transducer is small enough to fit inside a guide wire.

10. Fill the gaps in the sentences below with suitable forms of the verbs from the list below:

undergo, move, want, be, allow, tell, base, produce, talk, use, combine

- This new technique … more patients to get back on their feet more quickly.
- Heart disease … a leading cause of death and disability in the world.
- A lot of people in the use … surgical procedures to relieve problems with the blood supply to their hearts.
- The problem was that they … to locate the station on this level.
- As any microscopist … you, you can't get a clear image of anything if the floor on which the microscope sits … in response to every passing footstep or cable car.
- The color device … on an innovative technique. The modulated beams … with a fiber optic system.
- They … images using these instruments for about 10 years.
- As part of s National Marine Fisheries Service program, researchers … IR imaging to study dolphins captured in tuna fisheries in the eastern tropical Pacific.
- The companies … with about developing applications and new sampling protocols for the technique.

11. Divide the text into logically complete parts and entitle these parts using both sentences from the text and sentences of your own.

12. State the main ideas of the text "Optical Technique Guides Cardiac Procedure" in 10-12 sentences.

13. Write a summary of the text.

Topic for discussion:

Optical technique for treating heart diseases.

LESSON FIFTEEN

LASER RANGE SCANNER HELPS SURGEONS NAVIGATE

Pre-text exercises

1. Read the following for pronunciation:

consistency [kən'sistənsi]	gear [giə]
awkward ['ɔ:kwəd]	triangulation [trai'æŋgjuleiʃən]
interior [in'tiəriə]	phantom ['fæntəm]
tonque [tʌŋ]	variable ['vɛəriəbl]

2. Try to guess the meanings of the words in bold type. Study the use of these words:

anticipate *v.* 1) expect that something will happen and be ready for it,
2) think about something that is going to happen, especially something pleasant,
3) do something before someone else,
4) use or consider something before you should

Mr. Huston anticipates that after a year or two of testing, the technique will move into wider-scale experimental use in operating room.

indicate *v.* point to, show that a particular situation exists, direct someone's attention to something

This indicates an operation.

incorporate *v.* include something as a part of a group, system, plan

The article incorporates the newest information.
Truth and falsehood will not incorporate.

consistency *n.* 1) the quality of always being the same;
2) how firm or thick a substance is

The solution to the inconsistency is updating the images to incorporate shifting of the organ.

trial *n.* 1) a process of testing to find out whether something works effectively and is safe,
2) a short period during which you use something or employ someone to find out whether they are satisfactory for a particular purpose or job
The system has years of clinical trials.

mis *(prefix)* - bad, wrong, lack of something
match *v.* be equal to, to correspond with (in quality, colour, design, etc.)
The resulting mismatch between image and organ can mean missing a large portion of a malignant tumor during brain surgery.

dismiss *v.* refuse to consider someone's idea, opinion etc, because you think it is not serious, important etc
The cost and awkwardness of having such a bulky device in a cramped space has led many to dismiss this idea.

encompass *v.* cover or surround something completely
The brain is still a relatively stable organ because it is encompassed by the cranium.

afford *v.* 1) be able to do something without causing serious problems for yourself,
2) provide something or allow something to happen
Laser range scanning affords a fast, accurate, noncontact method of measuring the current shape of organs.

3. Give the Russian for:
to precisely target; incision areas; to cut an artery; during liver ablation; under the force of gravity; to produce custom-fit golf shoes; gear for soldiers; tumor margins

4. Give the English for:
полезное приспособление, быстрое выздоровление пациента, операционная, стоимость, громоздкий прибор, под давлением, быть окруженным чем-либо, исследовательская работа, внутренняя структура, создавать компьютерные модели

5. Give derivatives from the following nouns, using the suffix "y" and translate the obtained adjectives:
speed, bulk, sponge, cloud, rain, frost

LASER RANGE SCANNER HELPS SURGEONS NAVIGATE

A map can be a useful tool when on a road trip into unknown territory. Knowing where to turn can make the difference between a speedy arrival and losing hours. But in the operating room, having a map can make the difference between a patient's speedy recovery and additional painful surgery.

Such "maps" are commonly magnetic resonance (MR) or computed tomography (CT) images taken of an organ before surgery. They can indicate the location of organ features and precisely target incision areas, but the territory marked out by these images shifts dramatically under pressure from outside forces such as gravity or a surgeon's touch. The resulting mismatch between image and organ can mean missing a large portion of a malignant tumor during brain surgery or accidentally cutting a major artery during liver ablation.

The solution to the inconsistency is updating the images to incorporate shifting of the organ. One option is setting up for an MRI in the operating room; however, the cost and the awkwardness of having such a bulky device in a cramped space has led many to dismiss this idea.

Researchers in the department of biomedical engineering at Vanderbilt University in Nashville, Tenn., may have found a more plausible way to chart the changes. They use a commercially produced laser range scanner that images an organ during surgery to keep track of how reference points on the organ move. They then use a PC to compare these points against preoperative images and to construct a computer model of the organ that approximates how the interior structure has changed.

This navigation technique has already been tested in numerous brain surgeries. The trials have shown that such a modeling technique can easily accommodate more than half of the organ's deformations. However, although spongy brain matter can shrink, expand or sag under the force of gravity, the brain is still a relatively stable organ because it is encompassed by the cranium.

At Febryary's SPIE Symposium on Medical Imaging in San Diego, the Vanderbilt team presented research work on a greater challenge: using this technique to create computer models during liver ablation and resectioning surgery. The liver, which has a consistency similar to the human tongue and which is not supported by bone structure, can deform on the scale of centimeters in many directions – making it far more difficult to reference and chart.

"We thought it was time for the technology to grow up," said professor Robert L.Galloway. "To make this technique viable for ORs, it must be able to accommodate more radical changes than you find with brain surgery."

One of the first incarnations of the technique used freehand probes that had to be repeatedly touched to the organ's surface to acquire point-by-point data. The contrast easily deformed soft tissue. The device is designed for use in a wide variety of research and commercial applications. A manufacturer images golfer's feet

to produce custom-fit golf shoes, and the US military uses it to individualize gear for soldiers.

"Laser range scanning affords a fast, accurate, noncontact method of measuring the current shape of organs," said Michael I.Miga. "With the incorporation of the laser scanner, we don't have to worry about deforming the organ even further while we are trying to accommodate for deformations already present."

The 3.5-lb scanner uses a 530- to 672-nm, 8-mW laser and CCD array, both commercially available from various companies. Tests on a silicon liver phantom revealed that the scanner can capture more than 13.000 data points along exposed organ surfaces in little more than 20 seconds with submillimeter accuracy.

To use the scanner as part of the navigation technique, a surgeon first prepares an exposed organ and "packs" it so that it moves as little as possible during the operation. The scanner then sweeps the organ from a mechanical-arm-mounted position one to two feet away, using optical triangulation to establish a point-based reference grid, which is entered into a computer for cross-referencing with previous MRI or CR images. The computer determines how the organ's surface points have shifted and aligns the surface with its counterpart in the images.

The change in position of the points is correlated with algorithms estimating tissue elasticity and other general physical properties of the organ's structure to approximate a final computer model of the entire organ. For better estimation, surgeons also will use operating room ultrasound scans to provide updates of known deformations such as the movement of tumor margins. Using simple linear algorithms, the system can already accommodate up to 70 percent of deformation in some surgeries. That percentage will continue to grow as more complex algorithms are developed and the overall technique is refined.

The team has run only a few liver trials so far but has received funding to continue. Miga anticipates that, after a year or two of testing, the technique will move into wider-scale experimental use in operating rooms.

No matter how refined or widely used, however, a road map does not replace the eyes and instincts of a driver, and the technique is not intended to be the surgeon's sole guidance. Computational and scanning errors can and do happen.

"Just like any imaging system, there is a possibility of being misled," said Dr. William E. Chapman. "This will only be one component, along with a number of other surgeon-controlled variables. If things don't add up, then you stop and get the proper orientation."

The technique's primary purpose is to reduce the guesswork of surgical navigation by turning static, preoperative images into real-time guidance. The system has years of clinical trials and refining ahead; but one day, it may be a widely available and inexpensive way to give a sixth sense of direction to surgeons who can't afford to take a wrong turn.

***Notes*:**

lb - libra *лат.* - фут
spongy brain matter - пористое вещество мозга

cranium *лат.* - череп

Active words and word-combinations to be remembered

inconsistency *n.*	неустойчивость
incision *n.*	разрезание, надрезание
cramp *n., v.*	зажим; суживать
sponge *n.*	губка
sag *n.; v.*	прогиб; прогибать, ослабевать
tongue *n.*	язык
incarnate *v.*	воплощать
gear *n.*	1) механизм, приспособление устройство 2) одежда
margin *n.*	край, грань, предел
anticipate *n.*	ожидать, предвидеть

E x e r c i s e s

1. State the part of speech of the following words pointing out the word-building elements. Give their Russian equivalents.

navigate — navigability — navigable — navigator — navigation — navigational
vary — various — variously — variety
refer — referable — reference
anticipate — anticipation — anticipative — anticipatorily — anticipatory — anticipator
accident — accidental — accidentally
rich — enrich — enrichment
produce — producer — producible — product — production — productive — productivity

2. What do these pairs of words mean?

match — mismatch
miss — dismiss
lead — mislead
part – counterpart
contact — noncontact

3. Combine the words given in A with those given in B in pairs of antonyms.

A	move	add	B	useless	stand
	useful	give		subtract	different
	similar	find		take	lose

4. Write these abbreviations out in full:

MR
CT
3-D
lb
MRI
PC
Corp.

5. Arrange the following words in bold type with those in brackets and translate the combinations into Russian:

to anticipate (a success, a happy solution, a failure, a refusal, a disaster, a mistake)

to incorporate (a suggestion in a plan, information, one's thoughts into an article)

to incarnate (an idea, a dream, a vision in a sculpture(painting), the spirit of one's time)

to indicate (the way, the temperature, the location)

can't afford (the journey, the time, the money)

to afford (to speak freely, an opportunity, shelter, satisfaction)

6 Point out the nouns used as attributes (see the text, paragraph 2)

7. Translate into Russian paying attention

a) to the Emphatic Construction

Computational and scanning errors can and do happen.

b) to the Elliptical Construction

No matter how refined or widely used, however, a road map does not replace the eyes and instincts of a driver.

c) to the modal verb with Perfect Infinitive

Researchers in the department of biomedical engineering at Vanderbilt University in Nashville, Tenn., may have found a more plausible way to chart the changes.

8. Prefix can be used with words to alter their meaning. Look at the verbs in bold type. What are the differences in meaning?

- I arranged all these papers tidily on my desk, now someone has **rearranged** them all.
- She told him she never wanted to see him again. She expected him **to react** sensibly, but he threw himself on the ground and started crying. He **overreacted** as usual.
- I estimated the work would take five minutes but I **underestimated** how difficult it would be.
- What is worse: **pre-holiday** tension or **post-holiday** depression?

9. Read the following text and render it in Russian

TAGGING TECHNIQUE ALLOWS DUAL VIEWS

A new tagging approach has allowed researchers to use both light and electron microscopy to observe proteins as they mature, from structures, are modified and then degrade.

Scientists employ several tagging techniques to study protein dynamics. Their use of GEP and its derivatives allows easy and efficient monitoring of the protein distribution, but these tags are bulky and often larger than the protein being studied. They also cannot be used easy to highlight different stages of protein maturation. The green to red maturation of DsRed can provide information about protein maturation, but the color change is spontaneous, occurs gradually and cannot be easily manipulated to highlight a particular stage in a protein's life. Furthermore, none of these tags can be viewed with electron microscopy and thus cannot be used to correlate images captured with electron and light microscopes.

In the new technique, the protein of interest is engineered to contain a small receptor domain that is recognized by small, membrane-permeant, nonfluorescent ligands. Upon binding to the receptor domain, the ligands become brightly fluorescent. Researchers from the University of California, used two of these ligands to sequentially label temporally separated pools of a gap junction protein.

Older and newer proteins could be sharply distinguished under the light microscope, and the oxygen generated by one of the ligands could be used to produce a reaction product that could be imaged by electron microscopy. The approach could be extended to other protein systems.

10. Read the following text and state the main ideas in English

Two-photon excitation of fluorescent markers has proved to be useful in imaging living brain tissue because it has a high depth resolution. In theory, it is simple. A fluorescent marker that activates at a particular wavelength will activate at twice that wavelength as well. For this to happen, a powerful laser must hit the marker with two of the longer-wavelength photons almost simultaneously. Because high powers are needed, two-photon activation happens only when the laser beam is focused by a microscope objective and then only in the focal volume. That's good for research because it avoids a cone of fluorescence leading to the focal point. In addition, longer wavelengths are less damaging to living specimens and penetrate tissue more deeply.

With these advantages in mind, especially the ability to limit the effects of the light to the laser's focal volume, Kasai set out to use two-photon excitation to uncage glutamate. He explained that, when he began in 1995, a glutamate cage that had the four features necessary for his work did not exist. Useful cages must have a two-photon cross section large enough to be excited by a femtosecond laser operating in the infrared. They also must be rapidly photolyzed. "Photolyzed compounds diffuse before binding to their targets. The diffusion can substantially deteriorate the spatial resolution, even when the photolysis is as fast as 50 μs," he said.

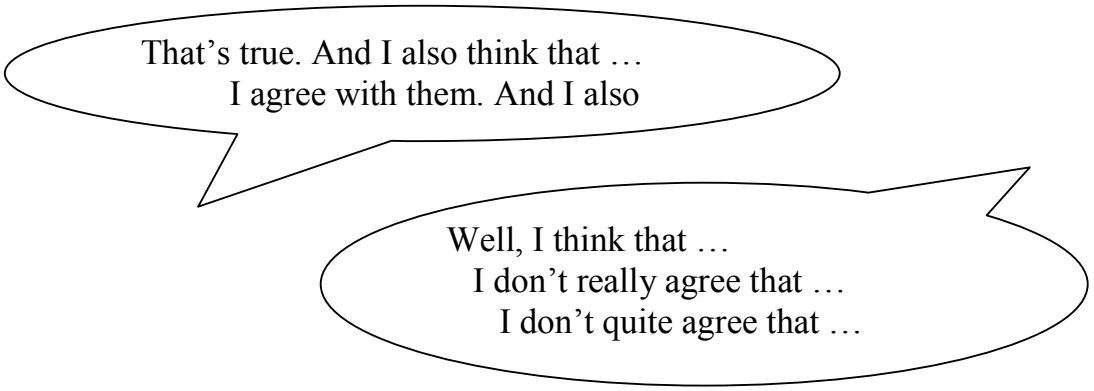
In addition, the cages must be very stable so that free glutamate cannot contaminate the sample and prevent analysis. And finally, they must be biologically inert. "Upon irradiation, caged glutamate is cleaved into glutamate and a free protective group. It is crucial that both the caged compound and the protective group do not have any biological effect upon neurons"

To address this need, Kasai turned to Graham C.R.Ellis-Davies in Philadelphia, who has developed several caged compounds widely in use and has synthesized several new caged glutamate compounds for two-photon testing. One by one, the Japanese group tested them until they found one, MNI-glutamate, that met the four requirements.

11 Complete the following statements:

- This navigation technique has already been tested in numerous brain …
- Such"maps"are commonly MR or CT images taken of an organ before …
- They can indicate the location of organ …
- The device is designed for … in a wide variety of research.
- A surgeon first prepares as exposed organ and "packs" it so that it moves as little as possible during the …
- Michael J. Miga anticipates that after a year or two of testing, this technique will move into wide use in …
- The computer determines how the organ's surface with its counterparts in the …

12. Say whether the following statements are true, of they are not, correct them using the phrases in the balloons below.



- The cost of this device has led many to accept this idea.
- They then use a PC to compare these points against post-operative images and to construct a computer model of the organ that approximates now the interior structure has changed.
- The brain is not a stable organ.
- The device is designed for use only in industry.
- Using simple linear algorithms, the system can already accommodate up to 90 percent of deformation in some surgeries.
- A road map replaces the eyes and instincts of a driver.
- Computational and scanning errors never happen.

13. Give questions to which the following statements might be the answer:

- They can indicate the location of organ features.
- The device is designed for use in a wide variety of research and commercial applications.
- The change in position of the points is correlated with algorithms estimating tissue elasticity and other general physical properties of the organ's structure.
- If things don't add up, then you stop and get the proper orientation.

14. Answer the following questions:

What can having a map in the operative room make?
What are such maps?
What have the researchers in Nashville found?
What do they use a PC for?

15. Look through the main text and say what part serves as introduction, main part and conclusion. Give a summary of the text.

LESSON SIXTEEN

TARGETED IMAGING USING ULTRASOUND CONTRAST AGENTS

Pre-text exercises

1. Read the following for pronunciation:

biochemistry [ˈbaiəuˈkemistri]
angiology [ˌændʒiˈɔlodʒi]
angiogenesis [ˈændʒi:əˈdʒenisis]
therapy [ˈθerəpi]
echo [ˈekəu]
fortuitous [fɔ:ˈtju(:)itəs]
excitation [ˌeksiˈteiʃən]
echogenicity [ˈekoudʒəˈnisiti]
rehydration [ˌrihaiˈdreiʃən]

2. Try to guess the meanings of the words in bold type. Study the use of these words:

inception *n.* (formal) start
The doctor understands that is the inception of a serious disease.

hinder *v.* make it difficult for something to develop or succeed
Don't hinder me in my word.
This low blood-to-tissue signal ratio hinders the detection of small blood vessels.

distinguish *v.* 1) see, hear, recognize, understand well the difference
The twins were so alike that it was impossible to distinguish one from the other.
2) make out by looking, listening
A person with good eyesight can distinguish distant objects.
3) be a mark of character, difference
Speech distinguishes man from animals.

Furthermore the echoes from ultrasound contrast agents can be distinguished from those of other strong scatters.

rely on *v.* depend (on) with confidence, look to for help

He can always be relied on.

Several strategies have resulted from these investigations including harmonic imaging, which relies on detection of harmonics of the transmitted frequency produced by bubble oscillation.

delineation *n.* description of, a diagram of

signature *n.* 1) person's name signed by himself; 2) something that is closely related to an event

Can I have your signature on these letters?

They pay attention to noninvasive detection of pathology using disease-associated molecular signatures, detection of gene expression, investigation of drug localization and delineation of molecular mechanisms of disease.

replenish *v.* 1) fill something again; 2) put new supplies into something

Microbubble destruction is also exploited in "destruction-replenishment" techniques that estimate local perfusion.

mean *adj.* occupying the middle position between two extremes: the mean annual temperature in Malta

These nanoparticles have a mean diameter around 250 nm.

disrupt *v.* prevent something from continuing in its usual way by causing problems

Their quarrels are likely to disrupt the meeting.

The researchers are going to use freeze drying that may disrupt the lipid bilayers.

3. Give the Russian for:

ultrasound contrast agents; the article summarizes; an emphasis on the opportunities; both clinical and research applications; delineation of molecular mechanisms of disease; the interaction of ultrasound with contrast microbubble

4. Give the English for:

мешать, препятствовать, пополнять, снова наполнять, полагаться на что-либо, улучшить чувствительность ультразвука к чему-либо, новейшие ультразвуковые приборы, способность находить различие, лечение

5. Give derivatives of the following words:

replenish, incept, custom, sound, apply

TARGETED IMAGING USING ULTRASOUND CONTRAST AGENTS

The application of ultrasound contrast agents have recently expanded from blood pool enhancement to include passive targeting of physiological systems (in particular, the lymphatic and reticuloendothelial systems) and molecular imaging of factors expressed in angiogenesis, atherosclerosis, and inflammation. This article summarizes the progress made in targeted imaging using ultrasound with an emphasis on the opportunities this research provides for both clinical and research application. We begin with a summary of current ultrasound contrast technology and then review the latest research in the use of targeted ultrasound contrast agent.

Ultrasound is unique among the most popular medical imaging modalities—including X ray, computed tomography (CT), and magnetic resonance imaging (MRI) — that from its inception it has had roles not only in anatomical imaging but also in the imaging of physiology, as in the investigation of blood flow with Doppler ultrasound, and in therapy, as in the high-intensity focused ultrasound ablation of tissue. In the past 15 years, the clinical applications of ultrasound have been expanded with the development of intravascular ultrasound contrast agents, which improve the sensitivity of ultrasound to the blood pool. At the same time, significant advances have been made in the understanding of biochemistry. The newest ultrasound techniques combine ultrasound imaging technology with *actively targeted* ultrasound contrast agents; that is, agents to which one or more biologically active molecules have been attached such that the agents localize in a specific area of interest. Using targeted agents, ultrasound researchers hope to extend the clinical and experimental roles of ultrasound even further, into applications including noninvasive detection of pathology using disease-associated molecular signatures, detection of gene expression, investigation of drug localization, and delineation of molecular mechanisms of disease.

There are thousands of potential targets available for study by targeted contrast imaging. For example, adhesion molecule-1 (ICAM-1), and the fibrinogen receptor GPIIb IIIa are over expressed in regions of angiogenesis, inflammation, and thrombus, respectively. These molecular signatures can be used to localize ultrasound contrast agents through the use of complimentary receptor ligands attached to the contrast agent shell such that the ligand-receptor interaction tethers the agent to the cell of interest. If ultrasound techniques can be developed to detect these bound agents with high sensitivity, targeted imaging could make possible earlier, noninvasive detection of disease. Furthermore, the ability to differentiate between different disease-indicative molecular signatures could allow early assessment of pathology and expedite the design of customized treatments.

Blood is two to three orders of magnitude less echogenic than tissue due to the relatively small acoustic impedance difference between red blood cells and plasma. This low blood-to-tissue signal ratio hinders the detection of small blood vessels. Ultrasound contrast agents, typically between 0.1 and 8 μm in diameter, increase the echo amplitude from the blood pool and allow the detection of vessels

even as small as capillaries. To date, three general categories of agents have been studied: microbubble agents, liposomal agents, and perfluorocarbon-emulsion nanoparticles.

Lanza et al. have described the use of perfluorocarbon emulsion nanoparticles as ultrasound contrast agents. These nanoparticles have a mean diameter around 250 nm (approximately one-tenth that of typical microbubble agents), and they are composed of a lipid-encapsulated perfluorocarbon liquid. Their liquid composition makes them resistant to pressure and mechanical stress. Hall et al. have developed theoretical models for estimating acoustic reflectivity of different perfluorocarbon nanoparticles formulations. Their echogenicity is not as great as that of a gas-filled agent of similar size; however, their echogenicity increases when they are deposited in a layer. Furthermore, they have demonstrated that these nanoparticles can also serve as MRI contrast agents when gadolinium is incorporated into their lipid shell, so they may be useful for multimodality imaging studies.

They have also demonstrated the application of echogenic liposomes, less than 1μm in diameter, as ultrasound contrast agents. Liposomes are not typically echogenic, but these researchers have identified a formulation involving lyophilization (freeze drying) that may disrupt the lipid bilayers so that, upon rehydration, they entrap small amounts of air. Although they are subresonant scatters, their acoustic reflectivity at high concentrations is comparable to that of Optison at a low clinical concentration. Liposomes can be easily conjugated to antibodies or other adhesion ligands and, thus, are readily configured as targeted agents.

***Notes*:**

Lanza et al. - et alli *(лат.)* [et′eiliə] - и другие
angiology - ангиология (раздел анатомии)

Active words and word-combinations to be remembered

incept *v.*	начинать
inception *n.*	начало
delineation *n.*	чертёж, диаграмма, описание
adhesion *n.*	прилипание, связь
tether *v, n.*	привязывать, веревка, цепь
signature *n.*	признак, показатель, отличительная черта
hinder *v.*	мешать, препятствовать
rely on *v.*	полагаться на
replenish *v.*	снова наполнять
conjugate *v.*	сопрягать (присоединять)

Exercises

1. Arrange the words given in A and B in pairs of synonyms

A	size	B	personnel
	staff		close
	example		extent
	complete		lead
	guide		pattern
	remove		transfer

2. Arrange the words given in A and B in pairs of antonyms

A	bend	B	straighten
	broad		blunt
	damage		improve
	excellent		bad
	sharp		narrow
	emerge		vanish
	conventional		unusual
	agree		disagree

3. Combine the words in bold type with those in brackets. Translate the combinations into Russian

to improve (the sensitivity of ultrasound to the blood pool; somebody's conditions; one's handwriting; the faculties of talent; one's pronunciation; procedure)
to hinder (somebody in something; somebody's movements; somebody's influence; somebody from coming; somebody from sliding)
to replenish (supplies, one's wardrobe, with water)
to perform (a task, a test, an experiment, a procedure)
to distinguish (one thing from another; a light in the distance; the sound of a drum; sounds into high and low))

4. Translate the following verbs with the suffix " en- ":

enrich, entrap, enchain, encircle, enclose, encourage, encurl, enjoy, enlarge, enlink, enrage, ensure, entrust

5. Translate the following noun-groups into Russian:

ultrasound contrast agents –
blood pool enhancement –

current ultrasound contrast technology –
small acoustic impedance difference –
acoustic impedance mismatch –
destruction-replenishment techniques –

6. Give three forms of the following verbs:

make, begin, understand, lead, find, take, know, show, see, choose, draw, freeze, lose, seek, spread, throw, win, write

7. Fill the gaps in the sentences below with

1) a suitable preposition from this list:

in, in, in, in, of, of, of, by, with, with, for

- We begin …a summary of current ultrasound contrast technology.
- Significant advances have been made … the understanding of biochemistry.
- There are thousands … potential targets available study … targeted contrast imaging.
- This low blood-to-tissue signal ratio hinders the detection… small blood vessels.

- These agents consist … a gaseous center stabilized by an outer shell.
- The two agents have currently been approved … the USA … clinical use … cardiology.
- The interaction of ultrasound …contrast microbubble, has been studied extensively.

2) suitable forms of the verbs:

- The researchers (to describe) the use of perfluorocarbon emulsion nanoparticles as ultrasound contrast agents.
- These nanoparticles (to have) a mean diameter around 250 nm.
- They (to compose) of a lipid-encapsulated perfluorocarbon liquid.
- Contrast (to find) to accumulate in the reticuloendothelial system.
- In the study described briefly above, Demos et al. (to inject) acoustically reflective liposomes.
- Developing contrast agents (to enhance) the ability to detect and image blood clots (thrombi) in future.
- Ultrasound (to limit) in its ability to image through air (lung) or bone.
- Volume information (to obtain) by MRI or CT.
- One pharmaceutical company (to attempt) to design an agent that is detectable with low-intensity ultrasound.
- They knew that for thousands of years people (to try) to speed up computations.

- Since the middle of the 17-th century scientists (to look) for ways of increasing the speed of computation.
- Pascal (to design) an elementary adding machine in 1642.

8. Fill each gap in the text with “a” or “the”:

- … imaging of inflammation is … ideal application for targeted ultrasound contrast, agents since it involves … expression of adhesion molecules by… endothelial cells lining … vascular system.
- … inflammatory cascade as it applies to ultrasound targeting has been outlined by Linder; briefly, … inflammatory process involves … activation, capture, and adhesion of circulating leukocytes to … vascular endothelium, followed by their transmigration to … extra vascular space.

9. Translate the sentences paying attention to different functions of “have”.

- Lansa et al. have described the use of perfluorocarbon emulsion nanoparticles as ultrasound contrast agents.
- These nanoparticles have a mean diameter around 250 nm.
- Their liquid composition has to make them resistant to pressure and mechanical stress.

10. Read the text and state its main ideas in 5-6 sentences in Russian.

Current Clinical Use

In typical clinical use, a small amount (microliters to milliliters) of prepared contrast agent solution is injected intravenously during an ultrasonic examination, and the microbubbles travel through the circulation with (rheological) theological properties similar to erythrocytes, enhancing the echo signal from the blood pool. Contrast-enhanced ultrasound imaging has demonstrated significant clinical utility. Contrast echocardiography has been used to provide quantification of resting cardiac perfusion, with results comparable to current clinical standards. Contrast ultrasound has also been used successfully in radiology and oncology to improve the detection of blood flow in abdominal and peripheral vascular structures, as well as in breast, prostate, and liver tumor. It has been used to assess perfusion in organs including the kidney, brain, and liver.

In clinical trials, contrast agents are evaluated for minimal toxicity and ease of administration, in addition to high bubble-to-tissue signal ratio in the organ or system of interest. Targeted agent development requires at least two further consideration. First, the enhancement provided by the targeted agent depends on its selective localization at the desired site. This may be achieved either through *active targeting,* where a bioconjugate ligand specifically adheres to the target site, or through *passive targeting,* which relies on the pharmacokinetics of the agent as determined by its size and composition to concentrate it in a region of interest. Second, targeted contrast agents should ideally be differentiable from free-floating

agents. This could be achieved if the targeted agent has a long lifetime at the target site, while nonadherent agents have a short circulating half-life, it might also be possible to differentiate bound and free agents acoustically. A good discussion of these and other important issues in designing applications for targeted ultrasound contrast agents has been provided by Klibanov et al.

11. Read the text and say in English what it is about.

Tumors

D'Arrigo et al. studied the ultrasound contrast effect of small (≤2 μm) lipid-coated microbubbles in brain tumors and found that these microbubbles aided the detection of rat gliomas. Histological examination of glioblastoma (C6) and gliosarcoma (9L) cells in vivo and in vitro revealed that these contrast agents extravasated from brain microvasculature and were endocytosed by tumor cells, with the number of agents associated with tumor cells reaching a maximum level around 30 minutes after injection. Surrounding normal parenchymal cells had no associated contrast. In culture, microbubble uptake was demonstrated in glioblastoma cells, gliosarcoma cells, and microglia but not in primary astrocytes. It is hypothesized that uptake by microglia is not observed in vivo because the blood-brain barrier in a normal brain is intact, preventing contact between the contrast agents and parenchymal cells. These authors have demonstrated that this passive targeting mechanism is effective for delivering therapeutic drugs to brain tumors, brain injury sites, and spinal cord injury sites.

12. Read the text "Thrombus" and find the answer to the following question:

What has research in ultrasound targeted imaging been directed to?

Thrombus

A considerable amount of research in ultrasound targeted imaging has been directed towards developing contrast agents that will enhance the ability to detect and image blood clots (thrombi), which are associated with stroke, myocardial infraction, and deep vein thrombosis.

Unger et al. have developed microbubbles labeled with an arginine-glycine-aspartic acid (RGD) analog, which can bind to GPIIB IIIA receptors on activated platelets. In initial studies, these microbubbles were used to enhance the echogenicity of induced thrombi in dogs, and of human thrombi in vitro. Schuman et al. have developed a fixed-plate assay for microbubble targeting in which activated human platelets in 96-well plates were incubated with microbubbles, rinsed, and scanned by a visible light plate reader. The optical density of the plates was not significantly affected by nontargeted microbubbles (up to 30 μl per well). This paper also describes study in a mouse cremaster muscle in which targeted microbub-

bles were observed to adhere to microscopic thrombi created after injury to an arteriole or vein.

13. Complete the following statements.

- Liposomes are readily configurated as …
- Liposomes can be easily conjugated to …
- Liposomes are not typically …
- Freeze drying may disrupt …
- These nanoparticles can also serve as MRI contrast agents and may be useful for …

14. Say whether the following statements are true, if they are not, correct them using the appropriate phrases.

- Blood is two to three orders of magnitude less echogenic than tissue.
- This low blood-to-tissue signal ratio does not hinder the detection of small blood vessels.
- There are two general categories of agents.
- These agents have not been approved in the USA yet.
- Only microbubble agents have been approved for use in Europe and Canada.
- This article gives a summary of current ultrasound contrast technology and reviews the latest research in the use of targeted ultrasound contrast agents.
- There are only several potential targets available for study by targeted contrast imaging.
- The molecular signatures can't be used to localize ultrasound contrast agents.
- Microbubbles are hardly echogenic due to large difference in compressibility and density between the encapsulated gas and the surrounding tissue or plasma.

15. Answer the following questions:

Where can ultrasound contrast agents be used?
How many categories of agents have been studied?
What can you tell us about liposomal agents?
What progress has been made in targeted imaging?

16. Look through the main text and mark the paragraphs that seem important to you.

17. Speak on the topic of the text.

LESSON SEVENTEEN

MAGNETIC RESONANCE SPECTROSCOPIC IMAGING
(part I)

Pre-text exercises

1. Read the following for pronunciation:

glioma [glai'əumə]	quantify ['kwɔntifai]
infiltrative ['infiltreitiv]	morphology [mɔ:'fɔlədʒi]
necrosis [ni'krəusis]	ambiguity [ˌæmbi'gju(:)iti]

2. Try to guess the meanings of the words in bold type. Study the use of these words:

infiltrate *v.* pass through or into by filtering, pass through defences without attracting notice

Gliomas are infiltrative primary brain tumors.

lesion *n.* wound or harmful change in the tissues of a bodily organ caused by injury or disease

For evaluation of serial changes in the lesion, these images would ideally be obtained with relatively fine slice thickness (3 mm or less).

proliferate *v.* 1) reproduce by rapid multiplication of cells, new parts, etc.
2) reproduce; exist in large numbers

Primary brain tumors in adults are classified as being grades II, III or IV based upon histological evidence of increasing malignancy associated with the presence of abnormal proliferation.

highlight *v.* give prominence or emphasis to

Data acquisition protocols highlight several different properties of the tissue.

assess *v.* 1) make a judgment about situation after thinking carefully about it
2) calculate the value or cost of something

Most studies still use visual interpretation of the MR images or changes in linear dimensions to assess response to therapy.

benefit *v.* do good to
The sea air will benefit you.

sample *n.* specimen; one of a number; part of a whole

reliable *adj*. someone or something that can be trusted or depended on
The definition of these parameters requires a reliable and reproducible methodology for molecular characteristics of the brain.

3. Give examples using the following prefixes
re - , pre - , post -
Translate the words into Russian.

4. Give the English for:
способность, оценить, представлять, сравнивать, доказательство, хирургические образцы, различные свойства ткани, изменение, связанные с…

5. Give the Russian for:
primary brain tumors; in terms of; the most appropriate forms; lesion volume; to have a significant effect

MAGNETIC RESONANCE SPECTROSCOPIC IMAGING (part I)

Gliomas are infiltrative primary brain tumors that are extremely heterogeneous in terms of both their imaging characteristics and response to therapy. Anatomic magnetic resonance (MR) images are limited in terms of their ability to evaluate the spatial extent of the lesion and to distinguish tumor from treatment-induced necrosis. Molecular imaging technique that has shown promising results for assisting in the evaluation of gliomas is MR spectroscopic imaging (MRSI). Examples of these data are presented and compared with results obtained from diffusion-weighted and perfusion-weighted MR images.

Gliomas are the most common type of primary brain tumors in adults and are classified as being grades I, III, IV based upon histological evidence of increasing malignancy associated with the presence of abnormal proliferation, pleomorphism, and necrosis within image-guided biopsies or surgical samples. Although the prognosis for patients with high-grade gliomas is limited, the identification of

patients who are likely to benefit from more aggressive therapy and the ability to make an early determination of treatment failure are important issues in the management of the disease. Once a diagnosis has been made, patients are considered for several different forms of therapy, including surgery, radiation, and chemotherapy. Treatment failure due to tumor recurrence at or near the original lesion is common and typically leads to patients receiving multiple forms of therapy during the course of their disease. Despite having a modest impact on survival, these therapies are thought to reduce tumor burden and have been demonstrated to have significant effect upon outcome in selected patient populations. While factors such as age, performance status, and tumor grade have been linked with difference in survival and are used in determining the most appropriate forms of therapy, the location of the tumor and its spatial extent are critical in deciding between alternative strategies. The definition of these parameters requires a reliable and reproducible methodology for noninvasively imaging morphologic and molecular characteristics of the brain.

Magnetic resonance imaging (MRI) is the modality of choice for evaluating brain morphology because it provides superior soft-tissue contrast with flexible data acquisition protocols that highlight several different properties of the tissue. It plays a critical role in diagnosing and directing biopsies or surgical resection, as well as planning focal radiation therapy and evaluating changes associated with response to therapy. Patients are typically scanned at initial presentation prior to treatment and at regular two- or three- month intervals. These scans rapidly generate large volumes of imaging data that represent the time course of changes in the lesion and surrounding brain. Although some centers have developed methodologies for quantifying changes in MR lesion volumes, most studies still use visual interpretation of the MR images or changes in linear dimensions to assess response to therapy.

Despite the widespread clinical use of MRI, interpretation of the images is complicated by the difficulties in identifying the true extent of the lesion and in distinguishing treatment effects such as necrosis and edema from tumor progression. In such cases it is necessary to make use of molecular imaging techniques such as MRSI that reflect functional rather than merely morphologic properties of the tissue. In the following discussion we examine how the addition of MRSI and MRI methodologies such as-diffusion and perfusion-weighted imaging can contribute to overcoming the ambiguities associated with using conventional MRI to evaluate response to therapy for gliomas.

***Notes*:**

MR - magnetic resonance
MRSI - magnetic resonance spectroscopic imaging

Active words and word-combinations to be remembered

infiltrate *v.*	фильтровать; пропитывать; проникать
proliferate *v.*	распространяться, расти, порождать
highlight *v.*	ярко освещать; выдвигать на первый план
assess *v.*	определять размер (ущерба,…)
benefit *v.*	приносить пользу, помогать, оказывать благоприятное воздействие
sample *n.*	образец
reliable *adj*.	надежный
despite *prep.*	несмотря на, вопреки
overcome *v.*	преодолевать
ambiquity *n.*	неясность, двусмысленность
course *n.*	курс, направление, ход, течение

E x e r c i s e s

1. State the part of speech of the following words pointing out the word building elements. Give their Russian equivalents.

infiltrate – infiltration – infiltrative
contribute – contributor – contribution – contributory
alter – alteration – alterable - alterability

2. Combine the words in bold type with those in brackets. Translate the combinations into Russian.

reliable (tools, assistants, information, witnesses, methodology, theory)
treatment (hard, rough, kind, full, early, new, heat)
subtle (mistake, distinction, charm, policy, senses, knowledge of subject)
primary (education, school, source, stress, duty, importance)
comprehensive (term, definition, knowledge, account)

3. Translate into Russian paying attention to the Nominative with the Infinitive.

- This theory is found to account for all known facts of radioactivity.
- Patients are likely to benefit from this therapy.
- These therapies are thought to reduce tumor burden.
- The photon is known to be stable.
- This situation is likely to change radically within the next decade.
- The symmetry between the properties of particles and antiparticles is known to have been established.

- This significant advance in understanding is known to be the result of a truly cooperative international effort.
- Light and matter seem to interact passively in some cases.
- This relation turned out to define the center of mass of the two particles.
- These differences appear to depend upon the impact parameters defining the different collisions.
- The two curves seem to be similar in form.
- Heat was thought to be a material substance.
- Our galaxy proved to be a spiral system.
- These radiations proved to be the same no matter what element served as their source.

4. Catch the meaning of the text and retell it.

Comparison between MRSI and Conventional

To establish the clinical significance of MRSI it is critical to know how the information that it provides is different from that obtained using existing methodologies. Several recent studies have directly addressed the spatial extent of the metabolic lesion versus the gadolinium-enhancing volume and region of hyperintensity on T2-weighted MR images. These showed a significant mismatch of anatomic and metabolic information, particularly in high-grade gliomas. In all cases the metabolic lesion had a significant component outside the Gadolinium-enhancing lesion extending a further 2-3 cm for grade-III and 1-2 cm for grade-II gliomas. Although there was some overlap between the tumor extent derived from the T2-weighted images and the metabolic activity defined according to the MRSI data, both high-grade tumors exhibited some extension of the metabolic abnormality beyond the borders of the T2 lesion that seemed to preferentially follow white matter tracts. These articles question the use of both the Gadolinium-enhanced lesion and the T2 lesion for defining the spatial extent of tumor and indicate that the MRSI data may play a significant role in planning focal therapy by limiting the damage to unaffected brain tissue and delivering differential treatment to different regions of tumor.

To investigate differences in the extent of morphologic and metabolic abnormalities for recurrent tumors, Nelson, et al. compared Gadolinium-enhanced MRI and 3-D MRSI data from 100 patients: 50% with grade-IV and 50% with a variety of mid- and low-grade tumors. Radiological interpretation of the MRI data indicated that 98% of the patients with grade-IV gliomas and 78% of the patients with lower-grade tumors had regions that exhibited contrast enhancement.

There were metabolic abnormalities with decreased NAA and elevated CHO outside the contrast enhancing lesions in 76 patients, with 46 of these abnormalities having at least one voxel with Cho that was elevated above the corresponding value in voxels from normal-appearing tissue in the same patient. Grade-IV gliomas were characterized by a higher percentage of metabolic lesions with voxels that had low normal metabolites and increased Lac/Lip and a lower percentage

(36) of voxels with elevated Cho outside the contrast-enhancing lesion. The mid- and lower-grade tumors had more voxels with tumor-suggestive spectra (56) outside the contrast-enhancing lesion. These findings are consistent with grade-IV gliomas having more extensive regions of necrosis and lower-grade tumors having more regions of nonenhancing tumor. The differences between the characteristics of the anatomic and metabolic lesions suggest that MRSI is likely to be critical for the assessment and treatment of patients with gliomas.

5. Read the text and find the answer to the following question:

What do these studies illustrate?

Figure 24 shows how the residual metabolic lesion as defined by our CNI in the postsurgery MRSI examination may be used to predict the location of radiological recurrence for patient with gliomas. This is the same patient as seen in Figure. It was clear that the new regions of enhancement were within the residual metabolic lesion. With time after treatment the

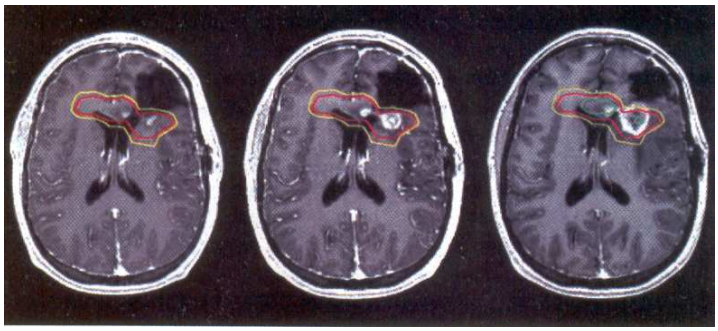


Fig. 24 Serial, aligned MR images from the same patient with superimposed contours corresponding to the Cho-to-NAA index. The first dataset was acquired four months after the beginning of fractionated radiation therapy (XRT) and shows a large increase in the Cho-to-NAA index contours and small regions of Gadolinium enhancement that are suspicious for recurrence. The next image was acquired six months after XRT when the patient was thought to have progressed and was treated with Gamma Knife radiosurgery to the enhancing lesions plus a small margin. The yellow and red contours that are superimposed on this image are the Cho-to-NAA index from the previous examination. The green contour shows the Cr-to-NAA index from this examination, indicating that the medial component of the lesion had higher Cr, suggesting that it may be better oxygenated. The third image is two months after Gamma Knife radiosurgery with the same contour superimposed and shows that the medial component of the lesion was stable but the lateral component had an increased enhancing volume.

metabolic lesion also increased until at six months after therapy it is classified as a clinical recurrence. The Gadolinium-enhancing lesion was treated with gamma knife radiosurgery, but to a region that was considerably smaller than the metabolic lesion. The subsequent pattern of growth of the anatomic lesion suggests that the new enhancement was due to radiation effect in an area that was previously tumor rather than due to a true increase in tumor volume. Of particular interest was that

the part of the gamma knife target with higher CR showed very little change, whereas the region with low CR showed radiological progression. These studies illustrate how metabolic imaging can complement anatomic MRI in predicting treatment effectiveness and elucidating patterns of treatment failure.

6. Read the text and state the main ideas in Russian.

The result of MRI and MRSI studies of patients with brain tumors underlines the importance of using a multifaceted approach to the evaluation of these regions of nonenhancing tumor may be left untreated or undertreated using current methods for defining the target for focal radiation therapy. For patients with recurrent disease, the inability of anatomic imaging methodologies to distinguish tumor from treatmemt-unduced necrosis makes the situation even more complex. MR techniques such as diffusion, perfusion-weighted imaging, and MRSI have the advantage of being able to be added on to the routine clinical MRI examination. Current data suggest that these methodologies provide complementary data concerning the metabolic, physiological, and structural properties of the tumor. Further studies are needed to determine the sensitivity and specificity of such parameters and to establish the time course of changes that occur in response to therapy. Quantitative analysis of the MR data should provide an objective basis for classifying tumors based upon their functional characteristics, for predicting which treatments will be effective for a particular patient, and for understanding the reasons for success or failure of new therapies.

7. Fill the gaps in the sentences below with suitable forms of the verbs:

- These scans rapidly (to generate) large volumes of imaging data.
- Some centers (to develop) already methodologies for quantifying changes in MR lesion volumes.
- Patients typically (to scan) at initial presentation prior to treatment and at regular two-or-three-month intervals.
- This (to move) towards the personalized treatment paradigm that (to attract) so much attention recently.
- The MR techniques highlighted in this article (not to limit) to applications in gliomas or, for that matter, neoplastic disease.
- Soon the therapeutic agents (to deliver) to clinic.
- Angiogenesis imaging techniques potentially (to widespread) clinical applications.
- This figure shows how a simple Hologram, that of a point source of light, might (to make).
- Magnetism (to refer to) in the oldest writing of man.
- The positive particle in the nucleus of the atom (to give) the name of “photon”.

- The electrons of the beam (to scatter) or (to deflect) by the nuclei.
- These general classes of experimental techniques (to apply) now to this kind of work.
- The subject of elasticity (to discuss) more fully in Chapter B.
- Radioactive isotopes also (to use) successfully for food conservation.
- For a long time Röntgen (to experiment) with the Crookes tube before he discovered a new kind of rays.
- The driver started the car after he (to examine) the engine.
- They were told where they (to have) their industrial training.

8. Decide whether these statements are true or false, according to the text.

- Anatomic MR images aren't limited in terms of their ability to evaluate the spatial extent of the lesion.
- MRI is widely used for clinical use.
- Patients are scanned only after operation.
- The therapies used do not reduce tumor burden.
- Conventional MRI evaluates response to therapy for gliomas.
- An in vivo molecular imaging technique is CT.

9. Ask questions to which the following statements might be the answer:

- Gliomas are infiltrative primary brain tumors.
- Treatment failure typically leads to patients receiving multiple forms of therapy during the course of their disease.
- The location of the tumor and its spatial extent are critical in deciding between alternative strategies.
- The definition of these parameters does.
- Yes, it is.
- These scans rapidly generate large volumes of imaging data.

10. Answer the following questions:

What is MRI?
What is it used for?
Has MRI found the widespread clinical use nowadays?

11. Outline the main ideas of the text.

12. Speak on the topic of the text.

LESSON EIGHTEEN

MAGNETIC RESONANCE SPECTROSCOPIC IMAGING
(part II)

Pre-text exercises

1. Read the following for pronunciation:

cellular ['seljulə]
heterogeneous [ˌhetəro(u)'dʒi:njəs]
heterogeneity ['hetəro(u)dʒi'ni:iti]
rectangle ['rekˌtæŋgl]
subcutaneous ['sʌbkju(:)'teinjəs]

2. Try to guess the meanings of the words in bold type. Study the use of these words:

uniform *adj.* 1) not varying in form, quality (uniform temperature)
v. 2) dress worn by all members of an organization (police, the armed forces

uniformity *n.* condition of being the same throughout
It leads to the uniformity of the main magnetic field.

contaminate *v.* make dirty, impure or diseased

suppress *v.* put an end to the activity or existence of

eliminate *v.* remove, take or put away
Key factors affecting the quality of in vivo proton spectra are the suppression of the tissue water signal, the elimination of contaminating signals from subcutaneous fat, and uniformity of the main magnetic field.

elevate *v.* send, promote to a higher or more important position

precede *v.* come or do before (in time, place or order)

If the histological diagnosis is correct for this patient it is clear that it must be possible for the elevation of lactate (Lac) to precede the formation of necrosis.

appropriate *adj.* suited to

heterogeneous *adj.* consisting of parts that are very different from each other

The relatively high sensitivity of protons means that they are the most appropriate nucleus for in vivo MRSI at the field strengths typically used for clinical MR scanners for evaluation of tissues that are spatially heterogeneous.

3. Give the English for:
соответствующий, подходящий, клеточный, удалять, прямоугольник, предшествовать, повышать, однородность, подавлять, загрязнять

4. Give the Russian for:
subcutaneous, heterogeneity, sequence, to become valuable, to predict something, to precede the formation of necrosis, rectangle

MRSI OF GLIOMAS (part II)

MRSI is a method for assessing tissue function by obtaining information about the composition and spatial distribution of cellular metabolites. The relatively high sensitivity of protons means that they are the most appropriate nucleus for in vivo MRSI at the field strengths typically used for clinical MR scanners for evaluation of tissues that are spatially heterogeneous. Key factors affecting the quality of in vivo proton spectra are the suppression of the tissue water signal, the elimination of contaminating signals from subcutaneous fat, and the uniformity of the main magnet field. A number of different approaches to acquiring proton MRSI data have been considered, but the most robust and widely used at the current time utilizes point-resolved spectroscopy (PRESS) for volume selection and 2-D or 3-D phase encoding to provide spatial localization. Figure 25 shows an example of one slice from a 3-D proton MRSI dataset obtained from a patient with a gliomas. The white rectangle on the T1-weighted post-Gadolinium image represents the PRESS-selected volume and the array of spectra is from voxels within that volume at a nominal 1-cc spatial resolution. The four-spectra blow up and color-coding illustrate the typical patterns of metabolites observed in a normal brain (white), a tumor (blue and red), and in regions of necrosis (yellow). The extreme spatial heterogeneity of the lesion is shown by the changes in color coding between neighboring voxels in the spectral array. The main peaks seen in the normal brain tissue are, from right to left, N-acetylasparatate (NAA), creatine (Cr), and choline containing compounds (Cho). NAA is a marker of normal neuronal function, and its reduction in tumors has been attributed to a low density of neuronal cells within the selected volume. The Cho peak includes contributions from free choline, glycerolphosphocholine, and phosphocholine and may be as much as three to four times greater in tumor than normal voxels.

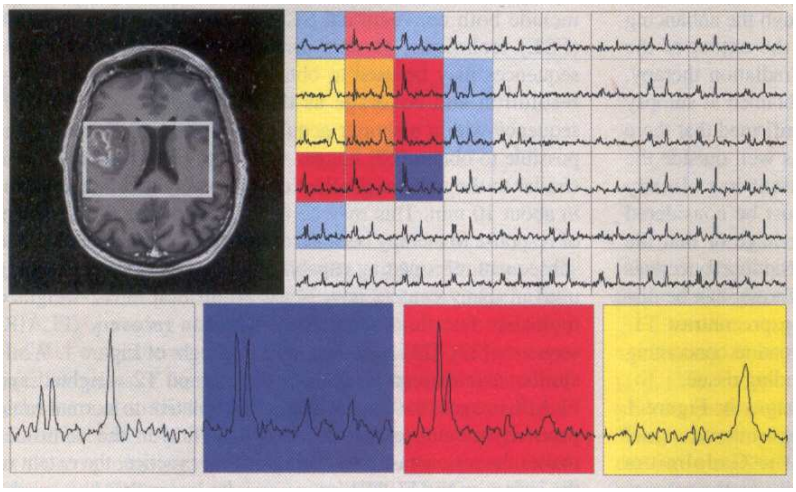


Fig. 25. MRSI data from a patient with a glioma showing the post-Gadolinium T1-weighted image with the PRESS selected volume superimposed on it, the spatial array of spectra from the same slice, and selected spectra from regions that show different spectra patterns. The white voxels correspond to spectra from normal brain tissue; the blue voxels to spectra with increased Cho and Cr but reduced NAA; the red voxels to spectra with increased Cho, moderate Cr, and reduced NAA; and the yellow voxels to spectra with reduced Cho, Cr, and NAA but increased Lac/Lip

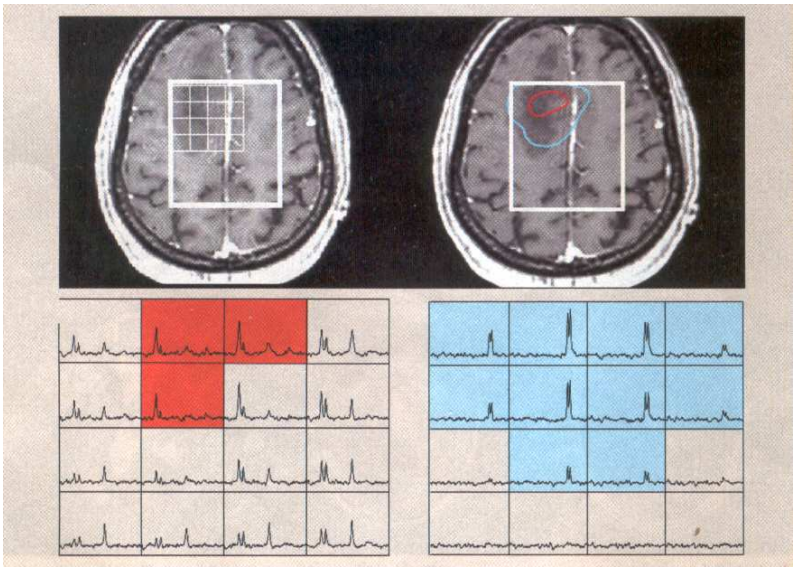


Fig. 26. Lactate-edited MRSI data from a patient with a nonenhancing grade-III glioma. The spectra on the left show Cho, Cr, NAA, and Lip, while the spectra on the right are from the same voxels but show only Lac peaks.

The increased Cho in tumor voxels has been interpreted as both an increase in cell density and in membrane turnover. Cr resonances reflect the energetic status of the tissue and may be both reduced in some regions of the lesion (red voxels) and increased in other regions (blue voxels). This means that there is typically a greater overlap between tumor and normal Cho/Cr ratios than Cho/NAA ratios,

and the areas with reduced Cr may be valuable in distinguishing regions of the tumor that are less well perfused, and hence, more resistant to radiation or chemotherapy.

Other resonances seen within gliomas are lactate (Lac) and Lip. In conventional PRESS acquisitions these have similar resonant frequencies, and it may be difficult to distinguish between them. Lac is a product of anaerobic metabolism and is therefore expected to reflect hypoxia, while the presence of mobile Lip is thought to correspond to cellular and membrane breakdown corresponding to necrosis. Spectra with peaks corresponding to Lac/Lip are typically elevated in the necrotic core (yellow voxels in Figure 25) of the tumor, but there is a large variation in intensity both within individual lesions and between tumors of similar grade. Figure 26 shows an example of data obtained using a Lac editing sequence that is able to distinguish between the two resonances. This sequence generates two sets of spectra, one with the Lac upright and the other with the Lac having a negative component. Adding the array gives one set of spectra with Cho, Cr, NAA, and Lip, and second set of spectra with only Lac. The patient shown in Figure 26 has an untreated nonenhancing grade-III glioma that shows elevated Cho, very low levels of Lip, and highly elevated Lac. If the histological diagnosis is correct for this patient, it is clear that it must be possible for the elevation of Lac to precede the formation of necrosis. These findings underline the value of Lac-edited MRSI and suggest that it is likely to become valuable for predicting radiation sensitivity and evaluating response to therapy.

***Notes*:**

NAA - N - acelyllasparate
Cho - choline containing compounds
Lac - lactate

Active words and word-combinations to be remembered

heterogeneous	различный, неоднородный, разнородный
rectangle *n.*	прямоугольник
contaminate *v.*	загрязнять
suppress *v.*	подавлять, сдерживать, пересекать
eliminate *v.*	устранять, исключать, уничтожать, ликвидировать, не принимать во внимание
elevate *v.*	повышать, поднимать
precede *v.*	предшествовать; быть, находиться или идти вперед; превосходить
appropriate *adj.*	подходящий, соответствующий
overlap *v., n.*	частично покрывать, частично совпадать, перекрывать; нахлестка, перекрытие

Exercises

1. State the part of speech of the following words pointing out the word building elements. Give their Russian equivalents.

eliminate – elimination – eliminative – eliminator
extreme – extremeless – extremely – extremeness – extremist – extremism – extremity
function – functional – functionality – functionally – functionate
resonance – resonant – resonate – resonator
high – highly – highness – height
precede – precedence – precedent – precedently

2. Arrange the words given in A and B in pairs of antonyms:

A	high	B	subtract
	contaminate		repel
	heterogeneous		practical
	attract		purify
	theoretical		false
	true		low
	correct		homogeneous
	add		incorrect

3. Combine the words in bold type with those in brackets. Translate the combinations into Russian.

to suppress (a rebellion, the truth, a yawn, one's feelings, a signal, anger, tears, laughter, publication)
uniform (life, cargo, temperature, scale)
sequence (chronological, natural, usual)
to elevate (the voice, eyebrow, the standards of taste, mind)
to interpret (a difficult passage, a sentence, an inscription, somebody's intentions)
to provide (a) somebody with money , somebody with everything he(she) needs, a boy with a good education, a car with a radio;
b) meals, military aid, an opportunity, necessary conditions)

4. Point out the sentences with the Nominative with the Infinitive. Translate them into Russian (Paragraph 3)

5. Read the text and

a) find the answer to the question:
In what stages can molecular imaging be used?

Noninvasive real-time observation of in vivo biological events at the molecular level is now possible using a combination of advanced imaging modalities and target-specific probes. This has opened a field referred to as “molecular imaging”. Although molecular imaging has been defined by several investigators, Luker et al. have a good general description as: “the characterization and measurement of biological processes in living systems by using remote imaging detectors”. In the past decade, the development of high screening mechanisms and interest in advances in personalized treatment has lead to the development of target-specific therapeutic agents. The advantage of molecular imaging in medicine is evident especially in the case of these personalized target-specific therapeutic agents. Molecular imaging can be used in two stages: 1) Preclinical development: Validation of potential disease targets in vivo and the biodistribution of new, tagged drugs at the desired site. In the development of new targeted therapies, the advantage of molecular imaging is the quantitative spatial distribution of the target in vivo. 2) Clinical application: Prior to the design of personalized treatment, molecular imaging can distinguish patient populations that would respond to targeted therapy from nonresponders. In addition, within the responder group, areas that may evade the therapy can be demarcated for combination therapy. Furthermore, disease progression and response to therapy can be followed in patients with faster feedback than current available methods.

In our effort to imaging and therapeutic agents with proper characteristics that effectively reach their target, we have designed a targeted antiangiogenic system that can also be used for molecular imaging of the neovasculature. Here, we describe our rationale behind choosing a vascular target for molecular imaging derived from our studies on vascular permeability in tumors. Next we demonstrate how imaging can be incorporated into vascular-targeted delivery systems to generate active therapeutic agents.

b) Write down the answer in Russian.

6. Examine figure 27, read its description given to the right and explain the picture in Russian.

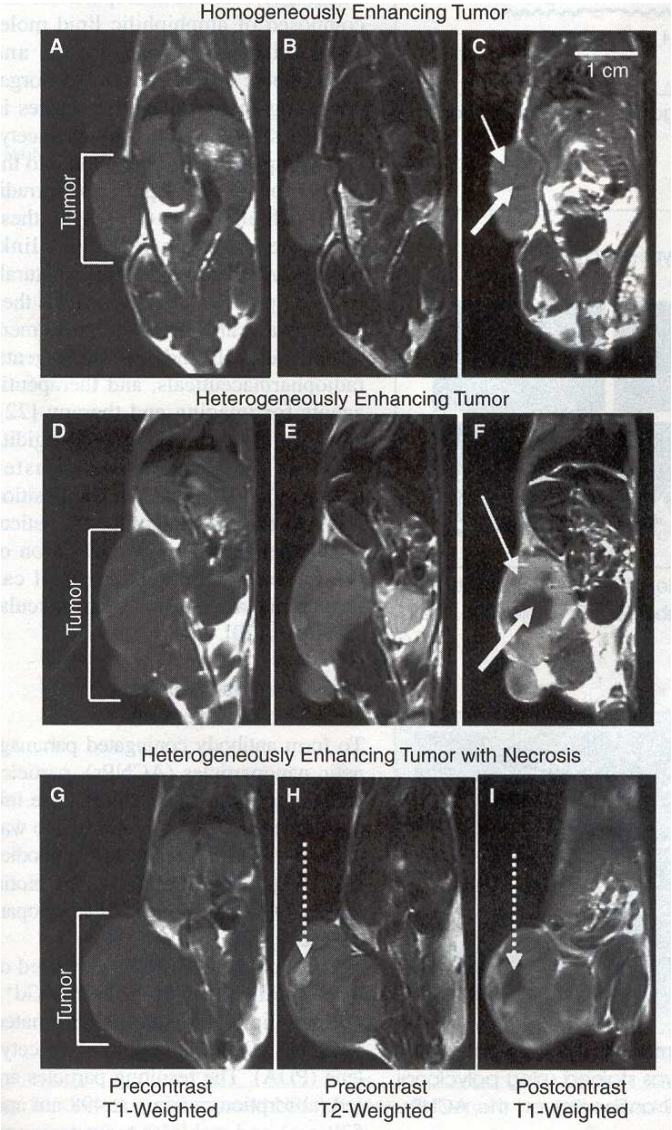


Fig.27. Temporal changes in tumor permeability to small molecule contrast agent (GdDTPA).Tumor at the early stages of growth shows a more homogenous and less permeable vascular profile. Three-tesla MR images obtained in C3H/K mice (age range, 8-10 weeks; weight range, 25-30 g) with an implanted subcutaneous squamous cell carcinoma VII tumor. The following images were obtained in a homogeneously enhanced tumor; A, Precontrast T1-weighted image. B, Precontrast T2-weighted image. C, Contrast-enhanced T1-weighted image. The following images were obtained in a heterogeneously enhanced tumor: D, Precontrast T1-weighted image. E, Precontrast T2-weighted image. F, Contrast-enhanced T1-weighted image. The following images were obtained in a heterogeneously enhanced tumor with necrosis: G, Precontrast T1-weighted image. H, Precontrast T2-weighted image. I, Contrast-enhanced T1-weighted image. All contrast-enhanced images were obtained two minutes after injection of the contrast agent. Contrast enhancement was observed in the periphery of the heterogeneously enhanced tumors (F), but no differential contrast enhancement was observed in the homogeneously enhanced tumors (C), in C and F, thick arrows indicate central region of tumor, and thin arrows indicate periphery of tumor. Tissue was removed from these areas for genomic analysis. In H and I, dotted arrows indicate necrosis. T1-weighted images were obtained with a spin-echo pulse sequence (300/13, one signal acquired, 256 × 192-pixel matrix, field of view of 8 cm, section thickness of 1.5 mm). T2-weighted images were obtained with a fast spin-echo pulse sequence

(4,000/85, one signal acquired, echo train length of eight, 256 × 192 matrix, field of view of 8 cm, section thickness of 1.5 mm.

7. Render the text in Russian.

We have discussed the impact of molecular imaging on clinical and preclinical medicine. We have presented the potential problems of delivering the effective therapeutic dose and the properties that can help contribute to the drug efficacy. The rationale for the design of new antiangiogenic agents that can be used for imaging and therapy was presented. Finally, results from imaging and targeted nanoparticles based therapies were presented. In vivo imaging of angiogenic tumors using anti-$\alpha_V\beta_3$-targeted polymerized vesicles composed of the murine antibody LM609 attached to NPs labeled with the MR contrast agent gadolinium in the V2 carcinoma model in rabbits. MRI studies using this targeted contrast agent revealed large areas of $\alpha_V\beta_3$ integrin expression in tumor-associated vasculature that conventional MRIs failed to show. Other investigators have used microemulsions conjugated to an antibody targeted against $\alpha_V\beta_3$ as imaging agents. These materials also show contrast enhancement of tumor vasculature undergoing angiogenesis. Other markers, such as the PECAM-1 (CD-31), VCAM-1 (CD54) and VEGF receptor (flk-1), have been shown to be upregulated on tumor endothelium and associated with angiogenesis but have not been used in imaging studies. Furthermore, by modification of the NPs, we were able to use this imaging agent as an antiangiogenic gene delivery system. The results from these studies are very promising and are being further pursued.

8. Fill each gap in the text with “a” or “the” where necessary.

… Critical factors in using MRI and MRSI are in defining … effects of … different therapies on … parameters that are derived with these techniques … Figure 7 shows … effect of surgical resection on … spatial extent of … metabolic lesion for … patient with … grade III glioma. Although there is no … residual region with … decreased NAA and increased Cho.

9. Decide whether these statements are true or false, according to the text:

- MRSI is a method for describing tissue function by obtaining information about the composition and spatial distribution of cellular metabolites.
- The only key factor affecting the quality of in vivo proton spectra is the suppression of the tissue water signal.
- The extreme spatial heterogeneity of the lesion is shown by the changes in color coding between neighboring voxels in the spectral array.
- Different approaches to acquiring proton MRSI data have been considered in this article.

10. Fill the gaps in the sentences below with a suitable preposition from the list. Use the preposition as many times as it is necessary:

of, between, to, for, on, in, with

- The differences … the characteristics … the anatomic and metallic lesion suggest that MRSI is likely … be critical … the assessment and treatment … patients … gliomas.
- This sequence generates two sets …spectra.
- The differences … information content … the MRSI and MRI data are demonstrated … Figure 5.
- Similar changes … survival have now been reported … a second cohort … patients being treated … gamma knife radiosurgery.

11. Complete the following sentences:

- These findings suggest that it is likely to become valuable for predicting radiation sensitivity and evaluating response to …
- This suggests the assessment of … function.
- This sequence generates two sets of …
- There is a large variation in intensity both within individual lesions and between tumors of similar …
- It was clear that the new regions of enhancement were … the residual metabolic lesion.

12. State the main ideas of the text.

13. Divide the text into logically complete parts and entitle them.

14. Reproduce the text.

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