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INTELLECTUAL PROPERTY APPLIED TO MEDICAL IMAGING SYSTEMS IN PRESENT CONTEXT

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Rezumat. *Lucrarea prezentă aduce în discuție tehnologiile imagistice folosite în trecut și prezent, cu utilitate în neurochirurgie. Reprezintă o trecere sumară în revistă a tehnologiilor convenționale (aparatura ce folosește radiațiile X) și neconvenționale (aparatură ce folosește radiațiile electromagnetice și ultrasunetele), utilizate în practica curentă. Radiologia ca specialitate de sine stătătoare a cunoscut o evoluție remarcabilă în ultimii ani, ajutând neurochirurgia ca specialitate să se dezvolte având dispozitivele necesare pentru o mai bună diagnosticare a leziunilor sistemului nervos central și periferic ajutând la un planning operator mai eficient și un tratament chirurgical adaptat. Atât tehnicile radiologice convenționale cat și cele neconvenționale reprezintă un pilon esențial în aplicarea tehnicilor chirurgicale de bază în neurochirurgie. Pe măsură ce tehnicile imagistice au cunoscut o dezvoltare exponențială la fel și aparatura utilizată a cunoscut o îmbunătățire. Totodată acumularea și stocarea datelor cu caracter medical, reprezintă o provocare din ce în ce mai mare în ultimii ani. O data cu evoluția tehnologică, proprietatea intelectuală aplicată bazelor de date ce conțin informațiile pacienților capătă un rol din ce în ce mai important. Necesitatea centralizării și menținerii securității unor astfel de informații reprezintă un domeniu de cercetat.*

Abstract. *The present work discusses the imaging technologies used in the past and present, with utility in neurosurgery. It represents a brief overview of conventional (equipment that use X-rays) and unconventional (equipment that used electromagnetic radiation and ultrasound) technologies, used in current practice. Radiology as a stand-alone specialty has undergone remarkable development in recent years, helping neurosurgery as a specialty to develop, having the devices necessary for a better diagnosis of lesions of the central and peripheral nervous system, helping to a more efficient surgical planning and an adapted surgical treatment. Both conventional and unconventional radiological techniques represent an essential pillar in the application of basic surgical techniques in neurosurgery. As imaging techniques have undergone exponential development, so has the equipment used undergone improvement and upgrading. At the same time, the accumulation and storage of medical data represents an increasingly greater challenge in recent years. With technological evolution, intellectual property applied to databases containing patient information is becoming increasingly important. The need for centralization and maintaining the security of such information is a field of research.*

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1. Introduction

Medical imaging systems have always been a key element in the development and provision of high-quality neurosurgical care. Radiology and medical imaging are a branch of medicine that deals with the evaluation of anatomical structures and their representation in the form of images. In neurosurgery, these images can be used to diagnose, treat, and monitor disease of the central and peripheral nervous systems.

Radiology and medical imaging are a branch of medicine that uses ionizing radiation, electronic waves, and ultrasound for the evaluation of the anatomical structures and present them in the form of images. Conventional radiology systems use ionizing radiation of the type X-rays. These images can be used to identify normal or pathological anatomical structures. [3]

Images taken with the help of radiology devices are currently stored on an electronic medium and, when accumulated, form a database. This represents an important element that can be used to store and manage medical information. In the case of radiology, the database can be used to store radiology images, as well as information about patients, such as medical history, test results and treatment.

Intellectual property rights over databases are important for several reasons. First, they protect the investment of time and resources required to collect, organize, and manage these databases. Second, they encourage the creation and development of new databases, which are essential for economic and social development. Third, they protect the rights of legitimate database users, who have the right to access and use the information contained in them for commercial, medical, or scientific research purpose. In the medical field, databases of medical images and patient data can be used to improve diagnosis and treatment. In the research world, databases of scientific data can be used to accelerate innovation. [21]

2. Medical imaging systems

2.2. Imaging Methods

Medical imaging systems can be represented by the sum of radiology devices and software used to obtain and display images of anatomical segments on a screen or printed. Radiology equipment can be divided into conventional and non-conventional equipment. [1, 2, 4]

Conventional medical imaging techniques is utilize ionizing radiation to aiding in the diagnosis and evaluation of various medical conditions. This technology uses ionizing radiation [3, 4] to produce images of the internal anatomical structures of the human body. [6]

Röntgen Radiation

X-rays are produced whenever high-speed negative electrons are suddenly stopped by an obstacle. They have the same nature as light radiation. The wavelength of X-rays is expressed in units of angstroms (Å) or X units. (Fig. 1) [3]

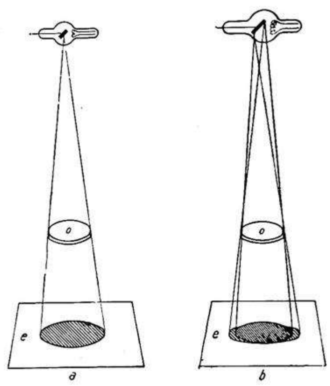


Fig. 1. Image formation in relation to focal length.
a. Small focal length; sharp image. **b.** Large focal length; creation of penumbra.

X-rays are electromagnetic waves with wavelengths measured in angströms. One angstrom is equal to 10,000th of a micron. In medical use, X-rays have a wavelength between 0.06-8 Å, which gives them sufficient penetration of tissues. Ultraviolet radiation has a wavelength between 0.4 – 0.2 μmm. [2, 4]

The formation of a radiographic image is a complex process that is governed by a number of physical and chemical principles. The interaction of X-rays with biological tissue is the primary factor that determines the image. X-rays are high-energy electromagnetic radiation that can penetrate tissue. The amount of X-rays that are absorbed by tissue depends on the tissue's density and atomic composition. Denser tissues, such as bone, absorb more X-rays than less dense tissues, such as fat. This difference in absorption produces the contrast that is necessary for medical interpretation. [2, 3, 5]

Radiographic images are formed by the interaction of X-rays with tissue. The ability of X-rays to penetrate tissue depends on the tissue's density and composition. Denser tissues, such as bone, absorb more X-rays than less dense tissues, such as fat. This difference in absorption produces the contrast that allows us to see the structure of the body. [1, 3]

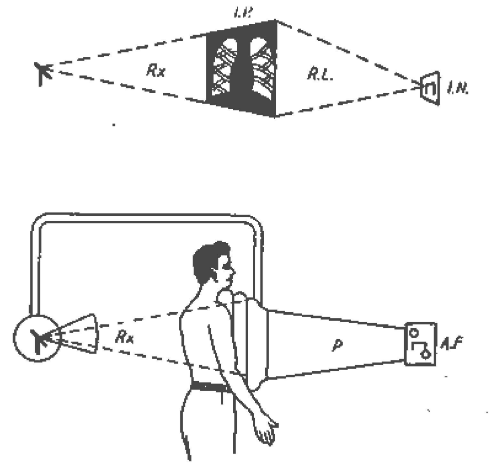


Fig. 2. The principle of the radiographic method (sketch)
Rx – X-ray beam; I.P. – Positive image formed on the fluorescent screen fixed at the large base of the pyramid; P – Pyramid; R.L. – Light radiation beam emitted from the fluorescent screen; I.N. – Negative image on the photographic film in the A.F. camera.

A radiographic device is mounted on a X-ray generator, such as a conventional diagnostic X-ray machine. This device consists of a special fluorescent screen, a darkroom in the shape of a pyramid or a truncated cone, and a photographic camera equipped with a high-brightness lens and increased separation power. (Fig.2) [2, 3, 5, 6]

The Phenomenon of Electromagnetic Resonance

The foundations of MRI were laid in the late 1940s and are based on the property of protons of H^+ placed in a strong magnetic field and excited by a radiofrequency (RF) pulse, to emit a signal that can be processed and converted into a digital image. Image formation involves the construction, acquisition, processing, and storage of data in an information system. (Fig.3) [8, 10, 11]

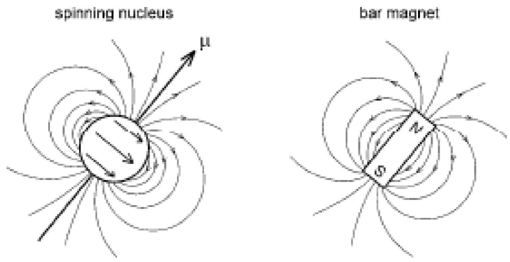


Fig. 3. Nuclei with non-zero spin possess a magnetic moment, μ, which causes them to have the same properties as small bar magnets. The directional markings on the nucleus itself show the direction of its spin axis, while the circumscribed arcs surrounding it and the bar magnet illustrate their respective magnetic fields. [9, 23]

The patient is situated within a potent magnet generating a homogeneous magnetic field. Upon exposure to this magnetic field, the hydrogen nuclei within the patient's body orient themselves parallel to the field direction. Subsequently, a series of radiofrequency (RF) pulses are applied to the region of the body being examined. These signals must be at a resonant frequency in order for the body's proteins to absorb them. The application of these pulses generates a transient, perpendicular magnetic field that engages with the hydrogen nuclei within the body. Upon exposure to this field, these nuclei absorb energy and alter the orientation of their axial rotation. When the RF pulse concludes, the nuclei re-align with the external magnetic field. Weak radiofrequency (RF) signals are released by the tissue and detected by coils within the MRI apparatus. [9, 23] These signals are rendered detectable by applying an RF pulse that rotates the energized protons by 90 degrees, allowing them to be measured as electrical current by the receiving coil. Subsequently, a series of computerized operations converts these signals into an image [8, 9, 10, 22, 23]. The term "magnetic resonance" (MR) is a shortened form of "nuclear magnetic resonance" (NMR). MR and NMR are both used to describe the physical phenomenon of nuclear magnetic resonance, which is the interaction of atomic nuclei with a magnetic field. In the context of imaging and spectroscopy, MR is used to create images of the body or other objects. [9] Omitting the term "nuclear," particularly in medical settings, aims to dissociate the technique from the high-energy associations of processes like nuclear fission (splitting of nuclei) and radioactivity (decay of unstable nuclei). NMR, in reality, is a low-energy phenomenon involving the interaction of atomic nuclei with radiofrequency (RF) waves. The intensity of RF used in MRI scanners has not been shown to pose any risk to humans or animals. (Fig.4) [9, 10, 11, 22, 23]

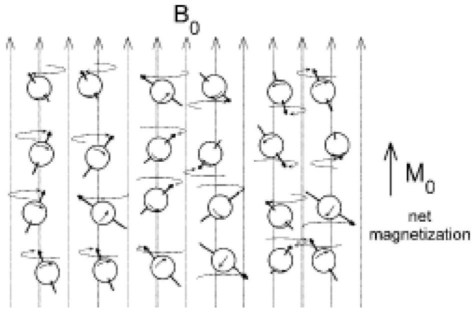


Fig. 4. In the absence of an external magnetic field, atomic nuclei are randomly oriented. B_0 When placed in a magnetic field, the nuclei align themselves with the field, with a slight majority pointing in the same direction. This results in a net magnetization along the field, known as the longitudinal magnetization, M_0. [9, 23]

Magnetic resonance imaging (MRI) and magnetic resonance spectroscopy (MRS) provide non-invasive techniques for exploring the internal anatomy and physiology of living subjects and ex vivo samples. These methods harness the principle of nuclear magnetic resonance (NMR), wherein atomic nuclei in a strong magnetic field absorb and emit electromagnetic radiation at a specific frequency, known as the resonant frequency, which falls within the radiofrequency (RF) spectrum. Due to the absence of documented detrimental effects from strong magnetic fields or radio waves, MRI and MRS are regarded as safe for human studies and animal research. [9, 10, 23]. Advanced MRI technology enables the generation of intricate three-dimensional images of internal body structures, encompassing soft tissues, bones, and even intricate vascular networks. These detailed visualizations empower medical professionals to diagnose a wide range of conditions, from tumors and vascular malformations to nerve injuries and inflammatory processes. Moreover, MRI's non-invasive nature allows its utilization for guiding surgical procedures with remarkable precision. [7, 8, 9, 10, 11, 23]. The intensity of the signal depends on a series of intrinsic characteristics of the tissues, as well as on external parameters related to the computer imaging technique, processing, and storage of them.

Ultrasonic waves

Ultrasound is a mechanical wave phenomenon. Ultrasound differs from other mechanical vibrations due to its high frequency that cannot be perceived by humans. It is observed that in most soft tissues, the speed is approximately 1500 ms^{-1}, which corresponds to a wavelength of approximately 1.5 mm at 1 MHz and 0.15 mm at 10 MHz. This explains why low frequencies are used in most medical applications – the minimum interaction volume between the ultrasonic wave and the tissue is limited by the wavelength of ultrasound. (Fig.5) [13]

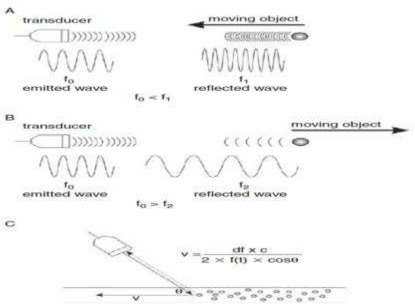


Fig. 5. The doppler effect. **A.** The Doppler effect causes the frequency of an ultrasound wave to increase when it is reflected off an object that is moving toward the source of the wave. **B.** The Doppler effect causes the frequency of a sound wave to decrease when it is reflected off a target that is moving away from the source of the wave. **C.** The Doppler effect offers a means to determine fluid flow velocity (v) by leveraging the shift in emitted ultrasound frequency (df), the original transmitted frequency (f(t)), the propagation speed of ultrasound waves (c), and the angle between the ultrasound beam and the flow vector (θ). [13]

The amplitude (A) of sound is a measure of its strength and is determined by how much the wave compresses the air. The frequency of sound is measured in hertz (Hz) and is a measure of the number of oscillations per second. The wavelength of sound is the distance between two adjacent peaks of the wave and is measured in meters (m). [12, 13, 15]

Soft biological tissues are liquid or quasi-liquid. In such materials, ultrasonic energy is typically propagated in the form of longitudinal waves. Transverse waves, if they do occur, are rapidly attenuated. [15]

The period (T) is the time it takes for a particle to complete one oscillation and return to its initial equilibrium position, moving in the same direction, and is measured in seconds. [13, 15]

Any continuous medium can be considered as being composed of a multitude of small particles. Each particle has an equilibrium position in the medium and, if a particle is displaced from its equilibrium position, a force proportional to the amplitude of the displacement acts on it, a force that tends to bring it back to its equilibrium position. Thus, a particle in a medium can be found in a simple harmonic motion. However, a particle in a medium is not isolated, but is elastically coupled to those around it, so it cannot move independently and any disturbance is transmitted through the medium in the form of a wave. The distance between two consecutive particles in the medium, with identical displacement amplitudes, is called the wavelength (λ). This distance implies that waves propagate with a finite propagation speed, c: $c = f\lambda$, where f represents the frequency. [15]

The human auditory system is capable of detecting sound waves with frequencies ranging from 20 Hz to 20,000 Hz. [15] This range is known as the audible range and is determined by the anatomical structure of the ear. The inner ear contains the organ of Corti, which contains sound-sensitive hair cells. When a sound wave hits the ear, it vibrates and stimulates these hair cells. These hair cells then produce electrical impulses that are transmitted to the brain. [13, 14, 15]

Sound that has a frequency greater than 20,000 Hz cannot be perceived by the human ear. This sound is called ultrasound and is used in a variety of applications, such as ultrasound imaging and sonar. [13, 14]

Ultrasound is generated by a transducer that converts electrical energy into high-frequency sound waves. These waves travel through the body's tissues and are reflected by interfaces between different tissues. [15] The transducer receives these reflected sound waves and analyzes the data to create an image of the tissue. (Fig.6) [12, 13, 15]

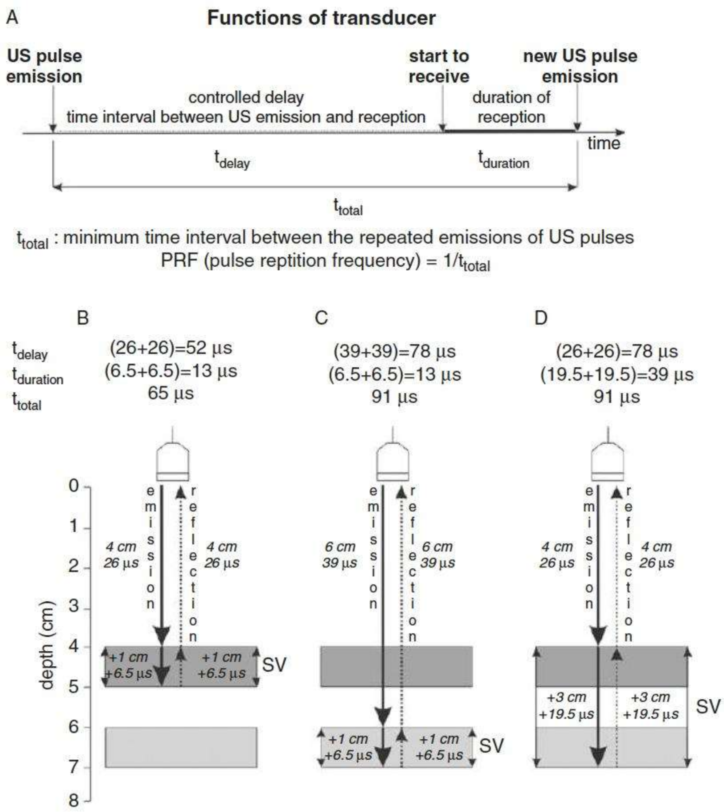


Fig. 6. Time-controlled sampling in Pulsed Wave (PW) Doppler.
In PW mode, time-controlled sampling (A) ensures that the receiver function of a crystal is activated only after a specified delay (t_{delay}) and for a predetermined duration ($t_{duration}$). This is crucial as the returned signal must be received before the transmission of the subsequent ultrasound pulse, limiting the maximum rate of pulse transmission (pulse repetition frequency, PRF). The maximum achievable PRF is inversely proportional to the total time required for an ultrasound wave to travel to a target at a specific depth and return to the transducer (t_{total}) **(A)**. By applying the known speed of ultrasound propagation in soft tissues (c = 1540 m/s) and the time interval between ultrasound emission and echo reception, it is possible to calculate the depth from which the reflected signal originates. It is established that ultrasound travels 1 centimeter (0.01 meters) in soft tissue in 6.5 microseconds (0.01 meters/1540 meters/second = 0.0000065 seconds = 6.5 microseconds). If the sample volume of interest lies deeper, the piezoelectric crystal commences receiving the reflected ultrasound signal after an extended delay (t_{delay}) **(B, C)**. Conversely, enlarging the sample volume (SV) necessitates increasing the duration of echo reception ($t_{duration}$) **(B, D).** [13]

The selection of radiology equipment is determined by the specific requirements of the patient and the clinical environment. Conventional radiology equipment is often use for initial screening and diagnosis, while non-conventional radiology equipment may be used for more detailed imaging or for diagnosis of complex conditions. [13, 14, 15]

2.2. Medical Imaging equipment

Conventional technologies

Conventional X-ray machines are medical devices used to produce images of the internal structures of the human body. These images are created by bombarding the tissues with X-rays, which are a type of high-energy electromagnetic radiation. [1, 3, 4]

The X-ray generator: This component is responsible for producing X-rays. It consists of a X-ray tube, which is a vacuum tube that contains a filament and an anode. The filament is heated, causing the release of electrons by thermionic emission. These electrons are then accelerated by a high-voltage electric field and strike the anode, producing X-rays. [3, 6]

High-voltage rectifiers: These components are responsible for converting alternating current into direct current of high voltage. This current is necessary to accelerate electrons in the X-ray generator. [3]

High-voltage and heating transformers: These components are responsible for increasing the electrical voltage of the alternating current. The high-voltage transformer provides the electrical voltage necessary to accelerate electrons in the X-ray generator. The heating transformer provides the electrical voltage necessary to heat the filament in the X-ray generator.

High-voltage capacitor: This component stores the high-voltage electrical energy that is provided by the high-voltage transformer. This energy is then released to accelerate electrons in the X-ray generator.

High-voltage cable: This component transports the high-voltage electrical energy from the high-voltage capacitor to the X-ray generator. [3]

Control panel: This part of the X-ray machine is used to control the machine and to set the exposure parameters. [2, 3]

Accessories: These include the patient support plate, the collimator, and the detector. The patient support plate is a critical component of the procedure, providing a stable and comfortable surface for the patient to lie on. The collimator is used to limit the X-ray beam to the area of interest. The detector is used to capture the X-rays that have passed through the tissues. (Fig.7) [3]

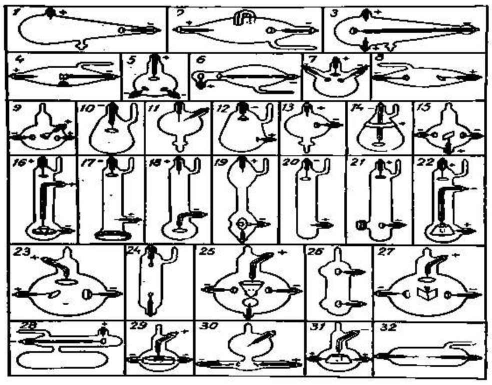


Fig. 7. X-ray tubes from the year 1896 (After O. Glaser, reproduced after Séguy).

Computer Tomography

The advent of this non-surgical imaging technique in the 1970s revolutionized the diagnosis and treatment of intracranial pathology. It is now a mainstay of imaging for the body and spine as well. [22]

A narrow X-ray beam penetrates the patient's head, and a detector [22] opposite the beam measures the degree of X-ray absorption by the tissues. Computer processing, alongside multiple rotating beams and detectors positioned in a complete circle around the patient's head, enables the determination of absorption values for numerous small tissue blocks. The reconstruction of these data onto a two-dimensional display (pixels) produces the signature appearance of a CT scan. For routine scans [22], slices are typically 5-10 millimeters thick. Slices 1-2 millimeters thick provide even finer detail, however, these 'high-definition' views necessitate a longer acquisition and processing time, and this technique is typically reserved for examining the orbit, pituitary region, and posterior fossa. (Fig.8) [3, 5, 6]

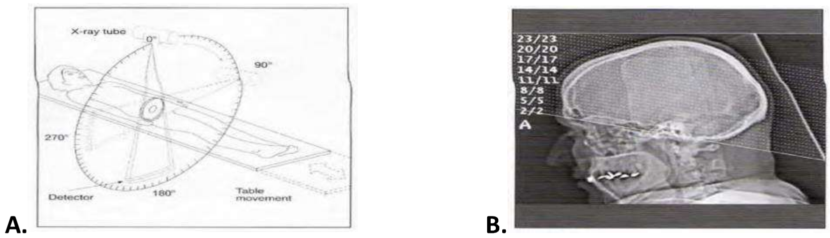
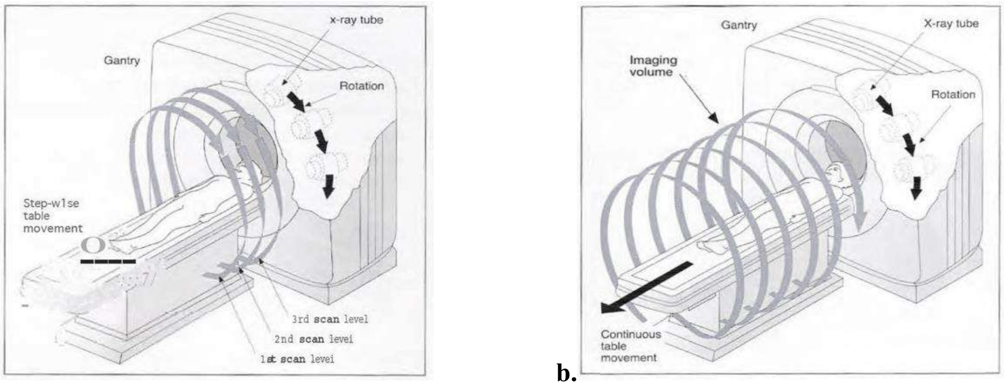


Fig. 8. General principles of CT. A. Most of CT slices are oriented perpendicular to the body's axis. These slices are typically referred to as axial or transverse sections. To obtain a predetermined slice thickness, the X-ray tube rotates around the patient for each slice. B. As the patient table moves

continuously through the gantry, a digital radiograph (also known as a "scanogram" or "localizer") is acquired, providing a reference image on which the desired sections can be planned. [6]

Windowing is a technique used to adjust the contrast and brightness of a CT image. By adjusting the window level and width, different tissues with different X-ray attenuation values can be displayed more clearly. For example, a low window level and width will highlight bone structures, while a high window level and width will highlight soft tissues. [5, 6, 22]

Intravenous contrast-enhanced dynamic CT scanning followed by two-dimensional image reconstruction provides a non-invasive method for visualizing intracerebral vessels. This technique can detect aneurysms up to 2 mm in size, but it is limited to imaging a small portion of the vasculature at a time. Angiography provides better visualization of the entire vasculature. (Fig. 9) [5, 6, 22]



a. b.

Fig. 9. Comparison of Conventional CT with Spiral CT. a. A sequence of images with uniform spacing is acquired in a sequential manner through a specific region. b. The X-ray tube traces a spiral trajectory around the patient. [5]

Non-conventional Radiological technologies

Nuclear Magnetic Resonance

The core component of an MRI scanner is the primary magnet, which produces the static magnetic field (B_0). The scanner also includes gradient coils and higher-order shim coils to adjust spatial variations in B_0. RF coils and associated circuitry are necessary for RF transmission and signal reception, and a computer system is used to control data acquisition and processing. (Fig. 10) [9, 11]

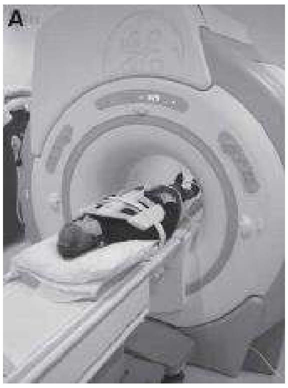



Fig. 10. Introduction to MRI
A. 1.5 tesla clinical whole-body magnetic resonance imaging (MRI) scanner; **B.** Example of other coils used in clinical MRI. [9, 23]

Magnetic field strength is measured in units of gauss (G) or tesla (T), where 1 T is equivalent to 10,000 G. Gauss is the more common unit for describing magnetic fields encountered in everyday life. For instance, Earth's magnetic field is about 0.5 G (5×10^{-5} T). In contrast, the magnetic fields employed in MR scanners are significantly stronger, ranging from 10,000 to 100,000 times greater, and are expressed in tesla. Most clinically used MR scanners operate at field strengths of 1.5 T or 3.0 T, while ultrahigh-field systems employed for animal studies can reach an impressive 14 T. [8, 9, 11, 23]

Apart from being exceptionally powerful, the magnetic field in an MR system needs to be remarkably stable to prevent the Larmor frequency from fluctuating over time. The field is typically produced by an electromagnet comprising windings of niobium-titanium wire, which attains superconductivity at approximately 10 K (-263°C). Submerged in a bath of liquid helium (4 K), these coils conduct substantial electrical currents with negligible resistance, generating a magnetic field that is both intense and stable. The most prevalent configuration is a solenoidal (cylindrical or toroid) geometry, as exemplified in Figures 10. During the scanning procedure, the subject or sample is positioned at the center of the solenoid, where the magnetic field is at its strongest and most uniform. [8, 11]

Ultrasound

This section delves into the characteristics and operation of ultrasound systems. The utilization of these systems for routine vascular diagnostics, particularly for discerning stenoses and occlusions, is the current gold standard for extracranial examinations and is steadily gaining prominence for intracranial assessment. As systems become increasingly compact and lightweight, their application extends beyond ultrasound laboratories into intensive care units for patient evaluations. [13, 14]

Ultrasound machines are devices used to visualize internal structures of the human body using high-frequency sound waves. They are used in many areas of medicine and have multiple component parts.

The pulse generator is the component that generates the ultrasound pulses that are transmitted to the patient's body. These pulses are typically short in duration, with a duration of a few microseconds. The frequency of the pulses is determined by the type of image that needs to be obtained. For example, for 2D images, lower frequencies are used, while for 3D images, higher frequencies are used. [15]

The ultrasound beam former is the component that directs the ultrasound pulses to the patient's body. It is composed of a series of coils that create a magnetic field that directs the sound waves. [15]

The transducer is the component that converts sound waves into electrical signals that are then transmitted to the computer of the ultrasound machine. The transducer is composed of a piezoelectric crystal that vibrates when exposed to sound waves. [13, 14, 15]

Pure Doppler ultrasound is modified to perform functional studies. If the data is from Doppler systems, the specific parameters are discussed. In general, the same fundamental principles apply to Doppler and duplex systems, and the system settings can be adjusted in a similar manner. [12, 13, 15] (Fig.11)

Fig. 11. High-performance ultrasound device with adapted probes for use in neurosurgery

3. Intellectual property applied in research

Medical radiology systems have always been a key element in the development of modern society with applicability in medicine. The rendering of anatomical elements in a way as close to reality as possible and without injuries to the human body, represents a progress worth noting achieved by modern technologies. Medical radiology systems are a valuable tool in medicine. They provide doctors with a safe and effective way to diagnose and treat diseases.

Large companies that hold copyrights and patents on primary technologies play an essential role in the development of various devices. Through knowledge of the basic elements, with perseverance and attention, the development of techniques has led to technological progress. [19]

Medical equipment manufacturers that use the basic principles of molecular physics are represented worldwide by renowned companies.

Table 1. A list of manufacturers of medical imaging devices, by category:

No.	*X-ray*	*CT*	*RMN*	*Ultrasound*
1	General Electric	General Electric	General Electric	General Electric
2	Philips	Philips	Philips	Philips
3	Siemens Healthiness	Siemens Healthiness	Siemens Healthiness	Fujifilm
4	Fujifilm	Fujifilm	Fujifilm	Siemens Healthiness
5	Hitachi Healthcare	Hitachi Healthcare	Hitachi Healthcare	Hitachi Healthcare
6	Canon Medical Systems	Canon Medical Systems	Canon Medical Systems	Mindray
7	Konica Minolta Healthcare	Toshiba Medical System	Toshiba Medical System	Samsung Madison
8	Carestream Health	Konica Minolta Healthcare	Konica Minolta Healthcare	Esaote
9	Agfa Healthcare	Carestream Health	Carestream Health	Canon Medical Systems

This list is not exhaustive but includes the most important manufacturers of medical imaging devices in the world.

Intellectual property (IP) [16, 19, 20, 21] is a legal concept that refers to intellectual creations and innovations, such as literary and artistic works, inventions, trademarks, industrial designs, and trade secrets. IP is important for stimulating innovation and creativity because it gives its holders exclusive rights that allow them to profit from their creations.

International intellectual property law is a set of rules and principles that govern the protection of intellectual property across borders. This law is essential for promoting innovation and creativity, as it provides a level playing field for businesses and individuals around the world. [20, 21]

International intellectual property law is based on a series of international treaties and conventions, of which the most important is the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), concluded within the framework of the World Trade Organization (WTO). TRIPS establishes minimum standards of IP protection that must be provided by each WTO member country. [16, 20, 21]

In addition to TRIPS, there are several other international treaties and conventions that govern the protection of IP, [20, 21] such as:

- The Berne Convention for the Protection of Literary and Artistic Works
- The Rome Convention for the Protection of Performers, Producers of Phonograms and Broadcasting Organizations
- The Paris Convention for the Protection of Industrial Property
- The Geneva Convention for the Protection of Industrial Designs

3.1. Medical database principles

Patient data base are confidential information about a person's health, including their medical history, test results, and treatments. This data can be used to diagnose and treat diseases, monitor health status, and conduct medical research. [17, 19]

Patient data security is important to protect patient privacy and prevent unauthorized data use. There are several measures that can be taken to ensure patient data security, [18, 19] including:

- The use of physical and electronic security measures to protect patient data, such as strong passwords, firewalls, and limited access.
- Educating employees about the importance of patient data privacy.
- Implementing data security policies and procedures.

4. Conclusion

The laws of physics have been the basis for innovation and development that has led the medical field to surpass new limits. Thanks to new technologies, it is currently possible to evaluate the human body in a friendly environment. The ability to restore anatomical elements to their normal position without causing injury to tissues and the possibility of making relevant medical decisions, makes the current technology place the medical act at the level of art.

As technological units improve remarkably in the elements of evaluating anatomical sequences and storing the obtained data, the need for developing the capabilities of storing, preserving, and protecting this information becomes imperative. In the past, this information was stored in large rooms called archives. Currently, these elements can be developed by storing information on an electronic system.

From this point of view, the battle for dominance in the technological market has always been fierce. The company that has succeeded or succeeds in developing a technology with maximum advantages with a minimum capacity of resources, dominates the market at that time. From this point of view, the legislation in the field of intellectual property is well-crafted. It just needs to be applied.

Conventional and unconventional radiological techniques used in medical practice personal data in a database. These data can be used to diagnose and treat diseases, monitor health status, and conduct medical research.

Information security is also the security of the medical act. If medical data is accessed or used unauthorized, risks to patient safety may arise, such as:

- Identity theft or fraudulent use of medical information.
- Discrimination based on health status.
- Incorrect identification of a patient.
- Physical, psychological, or emotional harm.

Therefore, the security of medical data must be guaranteed by both the state and the private sector.

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