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X-Rays and Their Uses on The Human Body

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Abstract:

This research included the study of X-rays and their applications in medicine, as it included: The first chapter identified X-rays and their most important sources, X-ray tubes and the dangers of X-rays. In the second chapter, the types of X-ray imaging in the medical field and the importance of X-ray imaging were identified. The stages of X-ray imaging and the parts of the body that are examined using these rays were also studied. The positions in which X-ray imaging is performed and other benefits of X-ray imaging were also studied and identified. The most important thing that was studied was the applications of X-rays in the medical field and the most prominent problems that can be detected by X-rays in dentistry. As for the third chapter, fractures, their types, methods of diagnosis and symptoms were identified, in addition to osteoporosis, methods of diagnosis, symptoms, causes and methods of prevention.

Keywords: X-Rays, Human Body, Applications, X-ray imaging.

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Introduction

Praise be to Allah, Lord of the Worlds, who sent down the Book, taught by the pen, taught man what he did not know, and commanded us to read and ponder, and made us a moderate nation witnessing over the nations, and prayers and peace be upon the one who was sent as a mercy to the worlds. Now then: It did not occur to Wilhelm Conrad Röntgen, while writing the memorandum announcing his mysterious rays (X-rays) on November 8, 1895 AD, and expressing that with the phrase (I have discovered something very interesting), that their uses and applications would overlap in human life as they did after nineteen hundred and nineteen years. Despite the media exaggerations about the expected benefits of their use, published in the pages of newspapers that followed the announcement of X-rays, these exaggerations in their entirety no longer represent more than a small part of the great services provided by these rays. On the other hand, no one expected at that time that these benefits might be accompanied by serious harm, no matter how strong the imagination of scientific writers was in those distant days. The medical field was the first to benefit from adding the unconventional capabilities of X-rays to its tools used to examine human bodies, as they helped doctors and therapists see what was not seen of the internal details of the body without surgery or bloodshed; so that patients would reap a cure that leaves no illness - God willing. Other fields varied in the degree of benefit from X-rays, and at the top of the list of competitors is the industrial field, then scientific research, then space research, then geophysical research, then exploration of resources such as mining and petroleum, as well as forensic medicine, judicial justice, archaeology, agriculture and the environment, and airport and facility security. The list is still growing with time (1).

1-2- X-rays

These rays are part of the electromagnetic radiation discovered in 1895 AD by the German physicist Wilhelm Conrad Röntgen (March 27, 1845 - February 1923 AD). X-rays travel in a vacuum at a speed very close to three hundred thousand kilometers per second regardless of their energy (99792458.2*10 meters / second). The energy of X-rays is measured in units called (electron volts).

The wavelength of the most commonly used X-rays ranges from 10 picometers to 10 nanometers, and therefore they have frequencies in the range from 3*10 16 Hz to 3*10 Hz19 Hz. On this basis, the energy of X-rays ranges from 124 electron volts to 124 kiloelectron volts. Although X-rays and ordinary light travel at the same speed in a vacuum and affect photographic plates (photographic films), X-rays are invisible.

With a high ability to pass through various opaque materials, such as: the human body, wood, and relatively thin slices of metals: such as aluminum and lead. All waves that form the electromagnetic spectrum have a lower frequency than X-rays except for gamma rays. We obtain the X-rays used in our daily lives from devices dedicated to producing them, while we obtain gamma rays from radioactive sources. Most of the gamma rays emitted from various radioactive sources have higher energy than X-rays; therefore, they have a greater ability than X-rays to pass through materials of high density, as their ability to penetrate different materials depends on their energies and the nature of the material through which they pass. X-rays, like gamma rays; They cannot be sensed by human senses (they cannot be seen, touched, smelled, tasted, or heard), and their straight path in space cannot be changed by the usual electric or magnetic fields, but both of them can deviate from their path at the interface between two different materials, or when colliding with elementary particles, such as electrons. X-rays, gamma rays, and the upper band of ultraviolet energy represent the ionizing part of the electromagnetic spectrum (capable of expelling electrons from the atoms of matter). While the remaining part of the electromagnetic spectrum, such as visible light, infrared rays, radio waves, television, communications, and navigation, represent the non-ionizing radiation family. Despite the similarity between X-rays and gamma rays in many properties, and their identity in a limited range of frequency and energy, the essential (radical) difference between them is the origin, as X-rays originate outside the nucleus of the atom; Therefore, they are called atomic rays (2).

1-3- X-ray sources

Since their discovery to this day, X-ray sources have been limited to two groups: natural sources and artificial sources. Natural sources are represented by blazing stars found in various parts of the universe, such as the stars in the constellation Scorpius (1-Scorpius X), located towards the center of the Milky Way in the southern hemisphere, which were discovered in 1962 AD. Artificial sources of X-rays are represented by special devices made by humans to be compatible with different life purposes. It is worth noting that no matter how different the design of the devices is, the components of obtaining X-rays are three: a source of electrons, a means of increasing the kinetic energy of those electrons, in addition to a solid physical body that the electrons collide with after accelerating them, called (the target). These three components are found in their simplest forms inside tubes evacuated of air to the maximum possible extent; therefore, these tubes represent the main part of regular X-ray production devices. The tubes that produce the rays differ in shape, and perhaps in internal details according to the type of application, but they agree on the basis of work (3).

1-4 X-ray tubes

X-ray tubes are either hermetically sealed or connected to a pump continuously to maintain the internal pressure at a certain value. The basic components of X-ray tubes can be identified by looking at what is included in Figure 1. It is noted that the main parts are a hermetically sealed glass casing usually made of special glass that contains the cathode circuit and the anode, under very low pressure (less than 0.01 mm Hg, knowing that normal atmospheric pressure is equivalent to 760 mm Hg). The cathode circuit includes a filament covered with a cathode mask (the filament is a very thin wire made of a material with a high melting point so that it does not quickly deteriorate with high temperature). As for the anode, it includes the target material facing the cathode. In addition, there must be a continuous source of electrical energy that causes a large electrical potential difference between the two ends of the tube during operation, provided that the anode is positive relative to the cathode. The electrical potential difference reaches tens of thousands of volts. Every thousand volts is called a “kilovolt” (4).

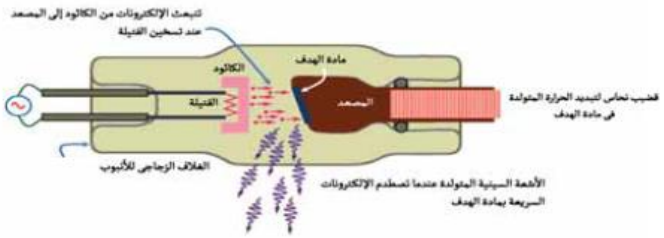


Figure 1. Simplified diagram of a fixed anode and hot filament X-ray tube.

When the filament is heated, a stream of electrons with low kinetic energy is emitted from it. These electrons gain very large energy due to their exposure to an electrical potential difference while they are moving towards the target. The stream of accelerated electrons is called the "tube current". When the accelerated electrons collide with the (target) material, X-rays are produced, which are emitted from the target material in almost all directions; therefore, collimators are used to restrict the directions of the resulting X-rays to a specific direction, and then form a beam of parallel rays that can be used in various useful applications. In order for X-ray tubes to operate with high efficiency, the air pressure inside the glass envelope must be very low (very high air vacuum); this is to prevent the accelerated electrons from colliding and interacting with the air atoms in the tube, and thus losing part of their energy that is used to obtain the rays with the required intensity. Evacuating the air from the tube also protects the hot filament from changing the efficiency of its surface due to oxidation, and thus the density of the electron flux emitted from the surface of the filament decreases. The air trapped in the components of the X-ray tube is evacuated during manufacturing by successive heating cycles to ensure that the vacuum inside the tube remains constant. However, some tubes accumulate a little air, either after long periods of use or because the tube is not properly welded to the end connections through the glass jacket. Regardless of the reason for the air, the filament quickly breaks down in tubes containing even a small amount of air, rendering the tube useless. Most X-ray tubes include an active ion trap to remove air atoms and molecules that appear in the tubes, regardless of their source, thus overcoming this problem. The glass jacket of the X-ray tube can absorb some low-energy X-rays because it contains silicon. A beryllium window has

been made in some X-ray tubes to overcome this problem. The purpose of this window is to allow as much of the low-energy X-rays to pass through the jacket and out of the tube, which operates at a relatively low voltage. The reason for choosing beryllium is that silicon has a higher density than beryllium (silicon's density is 2.33 g/cm3, while beryllium's density is 1.85 g/cm3), in addition to the fact that a silicon atom contains fourteen electrons, while a beryllium atom contains only four electrons; therefore, beryllium absorbs a much smaller amount of low-energy X-rays than silicon does.

1-5- Mechanisms of X-ray Emission from Matter

There are two different mechanisms for producing X-rays from matter. The first is called the braking mechanism, named after the German word bremsstrahlung, which produces continuous X-rays, also called braking rays. The second mechanism produces characteristic X-rays.

1-5-1 Continuous X-rays

Continuous X-rays are produced when high-energy accelerated electrons interact with the nuclei of atoms in the target material. When the accelerated electron passes near the nucleus, an interaction occurs between the electric field of both, resulting in a sudden deviation of the electron's path, and the loss of part of its energy due to the decrease in the acceleration of motion, which is called the "braking" process (see Figure 2). The energy lost by the electron is spread in space by electromagnetic fields, i.e. in the form of electromagnetic waves according to Maxwell's general theory of electromagnetic radiation. The acceleration of a single electron may decrease more than once along its path in the target material. Each interaction of this type may result in the loss of part or all of the electron's energy, and thus the resulting photons may have any amount of energy up to a maximum value equal to the original energy of the accelerated electron, i.e. the energy of the resulting X-rays is continuous and confined to a certain range; therefore, they are called (continuous X-rays). The direction of the photon emission also depends on the electron's energy (5). The higher the electron's energy, the closer the direction of the photon's emission becomes to the direction of the accelerated electron before being affected by the electric field of the protons of the nucleus. Therefore, when the electron's energy reaches several million electron volts, as happens in particle accelerators, the accelerated electrons bombard the target material from one side, and X-rays are emitted from the other side. In relatively low-voltage X-ray tubes, the resulting X-rays are emitted from the same side of the target, and are usually perpendicular to the direction of the beam of accelerated electrons coming from the cathode.

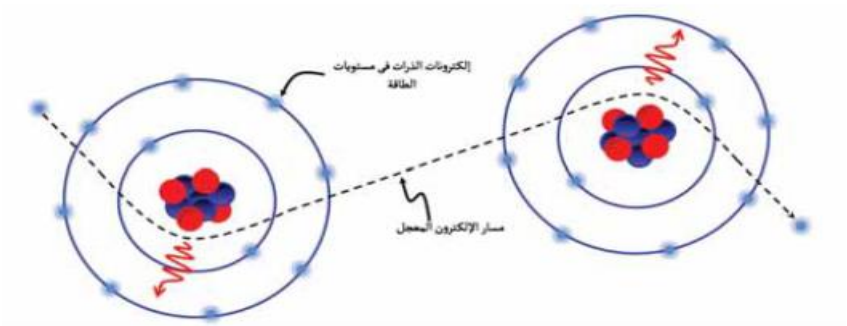


Figure (2) A schematic diagram representing the emission of continuous X-rays when the accelerated electron deviates from its path.

The efficiency of X-ray production depends on the atomic number of the target material, and the electrical potential difference between the anode and the cathode as follows: (efficiency = 10×-109 × atomic number × electrical potential difference). For example, if the target material is tungsten (74=Z), and the electrical potential difference is about 100 kilovolts, the efficiency is less than 1%, and thus the percentage of energy converted to heat in the X-ray tube is more than 99%; therefore, the method of disposing of this high heat must be highly efficient, in addition to choosing the target material with a melting temperature as high as possible, taking into account the other properties that it must have (6).

1-5-2 Characteristic X-rays

Not all accelerated electrons that bombard the target material suffer from a decrease in acceleration of motion; as a result of their proximity to the nuclei of atoms, but some of these electrons collide with electrons in orbits close to the nucleus. This collision results in the ejection of some electrons from their orbits outside the atom, and then the atoms become ionized. While the energy of each of the original accelerated electrons decreases by the amount lost in the collision, which is equal to the amount of energy gained by the ejected electron. Part of this energy is spent by the ejected electron in overcoming its connection with the nucleus of the atom, and it moves with the remaining part of the energy away from the atom, leaving a gap in the orbit it was occupying. Once a gap is formed in the orbit, one of the electrons from the outer orbits far from the nucleus collapses to fill the vacant place (see Figure 3).

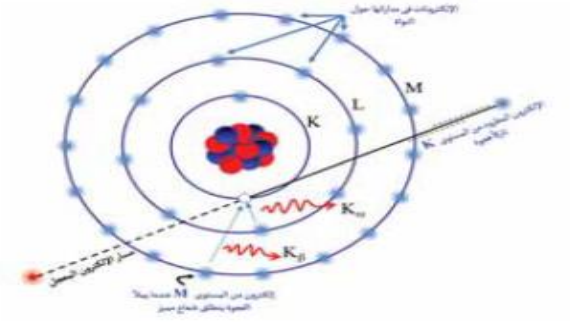


Figure (3) Distinctive X-rays are produced when an electron moves from the orbits far from the nucleus to fill the gap left by the ejected electron.

1-6 Other sources of X-rays

X-rays are currently produced for a number of medical and non-medical applications, by traditional production devices, whether mobile or fixed) that rely on X-ray tubes, in addition to charged particle accelerators, such as: linear accelerators, Betatron accelerators, Cyclotron, and Synchrotron, which are huge and complex equipment in terms of design and components. A beam of electrons is accelerated to very high energies; for various purposes; and when necessary, the accelerated electrons are allowed, in the first three types, to collide with a metal chip (target material), which has a large atomic number and a high melting point such as tungsten, and then these electrons lose most of their energy; to appear in the form of continuous X-rays with a wider range and higher energy than those produced by traditional devices; to meet the requirements of a wide range of useful applications.

Here we present a simplified idea about two of those giant sources of artificial X-rays, which are the linear accelerator and the synchrotron; Because the rays emitted by them are related to several fields:

1-6-1 Linear accelerator:

The linear accelerator (linac) is one of the oldest means of accelerating subatomic particles to very high speeds approaching the speed of light. It was invented in 1928 by Rolf Wideroe (July 11, 1920 – October 11, 1996). Linear accelerators vary greatly in length; starting from the well-known cathode ray tube, up to several kilometers. These accelerators are used in several applications, such as: producing X-rays, for medical, industrial and scientific purposes, or others. The design of the linear accelerator depends on the type of particles to be accelerated, such as electrons, protons, or ions (7).

1-6-2 Synchrotron

Synchrotrons are large, highly complex, and high-tech devices. Synchrotrons are usually located in national or regional centers; This is due to its large size, complexity, and high operating cost; hence, researchers must travel to it to benefit from its unique capabilities. The synchrotron is a special type of circular particle accelerators, where the magnetic field that causes the particles to rotate in a circular path and the electric field that causes the particles to accelerate are precisely synchronized with the beam of moving particles. Figure (4) shows that the charged particles, whether electrons or positrons (positively charged electrons), are injected into a ring-shaped chamber that is evacuated to a very high degree of air, which may reach about 10-torricelli. (A torcelli is a unit of pressure equal to one

millimeter of mercury). The circularity of the hollow chamber is not complete, but consists of a series of arcs connected to each other by straight sections.

The particles enter the ring via the injection magnet, then move around the ring at a speed close to the speed of light, and are affected by a series of magnets that work to curve the path of the charged particles, where the charged particle moves in a circular path when affected by a uniform magnetic field perpendicular to the path of motion. There is an additional set of magnets, quadruple and hexapole, which are used to focus and shape the particle beam, as they move around the ring, during which those particles lose some of their energy. The energy lost by the particles when they move through radio-frequency cavities is compensated, as synchronous electromagnetic fields give energy to the particles; to keep them rotating around the ring at a speed close to the speed of light.

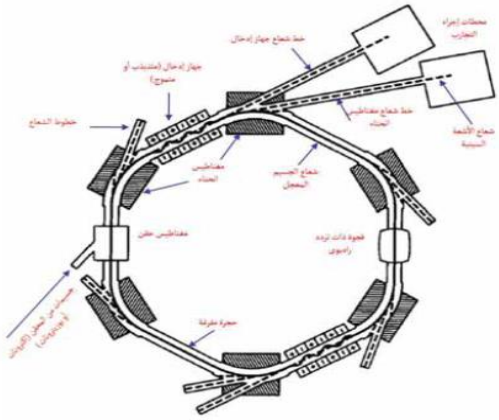


Figure (4): A schematic drawing of a synchrotron used as an X-ray source.

1-7 Benefits of X-rays

After its discovery, X-rays have become very important in human medicine because they help easily diagnose diseases and know the exact cause of pain and various diseases. The most important benefits of X-rays are also the following:

- ✓ Facilitates and supports treatment plans and makes them simple.
- ✓ Helps diagnose diseases in a painless way for the patient in order for doctors to evaluate the available treatment options.
- ✓ X-rays help in knowing the path of the catheter or any device that enters the body and work is done according to what the medical team sees in the X-ray machine.
- ✓ X-rays facilitate the treatment and removal of tumors in addition to getting rid of any blood clots or any blockages in the body. In addition to the above-mentioned benefits and uses of X-rays, we must also clarify some points for the uses of these rays

  Radiography is used to detect bones, teeth and the locations of solid objects such as lead in the body or to detect tumors.

- ✓ Thanks to these rays, large fractures can be seen with high accuracy, because the rays can penetrate soft objects such as flesh and skin, but cannot penetrate solid objects such as passing through bones. Although they can cause cancer, they are, on the contrary, used to treat and eliminate cancerous tumors. X-rays are also used in industry to detect cracks and defects in metal molds and wood. Studying the absorption spectrum of these rays in materials has helped make these rays a way to detect or analyze the elements that make up different materials. Sometimes X-rays are used to distinguish each chemical element, and it has become possible to measure the thickness of solid materials and scan industrial pieces to search for defects that may not be noticed with the naked eye. X-rays are also used in security to monitor passengers' bags at the airport to search for bombs or weapons to protect the country from terrorism or criminals.
- ✓ X-ray diffraction is used in the science of studying solid objects, and it became clear that there is symmetry in some types of solid materials or crystals, and this was the beginning of Jabbar's launch in studying the properties of solids or knowing the atomic structure of elements.

- ✓ X-rays are used in the field of art to identify and distinguish between real paintings and fake paintings because the colors used in old paintings contain many mineral compounds that absorb X-rays, while the colors used in modern paintings are organic compounds that absorb X-rays in smaller proportions.
- ✓ X-rays at the dentist
  X-rays are used in dental clinics because they: take pictures of teeth on film and identify decayed teeth or teeth that need extraction or filling, or make dental or molar restorations, but developing the dental X-ray film takes time in addition to the difficulty of storing and recording these films. Therefore, the method of film photography was developed and digital photography began to replace it using digital sensors, and this method requires exposing the patient to less radiation during imaging. Then the image appears directly on the monitor screen and while taking X-ray images, care is taken to protect parts of the patient's body that are not included in the examination area by lead barriers. Also, the nurse working on the X-ray machine leaves the room after preparing the patient for imaging, then operates the device from outside the room so that she is not exposed to radiation.

1-8 The most important uses of X-rays:

X-rays have contributed and continue to contribute to the diagnosis and treatment of many diseases, and thus X-rays help improve human health in different parts of the world. Imaging and diagnostic systems have benefited from the development of technology, as these systems have evolved from simple units designed to photograph special anatomical cases to systems that can display the entire human body and obtain information related to the functions of certain organs in addition to information about the chemical processes that occur in organs and tissues. All of this has been achieved through the tremendous development in the world of digital technology.

The following are the most important X-ray devices and systems used in the medical field:

- A simple imaging device uses an X-ray device with a fixed beam. This imaging technology depends on the penetration of rays into the human body and on the difference in density of different organs, as the rays penetrating from the body fall on a shiny plate that generates photons that in turn fall on an imaging film, which in turn will show us a two-dimensional image that can be used primarily in cases of bone fractures such as limb bones and for imaging the lungs.
- Endoscopy: It allows for real-time imaging of the patient's body using different means to image the organs while they are performing their functions. Here, this technology requires a device to enhance the image that ultimately appears on a television screen. It is also possible to take still shots that can be saved electronically. Endoscopy is used in special medical cases such as cardiac treatment cases.
- Computed tomography: This technology uses a rotating beam of X-rays with rotating detectors in parallel, where the computer connected to it reconstructs the images to finally obtain a three-dimensional image. It is also possible to obtain cross-sectional images of any part of the human body, which gives a more accurate and clear diagnosis.
- Simple computerized imaging, in which the classic film was replaced with a phosphorous storage plate.
- Direct digital imaging, in which an effective detector network is used, the resulting signal is converted into digital signals.
- Computerized endoscopy: It is a device developed from regular devices, as digital technology was used to develop this system, and it has become used in what is called interventional X-rays. Here, dental X-ray imaging is accompanied by surgical operations to achieve higher accuracy in surgical work.
- Mammogram is used in breast diagnostic cases.
- Radiography in medicine to detect teeth and bones and their fractures and to determine the locations of solid objects such as shrapnel or bullets in the body, as well as to detect tumors in the body. Thanks to these rays, it has become possible to see bone fractures with high accuracy, as these rays can penetrate soft objects such as skin, but they cannot pass through bones, which leads to the appearance of the latter image, the most important feature of which is the lack of side effects.
- Doctors also use these rays to treat and eliminate cancerous tumors. X-rays kill and eliminate cancer cells, while healthy body cells regain their vitality after a short period and return healthy and healthy.

- X-rays were also used in industry to detect flaws and cracks in metal molds and wood used in the manufacture of boats. Studying the absorption spectrum of these rays in the material helped make X-rays a way to detect and analyze the elements that enter into the composition of different materials. In this case, X-rays are used to distinguish each of the chemical elements. It has become possible to measure the thickness of solid materials and scan industrial pieces for defects that cannot be noticed with the naked eye using these rays.
- In the field of security, X-rays are used to monitor passengers' bags at airports in search of weapons or bombs
- In the science of studying solid bodies, using X-ray diffraction, it became clear that there is a certain symmetry in some types of solids (crystals), and this was the beginning of a huge launch in studying the properties of solids and crystal structure, and knowing the atomic structure of elements.
- In the field of art, it was used to identify the styles of painters and distinguish between real paintings and fake paintings, because the colors used in old paintings contain many mineral compounds that absorb X-rays, while the colors used in modern paintings are organic compounds that absorb X-rays to a lesser extent.

1-9 Risks of X-rays

Humans are exposed to ionizing and non-ionizing radiation in daily life, intentionally or unintentionally. The manifestations of radiation exposure vary in terms of the method of exposure, the relationship of the exposed person to the radiation source, and the intensity and duration of exposure (8).

- ✓ Breaking (cutting) the chromosome into smaller parts (main-chain scission), which reduces the viscosity of the cell nucleus, and leads to the presence of new molecules with no specific function in the cell. Therefore, ionizing radiation causes structural aberrations with pieces of chromosome breakage products, and the formation of unknown abnormal shapes. The unequal division of nuclear chromosome materials between daughter cells leads to the production of abnormal nuclei that cannot survive. Thus, the effects of radiation begin to appear in the second or third generation of tissue cells.
- ✓ Creating cross-linking (bridges to connect distant sites that are not normally linked; to increase the viscosity of the cell nucleus, prevent normal chromosome separation during mitosis, and copy genetic information.
- ✓ Creating point lesions, such as tearing single chemical bonds. These point lesions are not detected early, but they can cause slight modifications to the molecule; resulting in a malfunction in the cell's function. Therefore, at low radiation doses, these injuries are considered the most likely at the cell level, and thus lead to the delayed effects of radiation at the level of the whole body.

Laboratory experiments have proven that all types of effects of ionizing radiation on large molecules are reversible during internal cellular repair, especially when the injuries are simple, and then the cell returns to its previous state after healing (9).

Different tissues can be classified in terms of their relative sensitivity to radiation, as tissues with:

- ✓ High sensitivity to radiation, such as: lymphatic tissues, bone marrow (Marrow) Bone, blood, testicles, ovaries, and the lining of the intestine.
- ✓ Relatively high sensitivity to radiation, such as: skin, and other organs with an epithelial lining (cornea, oral cavity, esophagus, rectum, bladder, vagina, cervix, and ureter).
- ✓ Moderate sensitivity to radiation, such as: stomach, developing cartilage, small blood vessels, developing bones, and the lens of the eye.
- ✓ Relatively low sensitivity to radiation, such as: bones, or fully developed cartilage, salivary glands, respiratory organs, kidneys, liver, pancreas, thyroid gland, adrenal glands, and pituitary gland.
- ✓ Low sensitivity to radiation, such as: muscles, brain, spinal cord, and central nervous system, because they are mainly composed of cells that are very slow to divide, and do not renew at all.

Organs and tissues that have low or relatively low sensitivity to radiation are considered radioresistant, meaning that they are not affected by relatively low doses. In order for the effects of radiation to appear in them, they must receive high doses in a relatively short period of time.

1-10 Exposure in the medical field

Exposure to X-rays is not limited to patients only, but also extends to practitioners. The number of people exposed to radiation occupationally in medicine is much greater than in any other practice, due to the wide spread and the number of medical procedures in which radiation sources are used. The average collective dose as estimated by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCAER) is higher in the medical field than in any other field dealing with radioactive sources.

Individual occupational exposure varies greatly among health care providers related to radiation according to the number of procedures performed, the skill and experience of the specialist. Most of them are exposed to an annual dose well below the dose limits recommended by the International Commission on Radiological Protection (ICP); however, there are specific procedures that give high doses to members of the medical team, such as: interventional medical procedures guided by fluoroscopy.

1-11Effects of radiation on the fetus

Congenital defects appear in humans and animals without exposure to X-rays or any other ionizing radiation. The average incidence of birth defects in children is about 6%. Some deformities disappear after birth, but most of them become apparent later despite not being detected at birth. The percentage doubles to 12% if children are examined until adulthood. The percentage of congenital deformities increases among children born to mothers whose wombs were exposed to radiation without knowing that they were pregnant; which indicates that physical effects on the fetuses develop over time. This requires immediate counseling for pregnant patients after exposure to radiation as soon as they know that they are pregnant. Non-carcinogenic effects on the fetus can be summarized in three categories as follows:

- ✓ Radiation-induced lethal effects: They occur after the amniotic sac attaches to the uterine wall or, with very high radiation doses during all stages of fetal development inside the uterus. If induced, the fetus dies before or after birth due to the deformities caused by the radiation.
- ✓ Deformities: Especially during the period of formation of the main organs of the body, especially the most active stages in cell multiplication, i.e. from the eighth to the fifteenth week, and their effect may extend to the twenty-fifth week. Examples of these deformities include: deformity in the general appearance of the body, delayed growth, and a decrease in the intelligence quotient that may reach severe mental retardation.
- ✓ Growth disorders without induced deformities: This occurs at all stages of fetal development, especially if radiation exposure occurs in the last period of pregnancy.

The degree of severity of non-carcinogenic radiation effects in fetuses depends on the stage of pregnancy, the radiation dose received, and the dose rate, as it was found that most pathological effects in the fetus decreased significantly when the dose rate was reduced. This shows the importance of not performing any radiation examination of the pelvic area in women during pregnancy, especially if other alternatives are available (10).

2-1 Medical applications of X-rays

X-rays came into use immediately after their discovery. The medical field was the first application to benefit from X-rays, due to their unusual properties that enable us to see the components of the body from the inside without surgery, bloodletting, or even anesthesia. It only takes a few minutes, and medical X-ray imaging used in diagnosis was and still is more widespread than others to this day; to study the changes that occurred in the basic structure of the healthy human body, whether in the form of unwanted tissue growth (tumors of both types: benign and malignant), the presence of cracks or fractures in the bones, or tooth decay, and so on. In later stages, X-ray production devices were developed, which are used in the treatment of cancerous diseases.

2-2 Types of X-ray imaging in the medical field

X-ray imaging is one of the fastest and easiest ways for the doctor to examine the internal tissues and organs of the body; because it represents an excellent tool that helps evaluate the condition of bones, teeth, and jaws. It is also used to examine the chest cavity area including the lungs, heart, breast examination, digestive tract, kidneys and ureters, by obtaining high-resolution images. It is also used to measure bone density, orthopedic surgery, and treat various sports injuries. X-ray imaging is also a fundamental pillar in detecting and diagnosing cancer, and then treating it. Diagnostic X-ray imaging is still the most widely used diagnostic procedure worldwide, such as: computed tomography (CT),

interventional radiology, ultrasound, magnetic resonance imaging, and nuclear medicine. Diagnostic X-ray imaging includes a wide range of techniques and applications (11). However, it can be divided into two main categories:

- Regular radiography and computed tomography, where we obtain a “still image” of the imaged area and display it on film or on a computer screen.
- Fluoroscopy, where we obtain instant moving images of the organ directly on a monitor or computer, in order to examine the internal functions of the body.

2-3 The importance of X-ray images

X-ray images are: a tool to help assess the patient's condition, however, they do not only affect the diagnosis, but their effect extends to estimating the patient's possible probabilities, and then choosing the optimal method of treatment. The X-ray imaging process must be done at the appropriate time in the stages of the patient's condition development; so that the X-ray image can play its desired role. The X-ray image must also match the necessary technical specifications before the image examination process; deducing information. The use of X-ray images can improve, God willing, the information collected through the clinical examination, and successful diagnosis requires an appropriate X-ray image and a good clinical examination.

The diagnostic X-ray imaging process should be done within the narrowest limits; because more X-ray images mean more radiation doses emanating from a source of harmful ionizing radiation.

2-4 Stages of X-ray imaging

The science of X-ray imaging in the medical field is based on preparing X-rays emitted from a suitable source, then projecting them onto the area of the body that needs to be imaged, then receiving the rays that have passed through the body, then recording them by an appropriate means that may be a film or a device; To count the photons, then process the film by chemical or physical means; to finally obtain the radiological image. There are four main stages in the X-ray imaging system, which are designed to improve image quality, reduce patient exposure to radiation, and are shown as follows

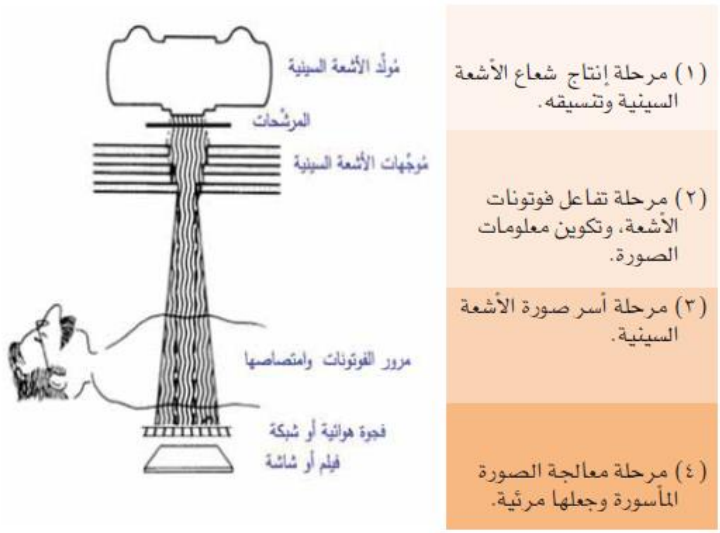
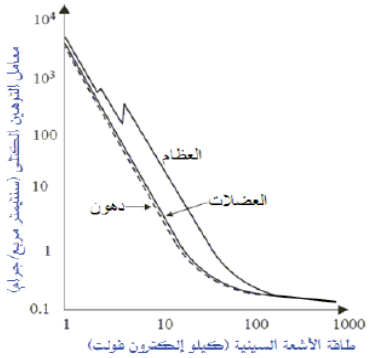


Figure No. (5) A schematic diagram showing the four main stages of diagnostic X-ray

The stage of producing and coordinating the X-ray beam, which includes the X-ray tube, filters and beam guides (collimators) designed to direct the X-ray photon beam of sufficient quality and quantity to the patient to image the body part under study. The stage of interactions of X-rays that collide with the patient's body to produce the absorption and attenuation patterns that will produce the visual information on the imaging film. The stage of the image capture and recording systems (film or electronic medium) to capture the pattern of photons that passed through the patient's body to produce the diagnostic image. The stage of processing the interactions resulting from the captured photons to make the information contained in the image visible, whether by electronic means or film processing. The

ability of X-rays to penetrate different materials depends on the energy of the X-ray photons and the physical properties of the material, such as the density and thickness of the body. The lower the density or thickness of the material, the higher the ability to penetrate at the same energy. The tissues and organs of the body differ in shape, size and density, and the value of the attenuation coefficient of rays in those tissues varies within a specific range of energy. X-rays are selected for medical radiology at an ideal energy that corresponds to the greatest variation in the attenuation coefficient values of the body components in the ray path, and thus we obtain good radiological images characterized by clear details that contribute to successful diagnosis. The attenuation coefficient represents a measure



of the decrease in the intensity of X-rays in their path, and is expressed in two ways: linear (SMA) or mass (cm2 grams). The intensity of the rays represents the number of X-ray photons falling on a unit area (m/cm) per second, and is also expressed as the intensity of the ray flux. In the first definition, the intensity of the rays depends on the distance between the source of the rays and the measurement site. Therefore, the use of beams is an urgent necessity to obtain parallel X-rays of constant intensity regardless of the application site and type (12).

Figure (6) Change in the value of the mass attenuation coefficient in different tissues according to the energy of the X-rays.

2-4-1 Chest X-ray

Chest X-ray is the most commonly performed radiological examination in the medical field, accounting for approximately 45% of all examinations used in this field. The imaging process takes only a few seconds; therefore, it may be thought that performing this task is easy. However, the opposite is true, as chest X-ray imaging requires experience and precision in performance; in order to obtain an image with the specifications that meet its purpose; because the chest contains tissues of different compositions, such as: the lungs, in addition to soft tissues and thick hard bones. The lungs consist of millions of alveoli with very thin walls, almost filled with air; therefore, producing an image that provides us with all the fine details of all the structures in the chest requires technology and experience.

Figure No. (7) An accurate radiological image of the chest area, in which the lungs appear darker than the bone areas.

What happens when a chest x-ray is taken?

The x-ray source must be on one side of the body, or the part to be imaged, while the film or radiation detector is placed on the other side. The detector or film absorbs the photons that have passed through the body.

Figure (8) During conventional chest X-ray imaging, the person stands between the radiation source and the film (or radiation detector) position.

After processing the film, its areas range from pitch black to bright white. The dark areas in the X-ray image represent tissues with low density, such as: lung and breast. As for the transparent areas, they represent tissues with high density, such as: bones (13).

The density of tissues is determined by what is called "optical density", which is proportional to the transparency of the film.

2-4-2 Examining the extremities with X-rays

The X-ray image is often used when examining accident victims; to determine the damage that occurred in the skeletal structure, as well as before performing orthopedic operations on the extremities, or after operations to install supporting screws as well; to ensure their correct position.

Figure (9) A picture of the humerus broken in an accident (right). And a picture showing the position and length of the fixation screws at the ankle joint (left).

X-ray imaging positions

The positions of the body during X-ray imaging depend on the anatomical location of the suspected diseased part, as well as the patient's condition, whether obese or thin. Since some parts of the body cover the internal structures of other parts when the projection is taken from any angle, the choice of body position and the relative positions of the x-ray sources aims to obtain the clearest possible image of the part to be imaged. X-ray examinations also require a

minimum of radiation exposure to protect the patient; therefore, two images are usually taken of the area to be imaged, with each image projected at a 90-degree angle. In some special cases, such as joint imaging, three images are requested of the same area.

Figure (10) shows the different positions adopted during X-ray imaging, to ensure

Other benefits of chest X-ray

Radiology is not only used to detect chest diseases, but it can also be used to reach more useful explorations that may be related to previous surgical procedures, or the placement and fixation of a thread, tube or device.

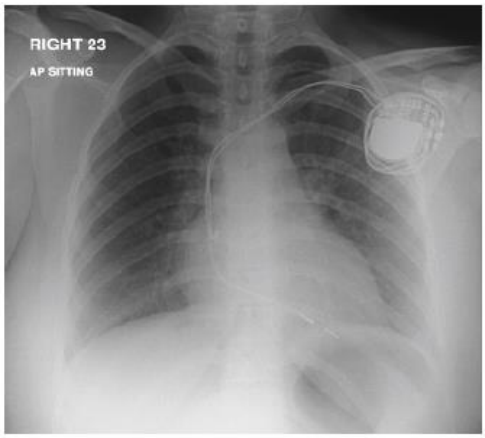


Figure (11) Ensuring the stability of the position of the dual chamber of the permanent pacemaker.

Limitations of using X-rays for chest imaging

- A two-dimensional X-ray image represents the components of the three-dimensional body; therefore, the details of depth information are lost.
- Matching the different levels on one level represents the projection of the contents of the levels, which makes the process of monitoring or detecting abnormalities very difficult, especially if their dimensions are small.
- Regular X-ray images do not help differentiate between different types of tissues if they are similar in density.

2-4-3 X-rays and dentistry

X-rays help the dentist to image the teeth and the surrounding tissues, and thus discover defects that cannot be seen with a simple visual examination and find dental problems and treat them early before their condition worsens. This technology not only saves our money spent on treating avoidable damages, but also saves us from the inconveniences and severe pain that may attack us at a time when we need to work or rest, if we adhere to early examination to detect dental defects when they begin to occur. It may be thought that the scope of application of X-rays in the field of dentistry is narrow, but dental radiographs vary, as they are represented by a picture of a single tooth, a group of adjacent teeth, the entire jaw, or taking a panoramic picture of the teeth. Each of them serves multiple purposes according to the type of examination in order to identify problems and then provide useful treatment.

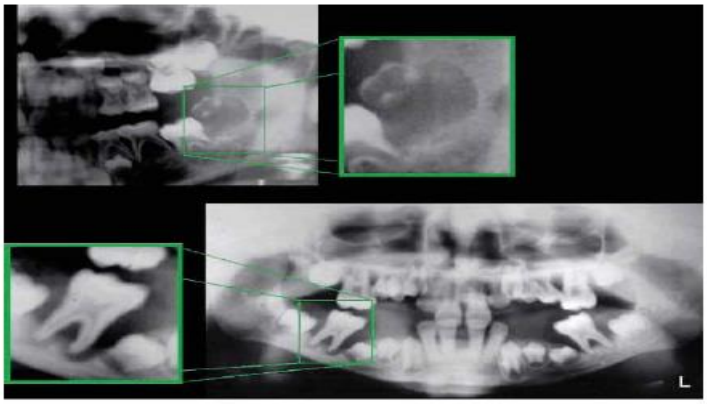


Figure No. (12) Panoramic radiographs of two cases of acute leukemia in children

displacement of the developing tooth (top); causing serious damage to the supports around the affected teeth.

Problems that can be detected by X-rays in dentistry

X-rays taken from children's teeth are used to:

- Detect tooth decay early.
- Determine the extent of sufficient space in the mouth to accommodate all future teeth.
- Determine the possibility of losing primary teeth and the proper growth of permanent teeth.
- Monitor the development of wisdom teeth and determine the extent of tooth penetration into the gums.

As for adults, X-rays can be used to:

- Identify and detect areas of decay that may not be visible by direct visual examination, especially if they are found in small areas between teeth such as molars and others.
- Test the presence of decay under the current filling.
- Detect bone problems in the jaws that accompany gum disease.
- Detect changes that occur in the bone, or in the root canal as a result of infection. Helps prepare for dental implants, braces, dentures, etc.
- Detect abscesses (infection in the root of the tooth, or between the gum and the tooth).

- Detect other abnormal development conditions, such as: abscesses, and some types of tumors.

2-4-4 Mammography Mammography

It represents an X-ray image of the breast, and is used to examine changes that may occur in breast tissue, such as breast cancer, and helps to detect them. Images can be obtained by placing one of the breasts in a special device to examine the breast radiologically. The device contains an X-ray tube with a rotating positive pole, and an image receiver mounted on opposite sides of a set of movable mechanical parts (gantry); to ensure imaging of the breast from different directions, with the possibility of changing the height of the breast support and pressure plate; to match the heights of patients. The design of this device allows the X-ray beam to pass through the examined breast, and form an image on the image receiver, such as: X-ray film.

Figure No. (13) One of the breast X-ray imaging devices (mammogram).

Breasts vary in size and shape from woman to woman, and from man to man, although the difference is not great in the case of men. The breast is mainly composed of glandular tissue in addition to muscle tissue and fat, so the density of the breast material is not high, and therefore the energy of the rays used in breast imaging is not high, as the X-ray tube operates in the range of 25 to 28 kilovolts, and the anode material is molybdenum, while the target material is rhodium. Mammography requires pressure on it during imaging, which causes discomfort for some women, which quickly disappears. Pressure on the breast is necessary to obtain excellent images that help in good diagnosis, in addition to reducing the dose of radiation acquired during imaging. On the day of the mammogram, a woman should not wear deodorant, perfumes, powders, or liquid preparations; for cosmetic or medical purposes, due to the possibility of the shadow of these things appearing on the X-ray film. The mammogram will be performed by a radiographer or another specialist. The patient may be asked some questions related to the examination and two images are taken for each breast in two perpendicular directions. If one is from top to bottom, the second image is from the side.

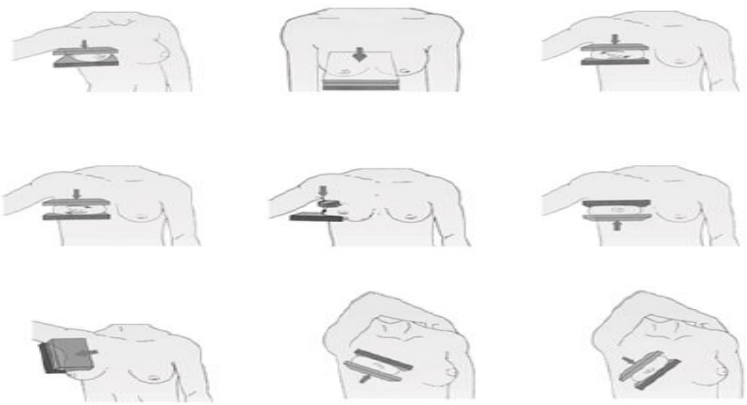


Figure (14) A side view of the breast during imaging while it is compressed between the pressure plate and the breast support.

The directions of the required radiological image projections vary from one patient to another as they depend on the patient's condition, the size and shape of the breast and the suspected location of the tumor. After completing the preparation of the imaging films, the radiologist may request other films or an ultrasound scan of the breasts to increase confirmation. A high-density mass appears in the mammogram image of a 69-year-old woman (left), and the oval-shaped tumor appears using ultrasound of the same woman (right) (15).

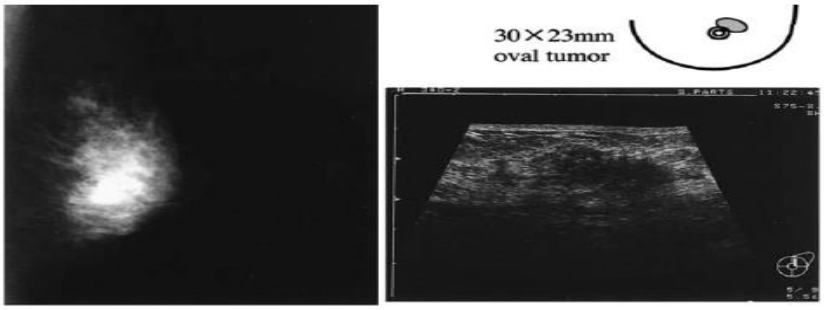


Figure (15) A different set of X-ray projection directions during breast imaging.

Figure (16) Two images using two different techniques for the same case (a patient's breast).

2-4-5 Angiogram

Angiogram is a procedure that involves inserting a flexible tube into the heart, and uses a water-soluble dye, such as iodine, to make the blood vessels visible, or more clearly, when performing X-rays with higher energy than in chest imaging. This technique is used to determine the location of clots, or narrowing (blockage) in the blood vessels; therefore, it is usually performed before bypass surgery (angiogram). Angiogram images are characterized by clear details of the blood vessels.

The use of a catheter makes it possible to combine diagnosis and treatment in one procedure, such as: inserting a dilating ring if there is a narrowing in the artery. As well as measuring blood pressure inside the blood vessel directly by a sensor placed in the head of the catheter.

Figure No. (21) The arrow indicates the area of blockage in the artery (right). During imaging; to obtain an angiogram for the patient (left).

2-4-6 Soft tissue imaging

When imaging soft tissues, such as the esophagus, stomach, duodenum, and intestines, the patient takes a meal of barium dye solution, or swallows some of it. Barium absorbs X-rays more than the surrounding tissues due to the large

difference between the atomic number of barium (56-Z) and the effective atomic number of water and soft tissues (7.42 = Ze), which leads to increased contrast and clarity in tissue images, as in the case of imaging the esophagus and intestines (see Figure 2-18). Barium imaging is a procedure that takes about a quarter of an hour, and is not stressful or harmful to the patient. The patient's preparation for imaging begins at midnight before the examination, by not eating or drinking anything after that until the imaging is completed. This procedure is very important, as the examination will not be convincing if the stomach or intestines are not empty. If the patient happens to eat something, the examination must then be postponed to another time. Diabetics who are about to undergo this imaging are advised to adjust the amount of insulin they take appropriately in line with the upcoming fasting period.

Figure (22) A digital radiograph of the intestines taken during an examination of the abdominal cavity (intestinal area) using X-rays.

Just before the scan, the radiologist will ask the patient in the imaging room to swallow a glass of sparkling liquid to create gas in the stomach. Then he or she will stand behind the X-ray machine and be given a white solution (barium) to drink. Some of this solution will settle on the wall of the esophagus, while the rest will travel to the stomach and intestines, which the radiologist will see on a monitor. During the imaging, the specialist asks the patient to change his position slightly periodically, then hold his breath (stop breathing for a moment; so that the image is clear without distortion. Immediately after the imaging, the patient can eat whatever he wants, and he must eat a lot of fruits and vegetables, and drink additional fluids; in order to remove any trace of barium in the intestines. There are several methods for imaging soft tissues with X-rays, including the following:

- Proctogram: X-rays and barium dye are used to image and examine the function of the rectum as well. The entire examination period, including preparation, takes about two hours, while the examination process itself does not take more than a quarter of an hour. The rectal area must be empty before the barium solution is given as an enema. This procedure may cause embarrassment to some more than it is painful or annoying; due to some cramps.
- Intravenous pyelogram: A special X-ray examination of the kidneys, and other parts of the urinary system such as the ureters, which are two tubes extending from the kidneys to the bladder. This examination does not require the patient to prepare well Especially with the exception of a dye injection in his arm, which helps the details of the kidneys, ureters and bladder to appear clearly on X-ray images. If the patient suffers from asthma, hay fever, or any allergies to food or medications, or if he has had a previous reaction to dye imaging in the past, he must inform the radiographer or radiologist.

This procedure is harmless, however, the patient may feel some temperature changes in the arm during the injection, in addition to an unpleasant metallic taste in the mouth. These symptoms are normal, but if the patient feels nausea or shortness of breath, or discomfort due to the pressure bandage on the arm, he must inform the work team immediately to address the problem.

Figure No. (23) Examination of the pelvic area, kidneys, ureters and bladder by X-ray.

2-5 Limitations and limitations of X-ray imaging

1. Obtaining an image in only two dimensions of a three-dimensional body means that the internal details of the body will appear stacked on top of each other, and therefore there is no information that can be inferred from the image about the details of the body's depth, and the spatial distribution of its components.

2. Regular X-ray imaging is unable to differentiate between soft tissues, especially when they are close in density and position.

3. There are no absolute measurements about the degree of transparency and blackness of films, but rather they are done relative.

These limitations and others encouraged the search for new alternatives that help detect internal body diseases using X-ray imaging as well, with the acceleration of data processing using computers. The search eventually resulted in the emergence of tomography.

2-5-1 CT-Computed Tomography

Tomography means obtaining images of cross-sectional slices of the human body or any three-dimensional body. Tomography initially relied on moving the X-ray tube linearly in one direction, while at the same time moving the X-ray film in the opposite direction; Therefore, the points of the center of rotation level are imaged, and the image appears in clear and sharp detail. As for all the points above and below this area, they are unclear, and appear as a distorted gray background on the film. This technology was later developed, as several generations of CT scanners appeared (16).

The tremendous success of the X-ray CT technique is due to the high contrast in soft tissue images; this is due to the lack of interference between the image of the required level and the rest of the body parts. In addition, the patient does not suffer from any pain resulting from the CT scan process, and he can know the result of the examination when discussing it with the specialist doctor.

After the entry of CT into the applied medical field in 1973 AD, it developed into the use of X-rays in multi-use three-dimensional imaging, such as: oncology, vascular radiotherapy, cardiology, trauma and trauma science, and even in interventional radiotherapy, in addition to studies to monitor and examine risk factors.

Stages of obtaining CT images

- Generating X-rays with the required specifications and coordinating them using ray guides, so that they become parallel beams.
- Determining the position of the patient to be imaged and directing the parallel rays to it.
- Collecting the rays passing through the patient's body using detectors.
- Processing the data using a computer; to reconstruct the image and then display it on a screen.

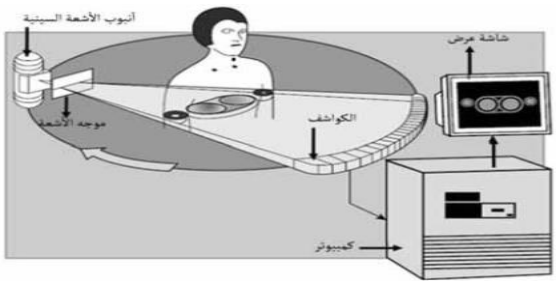


Figure No. (17) The different stages of producing a CT image.

Preparing for CT Scan

In some cases, such as CT scan of the abdomen and pelvis, patient preparation requires the following:

If the CT scan is scheduled in the morning, the patient must fast from midnight. If the CT scan is scheduled in the afternoon, the patient may have a light breakfast and then stop eating from 9 am. In some cases, the patient will be asked to drink about a liter of a water solution, or the patient may be given a dye injection before the scan; to increase the contrast so that the boundaries of the body components appear clearly.

Characteristics of CT images

- The CT image represents a cross-sectional part of the patient's body.
- The two-dimensional image in the CT scan corresponds to a three-dimensional slice in the patient.
- The CT slice is very thin, ranging in thickness from 1 to 10 millimeters.
- The two-dimensional array of screen points (pixels) in the CT image corresponds to an equal three-dimensional number of volume elements (voxels) in the patient, where each pixel area unit is the projection of a voxel volume unit from the body slice under imaging.

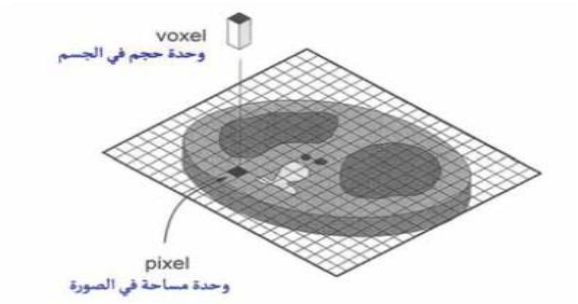


Figure (18) The CT image appears as a two-dimensional array of elements on the screen.

Each screen point on the CT image displays the average attenuation properties of X-rays from the tissue in the corresponding volume unit. Therefore, the image appears in different shades of gray depending on the absorption coefficient of the rays, where the higher the absorption coefficient of the rays in a certain area, the more transparent it appears in the image; due to the decrease in the amount of rays that passed through this area. The CT image is obtained after processing the attenuation data of the rays falling on the slice of the body to be imaged from several directions. It is possible to imagine what happens when solving the puzzle, as it is assumed that the body cross-section consists of only four squares. Solving the puzzle consists of three stages:

- Problem: Determine the directions of the rays falling on only four units.
- Method: Formulate the paths of the rays on the units in the form of equations.
- Solution: Determine the value of the absorption coefficient for each volume unit.

The accuracy of the CT image increases with the increase in the number of squares in the square centimeter of the cross-section of the body. Increasing the number of squares results in performing the mathematical processing in a longer time, or using super-fast computers.

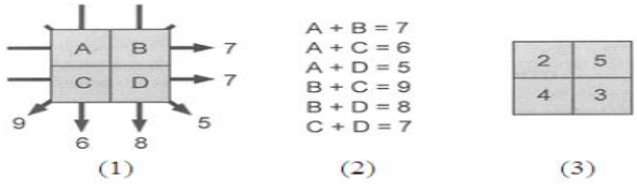
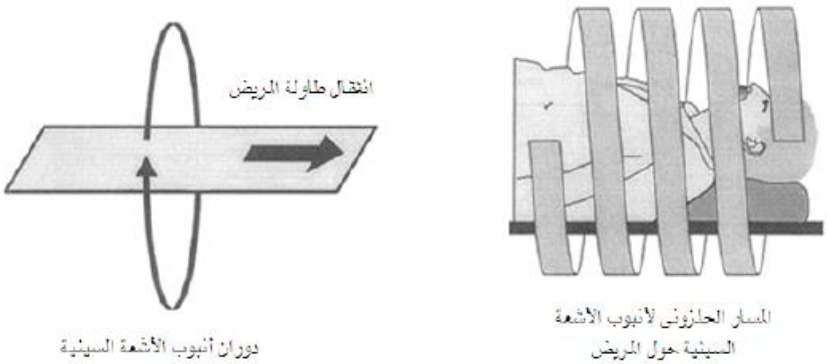


Figure (19) Simplified model; To determine the absorption (attenuation) coefficient of X-rays per unit of cross-section.

2-5-2 Helical CT

This type of imaging represents the sixth generation of CT development, in which data is acquired by the scanner, while the table on which the patient lies moves forward at a constant speed while the radiation source moves in a circular motion. Helical CT is characterized by high-quality images, with a lower degree of radiation dose acquired in regular CT. The speed of performing the examination ranges from 8 to 10 times, and is faster than regular CT to the point that it can be performed while holding only one breath. This speed is useful for all patients in general, the elderly, children, critically ill patients, and patients suffering from panic, fear, or anxiety when the examination period is prolonged in particular (17).

Figure No. (20) Helical CT is performed by moving the X-ray tube in a circular motion around the patient, while the patient's table moves along the axis of rotation forward.



Chapter Three

How to Detect Fractures and Diagnose Osteoporosis

3-1 Fractures

A fracture is a break in the continuity of a bone, and it is either caused by a force that exceeds the normal bone's ability to bear, such as fractures that occur as a result of traffic accidents, or a moderate force that exceeds the abnormal bone's ability to bear, such as fractures of the neck of the femur in patients with osteoporosis, or it is caused by a small, repeated force that leads to fatigue of the bones together for a period of time, such as stress fractures that occur in runners. Symptoms of fractures include:

- Severe pain at the site of the injury that increases with movement.
- Shortening or change in the shape of the affected limb.
- Swelling at the site of the fracture.
- Bruising that appears on the skin.

3-2 Types of fractures

Fractures can be divided based on several things, including those related to the fracture pattern, whether the fracture is horizontal, oblique, spiral or comminuted, and those related to the stability of fractures, which are divided into stable fractures and unstable fractures, and those related to the connection of the bones to the outer surface, which is the skin.

There are closed fractures where the outer skin is intact, and there is an open or compound fracture where there is an injury to the skin and a connection between the bones and the outer surface.

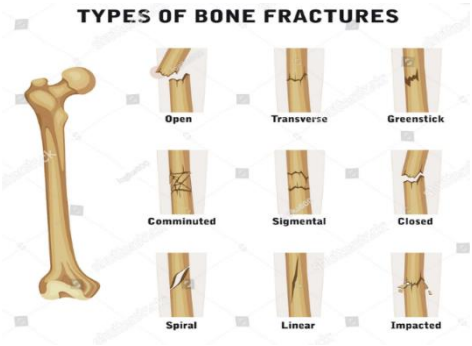
The types of fractures are summarized in four cases:

1. Simple or closed fracture: In this type of fracture, the outer skin remains intact without being torn or injured, and there are no injuries to the membranes around the bone.

2. Open fracture: This fracture is accompanied by wounds in the outer skin, and in some cases the tip of the broken bone may come out of the opening of the wound opposite the fracture.

3. Compound or compound fracture: In this fracture, there are injuries to the internal organs adjacent to it, such as blood vessels, the brain, lungs or liver, depending on the location of the broken bone and its proximity to the injured organ.

4. Other branch (hair) fracture: This is one of the most common fractures that affect children. In this fracture, the bone is broken from the inside, while the layer that covers it (the outer periosteum) remains intact.



3-3 Fracture Symptoms:

The first aider knows that the injured person has a fracture through the presence of the following symptoms:

- The injured person feels severe pain: Along the broken bone, there is a significant increase in the intensity of the pain, and the pain is most severe at or near the fracture site. The pain also increases significantly when trying to move the injured part or even touch it.
- Swelling of the injured area: This is the area surrounding the injured part, and due to its heat, the skin appears blue due to the swelling.
- Change in the shape of the injured organ: The organ takes a shape other than its natural shape, such as being shorter than normal or having a twisted shape in a place or an abnormal angle of the broken organ.
- Abnormal movement occurs in the injured organ: There is a possibility of hearing a crackling sound at the site of the fracture when moving the fracture site by hand. We usually do not resort to this, because it may cause a tear in the tissues surrounding the fracture, and due to the severity of the pain, it may lead to the injured person fainting.

3-4 First aid for fractures

- Relaxing the injured person and taking the appropriate position to begin first aid procedures.
- Do not give the injured person anything by mouth in case of fractures that require surgery.
- The bleeding associated with the fracture (if any) must be controlled and not washed or examined, but it must be covered with a clean, sterile bandage to stop the bleeding.
- The injured person with a spinal injury should not move for fear of tearing the surrounding tissues, as this may cause paralysis. If it is necessary to move it, this is done with the help of three or four people.
- In case of a fracture in the joints, the limb should not be placed in a straight line.
- Do not try to return the broken bone to its normal position.

- Tie the twisted limb with a pressure bandage to prevent it from moving, or use it involuntarily in anything that may cause pain.
- Monitor the injured person's vital signs.
- The injured person may be given painkillers such as (ibuprofen). Until the ambulance arrives or the injured person is taken to the hospital.

3-5 How to diagnose bone fractures

3-5-1 Clinical examination

The doctor looks at the symptoms of the fracture, which are: swelling, redness, pain, and deformities at the fracture site, and there are openings in the skin depending on the type of fracture. As for X-rays, the doctor looks at the image to ensure that there is no interruption in the continuity of the bone, and he must confirm whether it is a simple or complex fracture, whether it is inside or outside the joint, and whether it is inside the growth zones or not in order to determine the treatment method.

3-5-2 Radiographs

They are axial tomography images, so that the doctor can see the details of the fracture in order to determine the treatment method. When there are injuries to the ligaments or cartilage, the doctor sometimes has to perform an MRI to determine the appropriate treatment methods.

3-6 Osteoporosis

Osteoporosis or osteoporosis is a disease characterized by low bone density and damage to its structure to the point that it makes the bones fragile and susceptible to breakage. The fact that this disease is silent means that it is not usually accompanied by symptoms, it is usually revealed when a bone fracture occurs; as the bones have lost much of their structure and strength over several years, and the bones most affected by osteoporosis are the bones of the wrists and hips as well as the bones of the spine. In the context of talking about osteoporosis, it is noted that bones are vital tissues that the body maintains their strength by breaking down old ones and replacing them with new bone tissue. As for the prevalence and spread of osteoporosis, the Centers for Disease Control and Prevention has shown in English.

3-7 Causes of Osteoporosis

Bones go through a continuous life cycle, meaning that the body breaks down old ones and replaces them with new bone tissue. In fact, the rate of new bone building varies with a person's age. For example, when a person is in childhood, the rate of bone building is much higher than the rate of bone destruction, which causes a very noticeable increase in bone density. However, when a person reaches the age of twenty, the process of building and destroying bone becomes slower than before. In most cases, bone density is at its highest value when a person reaches the age of thirty. After that, as a person ages, the rate of bone destruction becomes faster than the rate of building it. As for the relationship that links the above to osteoporosis, it is simple, and it can be summarized by saying that the chance of

suffering from osteoporosis depends largely on the maximum bone density that a person reached in his youth. The higher the bone density, the less chance of developing osteoporosis. What determines an individual's maximum bone density is the genetic factor as well as the race to which the person belongs. In addition to the causes of osteoporosis, it is worth noting that although bone loss is considered a natural part of aging, there are some people whose bone loss rate is higher than normal; meaning that they lose bone density faster than others, which increases the chance of developing osteoporosis and being exposed to fractures.

Factors that make an individual vulnerable to osteoporosis and fractures include the following:

Women who have reached menopause; although osteoporosis can generally affect men, children, and women who have not reached menopause, women who have reached menopause are more vulnerable to osteoporosis than other groups, because bone density loss after menopause is faster than it was in the past, especially if a woman reaches menopause at an early age; that is, before she reaches the age of forty-five, or if a woman reaches menopause due to the removal of her ovaries. Taking a high dose of steroids for a period of more than three months. Having other health problems, such as some inflammatory conditions, or problems related to hormones, or problems related to malabsorption. Having a family history of osteoporosis, especially if one of the parents has suffered a hip fracture. Taking some types of medications that affect hormone levels or bone strength for a long period of time, such as anti-estrogen medications that many women need to take after being diagnosed with breast cancer. In this context, we urge the importance of adhering to the instructions of the specialist doctor regarding taking the medications he prescribes and not stopping taking them except after consulting, discussing and approving him. Current or previous infection with bulimia or anorexia. Having a low body mass index. Not exercising regularly. Smoking and drinking alcohol. Diagnosis of osteoporosis The diagnosis of osteoporosis depends on a set of examinations. The specialist doctor first cares about knowing the health history of the person concerned, then he conducts a physical examination, as well as X-rays of the skeleton, in addition to a set of specialized laboratory tests, such as Densitometry.

3-8 Treatment of osteoporosis

It is possible to resort to prescribing drug treatments before the condition develops into osteoporosis, and accordingly it can be said that the main goal of treating these cases is either to prevent osteoporosis or to slow down and delay the development of the problem at least, and other treatment goals include:

Maintaining bone density and mineral content as much as possible, in addition to the importance of avoiding injury from osteoporosis, and increasing the person's ability to perform daily activities to the maximum extent possible. The treatment aims to relieve the pain that may accompany osteoporosis. In the context of talking about treating osteoporosis, it is indicated that in addition to drug treatment for osteoporosis, the doctor recommends taking sufficient amounts of calcium, either through food, or it may require taking calcium supplements in some cases, and the doctor also recommends that osteoporosis patients take vitamin D, as its importance lies in helping the body absorb the calcium that a person takes through food, and in addition to these recommendations, it is necessary to practice appropriate sports exercises, especially exercises that depend on bearing weights, such as walking, which is In which the person carries all his weight. As for the treatment options available if the diagnosis of osteoporosis is confirmed; the specialist doctor prescribes appropriate medications to prevent further loss of bone density and possibly build bone density.

3-9 Prevention of osteoporosis

If a person is at risk of developing osteoporosis, it is recommended to take a set of preventive methods that contribute to reducing the chance of developing this disease, and these tips include the following:

Exercise regularly. Eating healthy foods, including those rich in calcium and vitamin D. Making some lifestyle adjustments, in terms of quitting smoking and abstaining from drinking alcohol.

Recommendations

1. Use lead shields because X-rays cannot penetrate lead.
2. Direct X-rays only to the targeted spot instead of using them randomly.

3. Prevent the use of X-rays except after providing adequate protection for people.

4. Pregnant women should be exposed to X-rays only when necessary. In these cases, the woman's abdomen is covered with a lead shield. This shield is able to partially protect the fetus.

5. The patient who is undergoing X-ray imaging will notice that the workers in the X-ray department and the doctors in it wear special lead gowns during the X-ray imaging procedure, which protects them from exposure to harmful amounts of radiation because they are always close to it during their work.

6. Sometimes the doctor injects a dye into the patient's veins, or the doctor may ask his patient to drink barium before the X-ray imaging. The reason for this is that the dye and barium block the passage of X-rays, which allows the doctor to see the anatomical details inside the body more clearly.

7. A patient who is allergic to dyes should tell the doctor or the staff in the radiology department what he is allergic to before the scan.

8. Parents should also be educated about the possible harms that can occur when exposed to large amounts of radiation and should be aware of the effects of radiation on their children.

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