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Medical Applications of Shortwaves

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Abstract:

The research aims to shed light on the effect of using the electromagnetic spectrum in harmony with its short waves and linking that to medical devices used for each short wavelength in the field of diagnosis and medical treatment, in addition to the use of mechanical waves, including sound waves, in medical diagnosis and treatment. Many chronic pains and cancerous tumors have become diagnosed or treated depending on the type of affected tissue and its sensitivity to radiation and the link between that and the appropriate wavelength for that case. With scientific progress or development, the use of artificial intelligence has become important in entering the world of medicine and using it in the field of diagnosis or treatment instead of human medical use, especially in the field of remote surgery, called radiosurgery, which requires a specialized cadre in the field of measuring the radiation dose through electronic computing of the dose depending on the type of tumor or cancer, its size and location, and the diversity of using short waves gives high flexibility in diagnosis and medical treatment.

1.1.Introduction

Waves are divided into electromagnetic waves and sound waves. Electromagnetic waves are waves that travel in space at a constant speed. For example, the speed of light is 10^8 m/sec × 3 and has two perpendicular electric and magnetic fields that differ in wavelength and energy according to their location in the electromagnetic wavelength. They start with long waves and end with short waves, which are gamma rays, as their wavelength reaches a length of 0.001 A. Electromagnetic waves are a form of energy that is not based on a material mass, i.e. it is a non-material and massless entity, but rather it is energy represented in the form of two fields, one electric and the other magnetic, that change over time and with changes in position. Electromagnetic waves can be generated from various and different sources. Some of them are generated from accelerating or slowing electric charges from alternating electric currents, and some of them are generated from hot, non-glowing bodies or from glowing, flaming bodies. Electromagnetic waves can also be generated when electrons move between different orbits in an atom or as a result of the decay of excitation energy in the nucleus of an atom. The sources of generating different electromagnetic waves will be detailed in the following paragraphs. Some of the properties of electromagnetic waves (rays) differ greatly depending on the source of their generation, although they share a number of general properties regardless of the source. The following will list some of the general properties of electromagnetic waves.

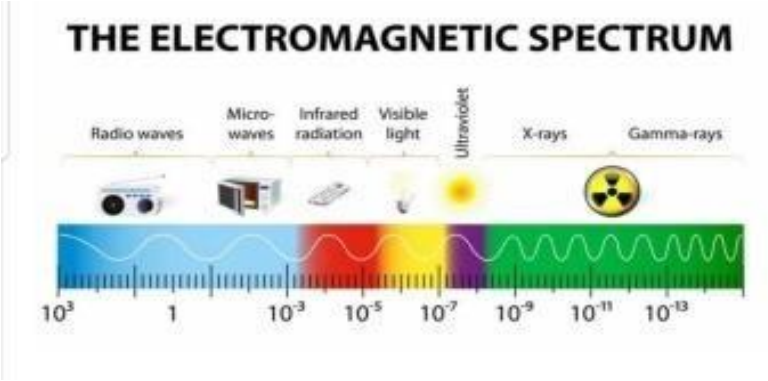

Figure 1: Electromagnetic spectrum

Electromagnetic waves include:

1. Long waves
2. Microwave waves
3. Infrared rays
4. Light waves
5. Ultraviolet rays
6. X-rays
7. Gamma waves

As for sound waves (mechanical): they are a group of waves produced by a specific source, possessing the necessary kinetic energy that works to move the air particles surrounding them and thus move from one place to another, and they do not move in a vacuum.

1.2. Infrared

The infrared segment is the wave segment whose frequency ranges between about 1 and 300 gigahertz (the end of the microwave segment) and 1014 × 2.4 hertz (the beginning of the visible light segment) (i.e. its wave frequency falls in the order directly below the frequency of red light. This segment is also known as the heat radiation segment. Its wavelengths range between about a millimeter and continue until it reaches the longest visible light wave, which is red, whose wavelength is between 70.0 and 300 micrometers (a micrometer is equal to one millionth of a meter). The waves of this segment are generated by hot bodies and molecules. These rays cannot spread far due to the ease of their absorption in the form of heat, as these rays lead to the excitement and movement of the atoms of the material as a result of the vibrational or transitional movement that these atoms acquire due to the waves, which in turn leads to an increase in the temperature of the body on which it falls. It was discovered by the British astronomer William Herschel in 1800, and its medical benefit to humans lies in the fact that it helps cells to renew or repair themselves. Infrared light also improves the circulation of oxygen-rich blood in the body. Which promotes faster healing of deep tissues and relieves pain. One of the properties of infrared therapy is its ability to penetrate the layers of the skin, providing a much greater depth that is able to effectively relieve pain. To improve wound healing, reduce pain caused by arthritis, increase endorphin levels, and activate neurotransmitters. The key to the effectiveness of infrared therapy is nitric oxide, which is an important gas for the health of the body's arteries**.**

Infrared light has been linked to many benefits including:

1. Promoting wound healing and tissue repair.
2. Stimulating the healing of ulcers and slow-healing wounds.
3. Improving hair growth.
4. Controlling psoriasis.
5. Pain relief.
6. Improving the appearance of the skin[5]

Infrared Therapy is applied in the treatment of various health conditions Including:

1. Arthritis.
2. Acute trauma
3. Muscle strain
4. Carpal tunnel syndrome.
5. Neck pain
6. Back pain.
7. Diabetic neuropathy.
8. Rheumatoid arthritis.
9. Temporomandibular joint (TMJ) pain. Figure 2: Infrared rays in medicine
10. Tendonitis and wounds.
11. Sciatica and surgical cracks.
12. Radiotherapy.

There are many painful conditions that can be treated with infrared light therapy.

These include chronic or acute pain caused by sports injuries.

Infrared light therapy is widely used in the treatment of sports injuries to treat injuries sustained by athletes, including a wide range of chronic and acute musculoskeletal injuries. In other applications, dentists use infrared light to treat many types of wounds and ulcers in the oral cavity. In addition, rheumatologists have used infrared light therapy to reduce pain and inflammation, especially in autoimmune diseases. Dermatologists also use light therapy to manage patients with burns, skin lesions, ulcers, and dermatitis.

1.3: Visible light

The form of electromagnetic waves that is perceptible to all humans and most creatures is visible light and its spectrum that the human eye can distinguish. Light is generally produced when objects are heated to a high temperature, as a result of the rearrangement of electrons in atoms and molecules. The wavelengths of visible light range from about 7.0 micrometers for red light to about 4.0 micrometers for violet light (i.e., its wave frequency ranges from 1014 × 2.4 Hz for red light to 1014 × 5.7 Hz for violet light). The visible light spectrum consists of seven colors arranged according to wavelength from largest to smallest as follows: red, orange, yellow, green, blue, indigo, and violet.

The sun is the main source of visible light within the solar system, and the sensitivity of the human eye to light depends on its wavelength, and this sensitivity reaches its peak at the average wavelength of about 56.0 micrometers, i.e. between yellow and green light. Visible light is one of the most important components of life, as it represents the basic energy in the process of photosynthesis in plants, the main source of food and oxygen.

Uses of visible light as a treatment Light therapy or phototherapy

Its effectiveness has been proven in some disorders Sleep disorders and psychological disorders. For example, light therapy is used to treat acne and neonatal jaundice. The retina is also exposed to therapeutic light to treat circadian rhythm disorders such as delayed sleep phase syndrome. Light therapy is also used to treat seasonal affective disorder and other non-seasonal psychological disorders. Light therapy applications also extend to treating pain, accelerating wound healing, hair growth, acupuncture, and improving blood properties and circulation. Low-power lasers and red

light in the 620-660 nm range are used in many of these applications, especially skin diseases such as eczema, psoriasis, skin infections, and some types of skin cancer.

Figure 3: Visible light therapy

1.4. UV rays

It is an electromagnetic wave with a wavelength shorter than visible light but longer than X-rays. It is called ultraviolet because the wavelength of violet is the shortest among the colors of the spectrum. Its wavelength range starts from 400 nanometers to 10 nanometers, and its energy starts from 3 to 124 electron volts. Ultraviolet rays are sometimes called black rays because they cannot be seen with the naked eye. The discoverer of ultraviolet rays is the German physicist Johann Ritter and the German physicist Victor Schumann in 1893. Its effect: The main positive effect of exposure to the medium wave of ultraviolet (UVB) is that it helps produce vitamin D in the skin. This segment overlaps widely with the X-ray segment, which will be discussed later. The sun is one of the most important sources of ultraviolet rays, and these rays can be easily produced by special, very bright lamps, for use in many scientific diseases and heating. Most of the ultraviolet rays coming from the sun are absorbed by the atoms and molecules of the upper layer of the atmosphere surrounding the Earth, known as the stratosphere, which protects humans and many other living organisms from the harmful effects of these rays. The ability of the stratosphere to absorb ultraviolet rays is due to the presence of a high percentage of ozone gas (which is a triatomic oxygen molecule, i.e. 3, in this layer), which represents a shield against these rumors, as ultraviolet waves, especially high-energy waves, interact with ozone molecules, converting the energy of these radiations into heat, which in turn leads to heating the stratosphere .

Medical applications of ultraviolet rays:

Ultraviolet rays have medical uses, such as skin diseases such as psoriasis and vitiligo. Long ultraviolet radiation (UVA) is used with topical psoralens medications to form what is called PUVA therapy. Ultraviolet rays are also used to sterilize some surgical instruments using special lamps.

Uses of ultraviolet rays in medicine as a treatment:

1. For the skin: Ultraviolet rays help activate the melanin pigment in the upper skin cells, and thus it helps give the skin a color known as tanning, in addition to its use in treating skin tissues and blood vessels.

2. For the eye: Ultraviolet rays work to treat some diseases and problems that occur in some parts of the eye; such as the cornea and retina, and thus activate the photoreceptors inside the eye, which enhances the occurrence of some chemical reactions correct the visual image.
3. Immune system: UV rays mainly help to redistribute some elements in the main and secondary cells of the immune system, thus changing the immune response by stimulating antibodies to protect the body from diseases.

Figure 4: Use of ultraviolet rays in medicine

1.5.X ray :

X-rays or X-rays: X-ray is an electromagnetic radiation with a wavelength ranging from 10 picometers to 10 nanometers, which is equivalent to frequencies between 30 petahertz to 30 exahertz 30×1015 Hz to 30×1018 Hz and energy ranging between 124 electron volts to 124 kiloelectron volts. It was discovered by the German scientist Wilhelm Roentgen in 1895 at the University of Würzburg. This band overlaps widely with the two frequency bands that precede it, which are ultraviolet rays, and the one that follows it, which are gamma rays. Most of the X-rays used in practical applications are produced by the slowing down of electrons accelerated to relatively high energies, when these electrons collide with material targets, especially heavy metal targets. Therefore, this type of X-ray is called bremsstrahlung X-ray. There is another type of X-ray that is emitted when the electrons of distant atomic orbits move to orbits closer to the nucleus, that is, when the atom gets rid of its excitation (i.e. its excess energy). In this case, X-rays are emitted with energy values that are characteristic of the atom of each element and differ from the values characteristic of other elements. Therefore, this type of ray is known as a characteristic ray of elements. Thus, characteristic X-rays are considered the fingerprint of a specific element. Different elements can be detected, no matter how low their concentration in different samples, by stimulating characteristic X-rays of elements and measuring their spectra. This technique has developed tremendously in light of the multiplicity of means of excitation of elements and has become one of the most important techniques for the non-destructive testing of materials and elements. X-rays are used in the medical field to diagnose many diseases, as well as in the treatment of superficial cancerous tumors, and in the sterilization of many medicines, products, and medical drugs .

Use of X-rays in medicine as a diagnosis:

1. Identify fractures or infections in bones and teeth.
2. Diagnose and evaluate the structure of the oral cavity and jaw.
3. Capture signs of joint changes that indicate arthritis.

4. Detect tumors on the bones.
5. Measure bone density to diagnose osteoporosis.
6. Detect pneumonia, tuberculosis, or lung cancer.
7. Examine breast tissue for signs of breast cancer using a special technique called mammography.
8. Look for signs of heart failure or changes in blood flow to the lungs and heart.
9. Detect problems in the digestive system, and sometimes a contrast material called barium is used.
10. Locate swallowed materials such as a coin or a small toy.
11. Used to support other diagnostic tests such as fluoroscopy. A continuous X-ray image is displayed on a screen. This makes it possible to follow the progress of a medical procedure (such as stent placement) or the movement of the contrast agent as it passes through the body.
12. Used in computed tomography.

Uses of X-rays as a treatment:

X-rays are used for therapeutic purposes, including:

1. As a treatment for cancer cells in high doses Radiotherapy kills cancer cells or slows their growth by damaging their DNA. Cancer cells, after their DNA is damaged, stop dividing or die and are then divided and eliminated by the body. It is used in the treatment of head and neck, breast, cervical, prostate, and eye cancer.

Figure 5: CT scan

1.6.Gamma rays

Gamma rays were discovered by the French scientist Paul Villard in 1900 and are expressed by the symbol "γ". Gamma rays are high-energy electromagnetic waves that are emitted from the nucleus of an atom when this nucleus disintegrates through alpha or beta decay and a new nucleus is formed that carries a certain amount of excitation energy, or when any normal nucleus, i.e., non-disintegrating (in any of the different excitation methods), is excited. The frequency band of gamma rays overlaps greatly with the frequency band of X-rays, and the frequencies of gamma rays range between about 1018 Hz and more than 1023 Hz for high-energy gamma rays. Despite the completely similar behavior of both X-rays and gamma rays, it should be realized that X-rays are emitted by the slowing down of charged particles, especially electrons, or by the transfer of electrons from orbits farther from the nucleus to orbits closer to it. As for gamma rays, they are

emitted from nuclei and have nothing to do with orbital electrons. Gamma rays are characterized by the ability Gamma rays are extremely effective in penetrating materials due to their high energy and because they are electromagnetic waves with no charge, as they can penetrate thick concrete walls and pass through them without losing any of their energy. Gamma rays are currently used in many medical fields for diagnosis, treatment and sterilization, and in industrial fields to give materials special properties, and to improve the properties of many applications, including medical, industrial and agricultural. Despite the many benefits of gamma rays, their risks are dire for humans and other living organisms that are exposed to large quantities of them. Uses of gamma rays in medicine:

1. In the field of tumors to treat malignant and cancerous tumors:

Through a process called Gamma Knife surgery, in this type of treatment, focused beams of gamma rays are directed to tumors in order to kill cancer cells. Nuclear medicine examinations that rely on radioactive materials also help to determine the activity of cells with great accuracy, thus making it possible to detect the disease in its early stages. It is also possible to know whether a person responds to treatment and determine the stage of cancer by determining the presence or spread of cancer in different parts of the body. Knowing the body's response to treatment. Detecting recurrence of cancer. Detecting rare tumors in the pancreas and glands.

2. In nuclear medicine imaging techniques: for diagnostic purposes, for example, it is used in "positron emission tomography" and "cameo gamma".
3. In sterilizing medical equipment: as gamma rays pass easily through medical equipment packages, they can only be stopped by dense lead (and kill living tissues such as viruses and bacteria).
4. In diagnosing and treating various diseases, including cancer, heart disease, digestive system, endocrine glands, nervous system, and many diseases.
5. Using gamma rays in heart disease Gamma rays have many uses in the field of heart disease, as they help detect the extent of coronary artery stenosis. Diagnosing damage to the heart after a heart attack. Choosing the appropriate treatment. Diagnosing heart function before and after chemotherapy.
6. Using gamma rays in bone disease Gamma rays are used in diagnosing and treating bones, by diagnosing bone fractures, infections, and arthritis.
7. Evaluating the ability of artificial joints and the body's response to them. Evaluating bone tumors. Determining Biopsy sites.
8. Use of gamma rays in the brain Gamma rays are used in the diagnosis and treatment of the brain, by diagnosing abnormalities in the brain in patients suffering from certain symptoms, such as seizures and memory loss. Detecting Alzheimer's disease in its early stages. Using them in surgical planning and identifying areas of the brain that may cause seizures .

Figure 6: Use of Gamma Knife in Medicine

The damage caused by short-wave rays and their effect on humans:

1 .Damage caused by infrared rays

The eye is damaged when exposed directly to these rays, or staring at them for a long time, as the eye tissues absorb these rays, which results in a change in the cellular material of these tissues and thin membranes. These rays also cause what is known as solar retinopathy. Inflammation of the eyelid and burns of varying degrees depending on the amount of exposure to these rays, which may reach third-degree burns. Low blood pressure.

Death of skin tissue in the area exposed to the rays for a long time, with pain in that area.

Dehydration of the body because infrared rays emit high temperatures.

2. Damage caused by visible light

In general, light therapy is a safe treatment, but some risks may occur after the sessions, the most important of which are:

Eye strain.

Headache.

Nausea.

Severe emotionality.

Excessive activity

Complications of phototherapy

Some complications affect the person in the long term, the most important of which are: skin cancer and aging.

3 .Ultraviolet damage

The damage caused by ultraviolet rays to the eye is cumulative,

The following are the most prominent damages (, which are called snow blindness or photokeratitis, cataract formation, lens opacity, pterygium formation, and tissue growth on the surface of the eye.

UV damage to the skin Ultraviolet rays, whether from the sun or industrial sources such as tanning beds, can cause many skin problems such as melanoma and non-melanoma, and the following are

the most prominent damages of ultraviolet rays to the skin: Liver spots, actinic keratosis, and solar elastic tissue degeneration. Skin burns, which is damage to skin cells as a result of exposure to energy from ultraviolet rays, as excess blood flows to the damaged skin in an attempt to repair it, which is why the skin turns red when sunburned. Several structural changes occur in the cells, fibrous tissues, and blood vessels of the skin, in addition to pigmented spots in the skin, such as freckles and moles And pigmentation. Accelerating skin aging, as ultraviolet rays destroy collagen and connective tissues located under the upper layer of the skin, causing wrinkles, brown spots, and loss of skin elasticity.

4 .X-ray damage:

In general, there are risks and benefits associated with all aspects of life, as well as with X-rays.

The use of ionizing radiation in X-ray examinations may cause damage to the genetic material (DNA) in the body, and the most important risks associated with this radiation are the following:

Exposure to high levels of X-rays can cause skin redness and hair loss.

A very slight increase in the risk of cancer due to continuous exposure to X-rays.

5. Gamma radiation damage:

Causing skin burns. Causing acute radiation syndrome or what is known as radiation sickness. Dangerous diseases such as cardiovascular diseases, and many types of cancer such as leukemia, breast, ovarian, and pancreatic cancer; when exposed to these rays. Health problems in the digestive system such as nausea and vomiting, and damage to the central nervous system. Effect on genetic material in the human body. Death of cells in the human body or disruption of their system. Possibility of damage to materials that gamma rays were used to sterilize. Possibility of changing the properties of the material that gamma rays were used to treat, such as: changing its color, texture, and ability to dissolve.

1.7.Conclusions

We concluded from our study in this research that short electromagnetic waves and mechanical waves

Ultrasound waves have a bright and very important side in medical uses, which include treatment and medical diagnosis of many cases of injuries and pain. At the same time, we shed light on the dangerous side of these waves in the event of their use or incorrect exposure to them and the dire consequences that result from exposure to them from damage and destruction of body tissues. As we mention in these points

1. The discovery of these rays created a breakthrough in the field of medicine in terms of diagnosis and treatment
2. Some of these rays are safe to some extent. Such as infrared rays and visible light.
3. Ultraviolet rays, X-rays, and gamma rays, despite their important benefits.
4. However, their incorrect use causes serious consequences that may lead to death. Such as contracting various types of cancer.
5. Most non-ionizing radiation is considered dangerous if the exposure time is increased, knowing that the dose is very low

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