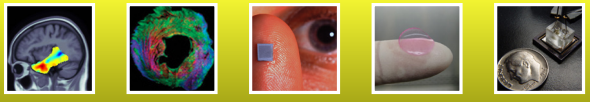

X-rays

What are medical x-rays?

X-ray of the lumbar spine

X-rays are a form of electromagnetic radiation, similar to visible light. Unlike light, however, x-rays have higher energy and can pass through most objects, including the body. Medical x-rays are used to generate images of tissues and structures inside the body. If x-rays travelling through the body also pass through an x-ray detector on the other side of the patient, an image will be formed that represents the "shadows" formed by the objects inside the body.

One type of x-ray detector is photographic film, but there are many other types of detectors that are used to produce digital images. The x-ray images that result from this process are called radiographs.

How do medical x-rays work?

To create a radiograph, a patient is positioned so that the part of the body being imaged is located between an x-ray source and an x-ray detector. When the machine is turned on, x-rays travel through the body and are absorbed in different amounts by different tissues, depending on the radiological density of the tissues they pass through. Radiological density is determined by both the density and the atomic number of the materials being imaged. For example, structures such as bone contain calcium, which has a higher atomic number than most tissues. Because of this property, bones readily absorb x-rays and, thus, produce high contrast on the x-ray detector. As a result, bony structures appear whiter than other tissues against the black background of a radiograph. Conversely, x-rays travel more easily through less radiologically dense tissues such as fat and muscle, as well as through air-filled cavities such as the lungs. These structures are displayed in shades of gray on a radiograph.

Source: Terese Winslow

When are medical x-rays used?

Listed below are examples of examinations and procedures that use x-ray technology to either diagnose or treat disease:

Diagnostic

X-ray radiography: Detects bone fractures, certain tumors and other abnormal masses, pneumonia, some types of injuries, calcifications, foreign objects, dental problems, etc.

Mammography: A radiograph of the breast that is used for cancer detection and diagnosis. Tumors tend to appear as regular or irregular-shaped masses that are somewhat brighter than the background on the radiograph (i.e., whiter on a black background or blacker on a white background). Mammograms can also detect tiny bits of calcium, called microcalcifications, which show up as very bright specks on a mammogram. While usually benign, microcalcifications may occasionally indicate the presence of a specific type of cancer.

CT (computed tomography): Combines traditional x-ray technology with computer processing to generate a series of cross-sectional images of the body that can later be combined to form a three-dimensional x-ray image. CT images are more detailed than plain radiographs and give doctors the ability to view structures within the body from many different angles.

Fluoroscopy: Uses x-rays and and a fluorescent screen to obtain real-time images of movement within the body or to view diagnostic processes, such as following the path of an injected or swallowed contrast agent. For example, fluoroscopy is used to view the movement of the beating heart, and, with the aid of radiographic contrast agents, to view blood flow to the heart muscle as well as through blood vessels and organs. This technology is also used with a radiographic contrast agent to guide an internally threaded catheter during cardiac angioplasty, which is a minimally invasive procedure for opening clogged arteries that supply blood to the heart.

Therapeutic

Radiation therapy in cancer treatment: X-rays and other types of high-energy radiation can be used to destroy cancerous tumors and cells by damaging their DNA [1]. The radiation dose used for treating cancer is much higher than the radiation dose used for diagnostic imaging. Therapeutic radiation can come from a machine outside of the body or from a radioactive material that is placed in the body, inside or near tumor cells, or injected into the blood stream [2].

Are there risks?

Medical x-rays have increased our ability to detect disease or injury early enough for a medical problem to be managed, treated, or cured. When performed appropriately and early enough, these procedures can improve health and may even save a person's life.

However, x-rays also produce ionizing radiation, which is a form of radiation that has the potential to harm living tissue. This is a risk that increases with the amount of cumulative lifetime exposure (i.e. all exposures added up over the life of the individual). The most significant risks are:

- A small increase in the possibility that a person exposed to x-rays will develop cancer later in life
- The possibility of cataracts and skin burns, but only at extremely high levels of radiation exposure

The risk of developing cancer from radiation exposure is generally small, and it depends on at least three factors—the amount of radiation dose, the age at exposure, and the sex of the person exposed:

- The lifetime risk of cancer increases the larger the dose per exam (including re-takes) and the more x-ray exams a patient undergoes.
- The lifetime risk of cancer is larger for a patient who received x-rays at a younger age than for one who receives them at an older age.
- Women are at a somewhat higher lifetime risk than men for developing radiation-associated cancer after receiving the same exposures at the same ages.
- Children have a longer life expectancy and, thus, have a higher relative risk for developing cancer than adults. [3,4]

You can reduce your radiation risks and contribute to your successful examination or procedure by:

- Keeping a "medical x-ray history" with the names of your radiological exams or procedures, the dates and places where you had them, and the physicians who referred you for those exams
- Making your current healthcare providers aware of your medical x-ray history;
- Asking your healthcare provider about whether or not alternatives to x-ray exams would allow the provider to make a good assessment or provide appropriate treatment for your medical situation
- Providing interpreting physicians and referring physicians with recent x-ray images and radiology reports
- Informing radiologists or x-ray technologists in advance if you are pregnant or think you may be pregnant.

Source: FDA-Radiation Emitting Products, "Medical x-rays", fda.gov, last updated 6-06/2012, accessed 5/21/13
For information about risks for specific procedures that use x-rays, please see the mammography or computed tomography (CT) fact sheets

What are NIBIB-funded researchers developing in the field of x-ray technology?

Current research of x-ray technology focuses on ways to reduce radiation dose, improve image resolution, and enhance contrast materials and methods.

References

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