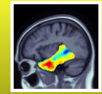
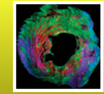
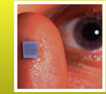
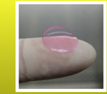
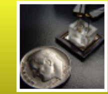






X-rays

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 (the number of protons in an atom's nucleus) 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 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

X-rays and other types of high-energy radiation can be used to destroy cancerous tumors and cells by damaging their DNA. 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. Click here for more information on radiation therapy for cancer.

Are there risks?

When used appropriately, the diagnostic benefits of x-ray scans significantly outweigh the risks. X-ray scans can diagnose possibly life-threatening conditions such as blocked blood vessels, bone cancer, and infections. However, x-rays produce ionizing radiation—a form of radiation that has the potential to harm living tissue. This is a risk that increases with the number of exposures added up over the life of the individual. However, the risk of developing cancer from radiation exposure is generally small.

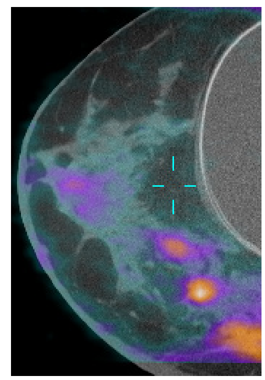
An x-ray in a pregnant woman poses no known risks to the baby if the area of the body being imaged isn't the abdomen or pelvis. In general, if imaging of the abdomen and pelvis is needed, doctors prefer to use exams that do not use radiation, such as MRI or ultrasound. However, if neither of those can provide the answers needed, or there is an emergency or other time constraint, an x-ray may be an acceptable alternative imaging option.

Children are more sensitive to ionizing radiation and have a longer life expectancy and, thus, a higher relative risk for developing cancer than adults. Parents may want to ask the technologist or doctor if their machine settings have been adjusted for children

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.

Dedicated Breast CT: Research funded by NIBIB has led to the development of a breast CT scanner (bCT) that allows radiologists to view the breast in three dimensions and has the potential to reveal small tumors obscured behind dense breast tissue. The scanner uses a radiation dose comparable to mammography by sending X-rays only through the breast and not the chest. At present, more than 600 women have been imaged using bCT in clinical trials. Results from these trials suggest that bCT is significantly better at detecting tumors than mammography, though mammography is better at detecting microcalcifications. Recently, positron emission tomography (PET) technology has been incorporated into the bCT platform. A PET scan highlights areas of increased metabolic activity, which could indicate the presence of a tumor. Additionally, injection of a contrast agent has been shown to improve bCT's ability to detect microcalcifications and could help radiologists distinguish benign from malignant tumors. Research is currently focused on ways in which bCT could be used to provide real-time image guidance for biopsy needle placement and minimally invasive ablation of tumors.



Breast image generated with dedicated breast PET/CT. Orange and purple represent areas of increased metabolic activity which indicate the presence of a tumor. Source: John Boone, Ph.D., UC Davis

Near-Infrared, Diffuse Light Imaging with Ultrasonic Guidance: Researchers funded by NIBIB have developed a novel, hand-held breast imaging system that uses visible light to distinguish benign lesions from early-stage cancer. The system creates maps of tissue density in a local area of the breast based on how the tissue scatters light; the denser the tissue, the more light is scattered, and the greater the likelihood that the tissue is cancerous. The method is currently being tested in a large number of patients undergoing surgery to remove a breast tumor. Early results indicate that the imaging system may be a promising adjunct to mammography for diagnosing breast cancer and determining disease prognosis. In addition, the system could allow surgeons to more rapidly determine tumor margins during surgery compared to methods used over the past twenty years. This could potentially reduce surgeries that need to be repeated because not all cancerous tissue was removed initially.

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