Medical imaging in modern medicine

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The next hundred years will no doubt produce further technical advances in radiology. But it will still take the trained eye of the physician radiologist to apply this technology to each patient’s health problems.

Soon or later, your doctor is going to look at his clinical notes and tell you “we need to make an X-ray examination to find out what is causing your problem”. In recent years, the doctor has been using newer imaging techniques – “isotope study”, “ultrasound”, “computerized tomography” or “magnetic resonance image”; all these are part of the modern discipline of radiology, which marks its 100th year in 1995.

In many countries, medical imaging is as common, as simple and as safe as a doctor’s use of a thermometer or stethoscope, and it extends a doctor’s powers of observation beyond what he or she can see or touch or hear. The risk involved in a medically justified and properly conducted X-ray examination is usually so low that it is far outweighed by the expected medical benefit.

Such images depict the passage of X-rays through our bodies and their partial absorption by different body organs and structures. To an X-ray beam, our bodies have four densities. Bones are the densest and block the most X-rays, while the air space in our lungs lets most of them pass through. The water density of the intestines and the fat densities of the muscles fall somewhere in between. The radiologist or other physician must become proficient in recognizing an abnormal shadow indicative of disease conditions. Thus, many forms of cancer are denser on X-rays than the normal tissues surrounding them. If the radiologist is interested in movement, a device called a fluoroscope allows real-time viewing of the beating of the heart, the pulsing of blood through an artery in the head, or the flushing of urine from the kidneys.

If the radiologist wants to look at the inside of an organ system, the patient is given a liquid such as barium sulfate which is opaque to X-rays. The radiologist can watch it flow through the oesophagus, into the stomach and ultimately the intestines, revealing narrowings, blockages, ulcers or even cancers in the lining of the digestive system. Other opaque liquids can be injected into blood vessels to look for narrowing or blockages which contribute to strokes or heart attacks.

Radioactive scanning

Today’s radiologist has other choices of imaging techniques besides X-ray studies. Many health problems can be detected and diagnosed by using trace amounts of radioactive substances, for instance an isotope called technetium 99m. The patient swallows or is injected with a tiny amount of technetium in a harmless chemical which concentrates in the organ to be studied. A scintillation detector called a gamma camera records the pattern of radiation taken up by that organ. If a cancer is present in the liver, for example, the isotope scan pattern is abnormal because the cancer absorbs the isotope differently from normal tissue.

With computerized tomography, the radiologist uses a complex
machine involving multiple X-ray sources and absorption detectors. The resulting image is a cross-sectional view, a bloodless slice, through the body. By viewing a series of slices at close intervals, the radiologist can get a complete profile of a body organ. A still newer cross-sectional imaging technique, magnetic resonance (MR), uses multiple image detectors and a computer integration programme. Instead of X-rays, it relies upon a strong magnetic field to generate radio signals from the atoms of our bodies. As with X-ray studies, contrast liquids can be given to the patient to enhance visual distinctions in complex body structures.

For ultrasound examinations, a pulsed beam of sound above the audible range is directed into a patient's body. Various body structures reflect the sound beam differently. These reflections make a pattern on a screen showing yet another version of anatomy and motion. After more than 30 years of use, no adverse health effects have been detected, making ultrasound ideal for examining the status of unborn babies or in other circumstances where a patient's exposure to large amounts of X-rays might be hazardous.

Special skills needed

For most X-ray, ultrasound, and nuclear medicine examinations, a technologist works with the patient to obtain still images for study by a radiologist. The radiologist usually participates in motion studies. But a radiologist or another specially trained physician is always involved in interventional radiology – procedures in which fluoroscopic studies are made of the motion of blood vessels or other body channels. In most medical systems, a patient's own doctor decides if an imaging procedure is needed and refers the patient to a radiologist. The referral may be to a hospital X-ray department, a private office or a clinic. Sometimes, the patient's physician may have his or her own X-ray equipment and perform the examination.

There are a few circumstances where an encounter with a radiology procedure does not depend on a doctor's referral. These are usually for population screening. The most commonplace example is the use of chest X-rays to detect tuberculosis in people who have no symptoms. In some countries, women over the age of 40 are urged to get regular breast X-ray examinations – mammograms – for the detection of breast cancer. A hundred years of X-ray science have made medical imaging a vital part of modern medicine. The next hundred years will no doubt produce still further technical advances in radiology. But it will still take the trained eye and educated mind of the physician radiologist to apply this technology to each patient's health problems.

Use of radiation in medicine: some historical notes

Röntgen's discovery of X-rays occurred in November 1895, and the results of his pioneering work were reported to the Society for Physical Medicine of Würzburg the following month. What is perhaps less well known is that, as early as 18 January 1896, a distinguished Hungarian physician, Endre Hőgyes, published a paper in a Hungarian medical journal, Orvosi Hetilap, in which he suggested that the new technology might have potential applications in medicine. His paper, entitled "Photography of the skeleton through the body using Röntgen's method", is illustrated by a series of remarkable radiographs, including one showing the skeleton of a frog (see alongside). This photograph seems never to have been reproduced after the original 1896 publication.

The first radiological journal, the Archives of Clinical Skiography, was launched in London in April 1896, while in the following year the X-ray Society (later renamed the Röntgen Society) was established, also in London.

Finally, the era of radiation protection legislation appears to have begun in October 1899, when the Provincial Government of Lower Austria issued a Decree (No. 8831 of 21 October 1899) imposing stringent conditions governing the use of X-rays for diagnostic or therapeutic purposes – a harbinger of the massive, and complex, regulatory standards that were to follow much later in many other countries.

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