Medical Council
Comhairle na nDochtúirí Leighis

X-Rays – Benefits and Risks

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X-rays are a form of electromagnetic radiation, just like light waves and radiowaves. Because X-rays have higher energy than light waves, they can pass through the body. X-rays were first discovered over 100 years ago and were quickly applied to medical diagnostic use. Today x-rays remain a valuable tool in diagnosis and treatment of many injuries and diseases.

We now know that the use of x-rays is not without risk. This leaflet aims to outline the benefits and risks of x-rays in terms that are easy to understand.

Techniques that use x-rays

X-Ray

Radiography
This is the familiar X-ray where a beam of x-rays produced by an x-ray machine is directed at the part of your body that is being examined and on to a special film to make a picture. Most people have had **dental x-rays**. These are extremely low-dose tests that pose almost no risk. **Chest x-rays** are another common test. X-rays are often taken of broken bones. **Mammography** is a test recommended for early detection of breast cancer. These tests use extremely short bursts of x-ray beams and pose little risk. (see Table).

Fluoroscopy
This technique uses x-rays to produce a moving image on a TV screen. Individual "still" pictures can be chosen and saved or the entire video may be saved. This technique is used to examine the intestine or to obtain images of flowing blood in blood vessels. For example, in a **barium meal** a drink of barium is used to give moving pictures of your stomach and intestine. An iodine-based dye can be injected into an artery to obtain images of the arteries of the heart or of the leg in a procedure called an **angiogram**. This technique can also be used to guide treatment procedures such as drainage of an obstructed kidney, a **nephrostomy**, or widening of narrowed arteries, an **angioplasty**. Fluoroscopic examinations usually involve higher radiation doses than simple radiography.

Computed tomography (CT) scan
This is a more sophisticated way of using x-rays. The patient lies on a narrow table which passes through a circular hole in the middle of the scanner. Many tiny beams of x-rays pass through a slice of the body on to banks of detectors. The X-ray sources and the detectors rotate around inside the machine. An image of the slice is formed by a computer and displayed on a TV screen. The patient moves slowly through the hole to take pictures of different slices of the body and sometimes to produce 3D pictures. If many slices are imaged, the radiation dose can be as high or higher than that for fluoroscopy.

Nuclear medicine or isotope scan
This is another way of using radiation (though not actually X-Rays) to produce pictures. Instead of using an X-ray machine, a small amount of radioactive material (isotope) is injected into a vein (occasionally it is swallowed or inhaled). The radioactive material concentrates in a particular organ or tissue, for example in the skeleton for a **bone scans**. It emits gamma rays, which are a type of radiation that behaves like X-rays. A special camera detects the gamma rays coming out of your body and builds up a picture of what is happening inside you.

The radioactivity in your body falls to insignificant levels in a few days. The total radiation dose you receive while it is there will be similar to or less than that from fluoroscopy.

PET scan and PET CT scan
A **PET scan** is a special type of nuclear medicine scan that detects radiation from the emission of positrons. Positrons are tiny particles emitted from a radioactive substance administered to the patient. This can give information about how the heart is working, about the brain or in the detection of cancer in the body. Because the positrons are very short lived the radiation dose is low.

A **PET CT scan** is a new and very useful test that combines the advantages of the PET scan to detect an abnormality, such as cancer, somewhere in the body with a CT scan to define exactly what part of which organ is affected. While the information provided may be very helpful for patent treatment planning, the radiation dose of PET CT may be considerably more than that of CT alone. It is therefore critical to plan such a test with careful regard to tests already done and how it might replace other tests and the likely benefit to the patient of the information it is likely to give.

Ultrasound and magnetic resonance imaging (MRI)
These techniques produce images of inside the body without the use of X-rays or gamma rays and, so far, no ill effects have been seen from ultrasound or from the magnetic fields used in MRI examinations. These are therefore very valuable techniques but are not able yet to replace all types of X-ray examination. Also, MRI Scanners cannot be used on some patients who have pieces of metal in their body. So, although these new methods are used wherever possible, X-rays and gamma rays remain important for the diagnosis of injuries and disease.

Risks associated with use of X-rays
X-rays are a form of electromagnetic radiation, just like light waves and radiowaves. Because X-rays have higher energy than light waves, they can pass through the body. Just like other forms of high-energy radiation, X-rays can cause damage to cells in the body, which in turn can increase the risk of developing cancer. This increase in risk associated with each X-ray procedure is extremely low but does

slowly increase with the increasing number of X-rays tests you have. This is the same principle as the way in which increased exposure to the sun increases skin cancer risk.

Always remember the benefits of using X-rays
All the methods of medical imaging can bring very real benefits to patients. The overriding concern of your doctor and of the hospital radiology department is to ensure that when radiation is used, the benefits from making the right diagnosis, and consequently giving you the right treatment, outweigh any small risk involved. If, after reading this leaflet, you are still concerned about the possible risks from having an X-ray examination, ask your doctor how the information gained will help to improve your treatment. If treatment decisions depend on the findings, then the risk to your health from not having the examination is likely to be much greater than that from the radiation itself.

X-ray doses in perspective

We are all exposed to natural background radiation every day of our lives. In Ireland, the largest contribution is from radon gas which seeps out of the ground and accumulates in our houses (roughly 58 per cent of background radiation comes form radon). Another 16 per cent comes directly from rocks in the ground, while 14 per cent streams down on us from cosmic rays and the final 12 per cent comes from the food we eat.

Each medical X-ray or nuclear medicine examination gives us a small additional dose on top of this natural background radiation. The level of dose varies with the type of examination, ranging from the equivalent of a few days of natural background radiation to a few years (see Table).

The most common X-ray examinations are those of the teeth, the chest and the limbs. These involve exceedingly small doses that are equivalent to only a few days of natural background radiation.

Examinations involving many X-ray pictures and fluoroscopy (eg barium meals or barium enemas), CT scans of the body or bone isotope scans, involve higher doses. Even these represent only a fraction of our lifetime dose from natural radiation.

To put the risks of radiation from X-rays into perspective: a four-hour airline flight will expose you to the same amount of radiation (from cosmic rays) as from a simple chest X-ray. This is the same as the amount of radiation we would be exposed to naturally (from background radiation) over 10 days.

The radiation doses used for X-ray examinations or isotope scans are many thousands of times too low to produce immediate harmful effects, such as skin burns or radiation sickness. The only effect on the patient that is known to be possible at these low doses is a very slight increase in the chance of cancer occurring many years or even decades after the exposure. These risk levels represent very small additions to the 1 in 3 chance we all have of getting cancer Approximate estimates of

the chance or risk that a particular examination or scan might result in a radiation-induced cancer later in the lifetime of the patient are shown in the table.

Radiation risks in perspective

Just about everything we do in our daily lives carries some level of risk. We tend to regard activities as being “safe” when the risk of something unpleasant happening falls below a certain level. The lower the level of risk, the “safer” the activity becomes. For example, most people would regard activities involving a risk of below 1 in 1,000,000 as exceedingly safe. The radiation risks for simple X-ray examinations of the teeth, chest or limbs, can be seen to fall into this negligible risk category (less than 1 in 1,000,000 risk). More complicated examinations carry a minimal to low risk. Higher dose examinations such as barium enemas, CT body scans or isotope bone scans fall into the low risk category (1 in 10,000 to 3 in 1,000 risk).

As we all have a 1 in 3 chance of getting cancer even if we never have an X-ray, these higher dose examinations still represent a very small addition to this underlying cancer risk from all causes. As long as it is clearly necessary to help make the correct treatment decision for a patient, the benefits from any X-ray examination or isotope scan should usually outweigh these small radiation risks. It should be remembered that the higher dose examinations are normally used to diagnose more serious conditions when a greater benefit to the patient is to be expected.

What is the effect of having many X-Rays?

Each individual X-ray examination or isotope scan carries the level of risk indicated in the table. To estimate the effect of having many examinations, the risks for each one are simply added together. It does not make any difference whether you have a number of X-rays in one day or spread over many years, the total risk is just the same. If you have already had a large number of X-rays and the total risk is causing you concern, the need for each new examination should still be judged on its own merits. Before going ahead, your doctor must be able to reassure you that there is no other way of providing new information that is essential for the effective management of your medical problem. Make sure your doctor is aware of other X-rays or scans you have had, in case they make additional examinations unnecessary.

Radiation risks for older and younger patients

As you get older you are more likely to need an X-ray examination. Fortunately radiation risks for older people are lower than those shown in the table. This is because there is less time for a radiation-induced cancer to develop, so the chances of it happening are greatly reduced.

Children, however, with most of their life still ahead of them, may be at twice the risk of middle-aged people from the same X-ray examination. This is why particular attention is paid to ensuring that there is a clear medical benefit for every child who is X-rayed. The radiation dose is also kept as low as possible without detracting from the information the examination can provide.

A baby in the womb may also be more sensitive to radiation than an adult, so we are particularly careful about X-rays during pregnancy. There is no problem with something like an X-ray of the hand or the chest or the teeth because the radiation does not go near the baby. However, special precautions are required for examinations where the womb is in, or near, the beam of radiation, or for isotope scans where the radioactive material could reach the baby through the mother's circulating blood. If you are about to have such an examination and are a woman of childbearing age, you will be asked if there is any chance of your being pregnant. If this is a possibility, your case will be discussed with the doctors looking after you to decide whether or not to recommend postponing the investigation. There will be occasions when diagnosing and treating your illness is essential for your health and your unborn child. When this health benefit clearly outweighs the small radiation risks, the X-ray or scan may go ahead after discussing all the options with you.

Radiation risks for future generations

If the ovaries or testes are exposed to radiation there is a possibility that hereditary diseases or abnormalities may be passed on to future generations. Although the effect has never been seen in humans, lead-rubber shields may be placed over the ovaries or testes during some X-ray examinations, as a precaution. They are only necessary for examinations of the lower abdomen, back and hips on patients who are young enough to have children. Sometimes, however, it is not practicable to use such shields since they will obscure important diagnostic information.

Important points to remember

In radiology departments, every effort is made to keep radiation doses low and, wherever possible, to use ultrasound or MRI which involve no hazardous radiation.

The radiation doses from X-ray examinations or isotope scans are small in relation to those we receive from natural background radiation, ranging from the equivalent of a few days worth to a few years.

The health risks from these doses are very small in relation to the underlying risks of cancer, but are not entirely negligible for some procedures involving fluoroscopy or computed tomography (CT).

You should make your doctor aware of any other recent X-rays or scans you may have had, in case they make further examinations unnecessary.

The risks are much lower for older people and a little higher for children and unborn babies, so extra care is taken with young or pregnant patients.

If you are concerned about the possible risks from an investigation using radiation, you should ask your doctor whether the examination is really necessary. If it is, then the risk to your health from not having the examination is likely to be very much greater than that from the radiation itself.

Sources and references:

1. X-Rays: How safe are they? National Radiological Protection Board www.nrpb.org.uk
2. What are X-rays Radiological Society of North America www.RSNA.org

Risk of Common X-ray Examinations and isotope scans

Examination	**Equivalent period of Natural background radiation**	**Estimated Lifetime Additional Risk of Cancer per Examination**
Chest, Arms, Legs, Hands and feet, teeth	A few days	NEGLIGIBLE RISK Less than 1 in 1,000,000
Skull, head, neck	A few weeks	MINIMAL RISK 1 in 1,000,000 to 1 in 100,000
Mammography, Hip, Spine, abdomen, pelvis, CT scan of head *(Lung isotope scan)* *(Kidney isotope scan)*	A few months to a year	VERY LOW RISK 1 in 100,000 to 1 in 10,000
Kidneys and bladder [IVU] Stomach – barium meal Colon – barium enema CT scan of chest CT scan of abdomen *(Bone isotope scan)* PET/CT Scan	A few years	LOW RISK 1 in 10,000 to 3 in 1,000

Modified from : ‘X-Rays: How safe are they?’ National Radiological Protection Board