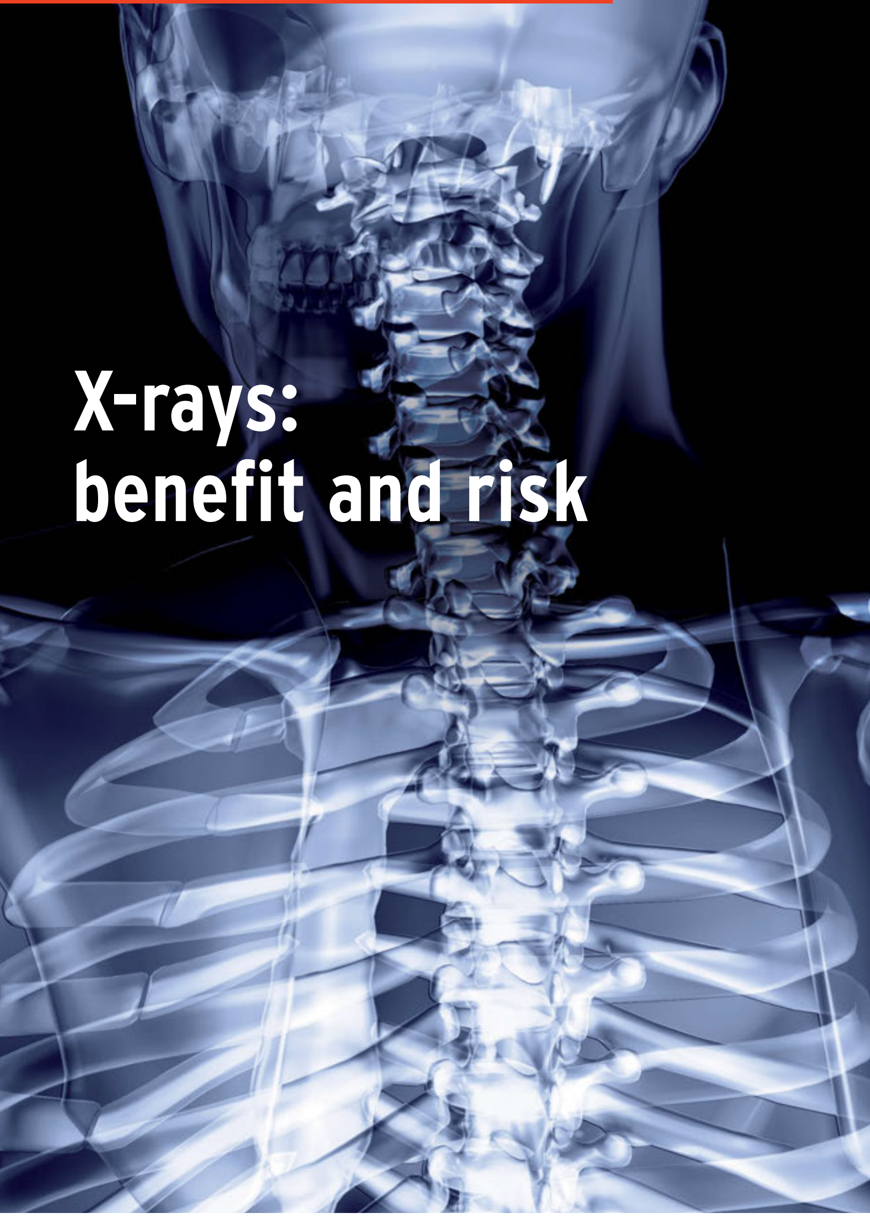
IONISING RADIATION

X-rays: benefit and risk



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Impress

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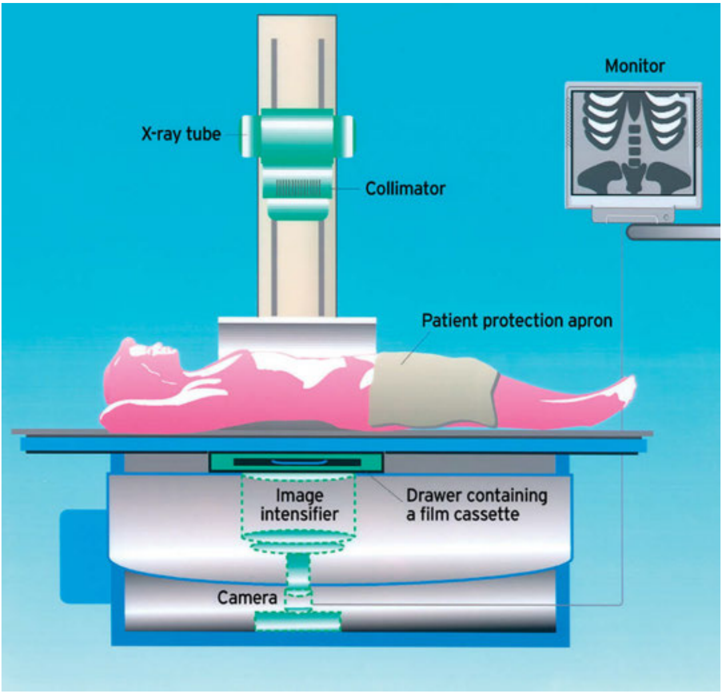
Contents

What is X-radiation?

X-rays belong to the so-called ionising radiation. When X-rays pass through human tissue, the energy imparted can be so high as to entrain genetic damage to the cells involved, subsequently resulting in radiation damage.



Schematic diagram of an X-ray assembly used for diagnosis.

Different materials act to attenuate X-radiation to a varying extent. A thin lead foil is already sufficient for almost complete shielding of X-radiation occurring in medical diagnostics. Non-metallic substances, such as organs or bone, provide less attenuation of the radiation. This effect is utilised in X-ray examinations: the radiation penetrating the body is rendered visible by a film-screen system or a digital detector. Dense structures, such as bone, come out pale and less dense tissues, such as fatty tissue, dark.

As soon as the X-ray machine is switched off, X-radiation will not be produced any more. This is the difference between X-radiation and nuclear radiation which emanates from radioactive substances and is emitted until all atoms have decayed.

How X-radiation acts on health

There is as yet no confirmed evidence as to the health effects of radiation at doses such as those occurring in radiographic procedures. It is, however, well known that ionising radiation in the higher dose range can cause malignancies such as cancer or damage to the unborn child in the womb. Indeed, these findings have to be transferred to the lower dose range relying on appropriate presumptions and modelling.

An X-ray image gives information on the patient's health.

Estimates of radiation risk assume a steadily increasing relationship between dose and cancer risk; that is, the higher the dose, the higher the risk. This is a precautionary assumption in radiation protection, implying that every medical examination using radiation involves an additional, albeit low risk.

As a general rule, the probability of cancer development is not equal for all people. There are individual differences such as strong or weakened body's defence against cancer cells or aging. The tissue of elderly people is less susceptible to radiation effects than that of younger people. Furthermore, cancer development is associated with a latency period. This is one of the reasons why elderly and seriously diseased people are less affected by the radiation risks from diagnostic radiology. Their life expectancy is often shorter than the time it takes to develop radiation-induced cancer, i.e. several years or decades.

Benefits and risks of medical X-rays

In Germany, medical X-rays make the most important contribution to man-made radiation exposure. It is generally believed that there is still a tendency towards taking too much X-rays in Germany. Although X-ray examinations can be of great utility, they also hold risks. The question of whether or not to take an X-ray therefore requires thorough consideration.

Broken bone after re-alignment.

Medical X-rays are vital for patients affected by conditions such as bone fracture requiring safe diagnosis and correct re-alignment under visual control. Misalignment could result in malposition, entailing pain and arthrosis later on.

Head injuries following an accident may be clarified by computed tomography (CT),

Medical X-rays facilitate monitoring of the healing process.

i.e. a special kind of medical X-rays. This procedure permits to confirm or refute suspected bleeding within the skull, thus either enabling timely surgery or avoiding unnecessary operation. Breast cancer early detection, or the detection of narrowings of the blood vessels are additional examples for the use of medical X-rays.

The X-ray Ordinance (Röntgenverordnung, RöV) stipulates that each and every X-ray examination shall be medically justified, i.e. that the benefit and risk associated with that radiation application shall be balanced thoroughly. This balancing is influenced by the patient's individual conditions. An X-ray examination is only justified when the patient's benefit from it outweighs the radiation risk involved. This is the case when the examination procedure is appropriate to answer the diagnostic question and no alternative procedure is available.

CT examinations have increased during the last few years.

Doctor using X-ray pictures to explain diagnostic findings.

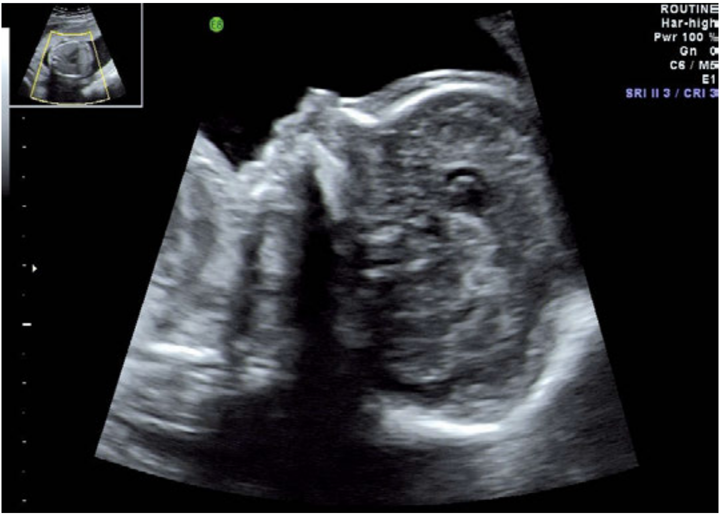
X-ray examinations shall not be conducted

- as a routine procedure;
- until all other findings compiled before then have been critically evaluated and the X-ray examination has been ascertained to be the only procedure providing the lacking information;
- exclusively as documentary evidence for reasons of liability or pursuant to insurance law.

Medical X-rays during pregnancy

In the case of pregnancy, it is crucial to critically consider the need for a radiological procedure. If possible the X-ray should be refrained from and possibly replaced by alternative examination procedures such as sonography, or postponed until after pregnancy where appropriate.

When balancing benefits and risks, the potential benefit for the mother must be compared with the potential risk for the child. In the case of special risks to the mother's health and life, X-rays are justified in order to rapidly establish safe diagnosis and begin treatment.



Ultrasound picture of an unborn baby's head in week 20 of pregnancy.

In some cases women are not aware of being pregnant at the time of radiation exposure. Such cases require retrospective consulting. In order to give well-founded, case-related decision support to both the woman concerned and the attending physician, the medical staff is offered the opportunity to raise a written request to the Federal Office for Radiation Protection (Bundesamt für Strahlenschutz, BfS) on the individual risk of the unborn child.

Further information is provided in the brochure Strahlenthema „Schwangerschaft und Strahlenschutz" (http://www.bfs.de/de/bfs/publikationen/broschueren/strahlenschutz).

Radiation dose from X-ray examinations

Diagnostic X-rays are subdivided into conventional radiography, X-ray fluoroscopy and CT.

Conventional radiography, which is most frequently applied, involves relatively low radiation doses. Some examinations such as those of motional processes (swallowing, heart action

Ranges of typical values of effective dose for frequent X-ray examinations in millisievert (mSv)	
Dental	< 0,01
Extremities (limbs)	< 0,01 – 0,1
Chest (thorax), 1 image	0,02 – 0,04
Skull	0,03 – 0,06
Cervical spine in 2 planes	0,1 – 0,2
Mammography, both breasts in 2 planes	0,2 – 0,4
Thoracic spine in 2 planes	0,2 – 0,5
Abdominal view	0,3 – 0,7
Pelvic view	0,3 – 0,7
Peripheral arteries phlebography (one leg)	0,3 – 0,7
Lumbar spine in 2 planes	0,6 – 1,1
CT braincase	1 – 3
Gall bladder, urinary tract	1 – 8
Urinary tract	2 – 5
CT chest (thorax)	4 – 7
Stomach	4 – 8
CT lumbar spine	4 – 9
Intestine (small intestine or contrast enema)	5 – 12
CT abdomen	8 – 20
Arteriography and interventions	10 – 30

etc.) require additional X-ray fluoroscopy, where the radiation dose to the patient is usually higher compared to conventional X-rays. CT is a tomography procedure of high diagnostic significance which is, however, associated with a relatively high radiation dose.

In order to evaluate and compare different radiation exposures and the burden possibly involved, the concept of "effective dose" has been introduced. Effective dose accounts for the different susceptibility of organs and tissues in terms of radiation-induced cancer development or genetic defect. The unit of effective dose is the Sievert (Sv), low dose values are expressed in terms of millisievert (mSv).

The lead apron protects from X-radiation.

Due to the progress made in X-ray technology, doses from many X-ray examinations have been reduced over the course of the last three decades. Particularly the development of more sensitive film-screen systems, advanced generator and image intensifier technology and digital systems have added to the reduction of radiation exposure. In spite of these technical advances, the mean radiation exposure of the general public is increasing, because X-ray examinations involving high doses, such as CT, are carried out more and more frequently.

The dose levels for one and the same examination procedure vary widely from case to case. This is due to individual differences between patients in terms of constitution, weight, etc, but also to technical, medical and diagnostic factors. A crucial factor is the experience of the medical staff (physicians and radiology assistants) as well as the quality of their advanced training.

Ranges of typical values of effective dose from frequent X-ray examinations are given in the table below in milisievert (mSv). The average value of radiation exposure of the general public from natural radiation sources may serve for comparison. This latter, i.e. the mean effective dose, is about 2.1 mSv per year in Germany.

Tips: How to keep your radiation exposure low

- Ask the medical staff to tell you why the planned X-ray examination is necessary.

- Your doctor is obliged to consider procedures involving less or no radiation exposure for your examination (e.g. magnetic resonance tomography or sonography). Ask specifically for alternative diagnostic procedures.

- Tell your doctor whether you have undergone similar examinations recently.

- Bring along X-rays produced up to now or have them requested.

- Prior to an X-ray examination, women should tell whether they are, or suspect to be pregnant, because X-rays during pregnancy should only be taken if there is good medical reason.

- Make sure that shielding of the parts of the body not under examination is considered (lead apron)

- Make use of the Röntgenpass (X-ray record card).

- Submit your Röntgenpass and have examinations entered.

Please find further information in the brochure “Medical X-rays – harmful or useful?” (http://www.bfs.de/de/bfs/publikationen/broschueren) and on the BfS website under www.bfs.de/roentgen.

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