

Medical imaging technology	Wave source	What can be imaged, and how?	Disadvantages / hazards
X-ray (standard photography)	X-rays, produced from the collisions of high velocity electrons into a metal anode like tungsten.	<p>The interior of the body (bones, tissues, organs) can be identified, since although X-rays can pass through the body, there is significant variation in the attenuation due to different tissues. Soft tissues and fats attenuate less than bone, and so represent darker areas in a X-ray photograph. The darker areas correspond to greater intensity of X-rays than are transmitted through the body.</p> <p>A contrast medium such as a barium meal or iodine can vary the attenuation of soft tissues, and therefore enhance clarity of X-rays of organs etc such as intestines.</p>	<p>X-rays need to be sufficiently penetrating to pass through the body. Although weakly ionizing compared to alpha and beta radiation, X-ray over exposure can lead to burns, cell damage and enhanced cancer risk.</p> <p>X-ray equipment requires high voltages and will require high density shielding for the user and patient. It is therefore going to be less portable and more expensive than ultrasound, but much less expensive than PET or MRI. Most dentists have a small X-ray machine, but only very large hospitals have an MRI machine.</p> <p>Adverse reactions to contrast mediums may occur.</p>
X-ray CAT scanner	X-rays, produced from the collisions of high velocity electrons into a metal anode like tungsten.	X-rays of multiple slices of the body can be digitized and combined in software to create a three-dimensional structural representation of the human body.	<p>A CAT scan will represent quite a large X-ray dose, so must be used sparingly with patients. A CAT scanner will be much more expensive than a dental X-ray machine, but still much less than an MRI or PET scanner.</p> <p>Adverse reactions to contrast mediums may occur.</p>
Gamma camera	Gamma rays, emitted from a radioactive tracer such as Technetium-99, which is injected into the body.	Gamma rays are emitted at the tracer moves through the body. Compared to the 'static, structural image' of an X-ray, the gamma camera reveals a more dynamic picture as the tracer propagates through the body via various fluid channels such as blood. It can be used to monitor the activity of organs such as the kidneys, lungs or brain.	<p>Gamma rays are ionizing, albeit weakly.</p> <p>Unlikely to result in comprehensive imagery</p>
PET scanner	Gamma rays, produced by the annihilation of electrons in the body and positrons produced by a radioactive beta-plus emitter such as Fluorine-18, which will be an oxygen atom replacement in glucose is using FDG.	As the positron emitter moves through the body, gamma rays produced will allow the source location to be tracked. This is similar in essence to the gamma camera, and can be used to diagnose cancers, plan heart surgery and identify the onset of brain diseases such as Alzheimers'.	PET scanners are very expensive, since the positron emitters have a short half life (Fluorine-18 is 110mins) and will have to be made in a specialized on-site laboratory.
Ultrasound A-scan	Ultrasonic waves of frequency 1-15MHz produced by a piezoelectric transducer, driven by a voltage pulse of the same frequency.	Reflections of ultrasound off impedance contrasts between tissue structures (e.g. muscle and bone) enable distance measurements to be made from the time delay of reflections. An A-scan is, for example, a good way to measure eyeball dimensions.	Resolution may not be as good as X-rays or MRI, but comparatively safe (no ionizing radiation), compact and inexpensive.
Ultrasound B-scan	Ultrasonic waves of frequency 1-15MHz produced by a piezoelectric transducer, driven by a voltage pulse of the same frequency.	Computer combination of A-scans taken at multiple angles can generate two or three dimensional representations of internal body structures.	<p>Resolution may not be as good as X-rays or MRI, but comparatively safe (no ionizing radiation), compact and inexpensive.</p> <p>Particularly useful for fetal scanning, where use of ionizing radiation could be risky.</p>
MRI	Driven precession of protons (at the Larmor frequency) about a strong applied magnetic field direction, result in a time varying magnetic field that can induce an EMF in a detector.	Like a CAT scan, can generate a three-dimensional representation of the internal structures of the human body with exquisite resolution. Can distinguish between tissues that have similar X-ray absorption characteristics, so can offer greater clarity than CAT, but without ionizing radiation or contrast media.	Very expensive, as the superconducting coils required need to be cooled with liquid helium. The machine is also large and complex, but similar in this sense to a CAT or PET scan. The strong magnetic fields also mean that it cannot be used with patients that have magnetizable metal implants such as hip replacements or pacemakers.