Hounsfield's units

Just to mention some brief history, the first CT-images was produced in 1971 in Atkinson Morley's Hospital in London. Sir Godfrey Hounsfield was awarded with the Nobel Prize in Physiology/Medicine with Allan McLeod Cormack in 1979 for their work with CT scans.

What is the Hounsfield unit

The name of this unit is in honor of Sir Godfrey Hounsfield (1919-2004) – one of the pioneers of the computerized tomography (CT). CT-imaging has revolutionized medical imaging and made it possible to diagnose malignant disease in the brain and in the abdomen – regions where ordinary X-ray imaging has been of little use. It is important to realize that Hounsfield units are not based on SI-units or derived from such. The Hounsfield unit is a way to characterize radiation attenuation in different tissues and thus making it easier to define what a given finding may represent. It measures radiodensity and is a quantitative scale.

Man is based on water and surrounded by air. This has been the background for creating the linear Hounsfield scale where water (at STP) represents a value of 0 and air represents a value of -1000. The complete formula is given as:

$$HU = 1000x\ ((\mu_X - \mu_{water}) / \mu_{water})$$

Typical values for different elements and tissues range from -1000 to more than +1000, air versus bone. Of importance is that fat is -100, muscle and blood around +40. This makes it possible to evaluate things that do not have a specific structure – a rounded tumor could be made of fat or not – benign or malignant. Fluid filled spaces, for example cysts, could contain something close to water or have an attenuation corresponding to blood – of course of great importance to the physician.

Substance	HU
Air	-1000
Lung	-700
Fat	-84
Water	0
CSF	15
Blood	+30 to +45
Muscle	+40
Soft Tissue	+100 to +300
Cancellous Bone	+700
Dense Bone	+3000

On the voxel

When recreating the data from a computerized tomography you will have a large number of data for "each cell" in the 3D-image of the patient. If you look at a computer screen "everybody" knows that there are a large number of square cells that make up the picture we see. In the CT-image the rotating camera creates 3D-data and the corresponding unit will be a volume pixel; a voxel.

Practical use of Hounsfield units

First of all it is of everyday use to characterize what you see in a CT-image – "water", air and blood are good examples of this. This is probably the intended use when Hounsfield created the unit and its scale. However there are more sophisticated ways to use the Hounsfield units. If you search PubMed on "Hounsfield units" you will get 1305 hits. Many of these are on the technical aspects of CT-imaging but a fair number of articles give information on the use of Hounsfield units in medicine. One brief example would be on the use of targeted receptor-inhibitors in renal carcinoma where you could "see" that the loss in attenuation in tumors corresponded to clinical effects of given therapy[1]. _____

[1]The loss of radiographic enhancement in primary renal cell carcinoma tumors following multitargeted receptor tyrosine kinase therapy is an additional indicator of response. Cowey CL, Fielding JR, Rathmell WK. Urology. 2010 May; 75(5): 1108-13.e1. Epub 2009 Nov 20.

Links

Related articles

External links

Bibliography

http://www.wikiradiography.com/page/Hounsfield++unit
http://en.wikipedia.org/wiki/Godfrey_Hounsfield
http://www.radiol.uu.se/utbildning/rtgsjuksk/Rtgteknologi/Rtg-teknologi-12.pdf
http://www.ncbi.nlm.nih.gov/pubmed?term=hounsfield%20units
Vítek František: Lectures on biophysics with medical orientation, Charles University in Prague, The Karolinum Press, 2001
http://www.impactscan.org/CThistory.htm
Cowey CL, Fielding JR, Rathmell WK. Urology. 2010 May; 75(5): 1108-13.e1. Epub 2009 Nov 20.