Sir Godfrey N. Hounsfield and his Influence on Medicine

W.C. Roentgen discovered X-ray in 1895, which is one of the most important discoveries for the benefit of mankind. Seventy-six years later Godfrey Newbold Hounsfield, a British electrical engineer, developed what is nowdays called computed tomography (CT), yet another invaluable tool for medical diagnosis where x-ray attenuation by different tissues is used to create cross-sectional images of human body. Hounsfield’s invention of CT parallels Roentgen’s discovery of x-rays as the two most outstanding contributions in the field of medicine. On August 12, 2004 Sir G. N. Hounsfield died at the age of 84 years. In this article, brief review of the life of Mr. Hounsfield is accompanied by a short description of evolution of CT technology.

Key Words: CT scan, Hounsfield unit, X-ray

Hounsfield and His Achievements

Godfrey Newbold Hounsfield (Figure 1), popularly known as G N Hounsfield was born on August 28, 1919 and brought up near a village in Nottinghamshire, England. He did his schooling from Magnus Grammar School in Newark where he excelled only in Mathematics and Physics. At a very early age he became intrigued to some electrical and mechanical gadgets like the threshing machine, the binders and the generators. During his teens he constructed an electrical recording machine and made hazardous investigations of principles of flight. He used to launch himself from the tops of haystacks with a home made glider and did lots of exciting experiments using water filled tar barrels and acetylene to see how they could be water jet propelled. On one occasion he even managed to get one to an altitude of 1000 feet.

He was interested in Aeroplanes, and at the outbreak of second world war he joined the Royal Air Force as a volunteer reservist and later became a radar mechanic instructor. As an appreciation of his excellent performance there he was granted to attend Faraday House Electrical Engineering College in London where he received a diploma. He was a man who lived modestly, enjoying country walks and his work. He worked long hours, and his colleagues stayed late because they enjoyed working with him. He had a sense of humor and he loved music. His colleagues found him enthusiastic, gentle, delightful, inspiring, “the nicest and most genuinely good person you could hope to meet”. In 1951 he joined the staff of Electro-Musical Instruments Ltd. (EMI) in Middlesex and involved himself in the development of computers, which were, then in their infancy. It was G N Hounsfield’s team who constructed the first all transistor computer, the EMIDEC 1100 in Britain. After working for some time with computers in EMI he was thinking on other areas of research such as exploring various areas of pattern recognition. During this course of time in 1967 an idea occurred to him which eventually lead to the development of the EMI Scanner and the technique of Computerized Axial Tomography (CAT). Initially it had nothing to do with medicine but was simply “a realization that you could determine what was in a box by taking readings at all angles through it”. He then extended the capability of a computer so that it could interpret x-ray signals so as to form a two-dimensional image of a complex object such as human head. He pursued the application of axial tomography to medical diagnosis, building a prototype head scanner and then a body scanner at EMI, which is now known as Computed Tomography (CT). His original scanner was built on an old lathe bed (Figure 2) which he had been using in a previous project working on computer stores. It took nine days to collect sufficient information, and more than two hours to reconstruct the image on an ICL 1905 mainframe computer. For scanning purpose he had utilized a gamma source, Americium 95, with a photon counter as the detector, the source made 160 traverses of the object, which was rotated 1° at the end of each traverse for a total of 180°.

Indeed the impact of CT was so immediate and so great that Hounsfield in 1979 was awarded the Nobel Prize for Physiology and Medicine along with a Nuclear Physicist Allan Cormack who did the preliminary works on Mathematical reconstruction. For his work Hounsfield
received numerous awards in addition to the Nobel Prize, and he was knighted in 1981 by the queen of Great Britain. To recognize the contribution of Sir Godfrey Hounsfield in the development of medical imaging systems, the Imperial College Imaging Sciences Centre instituted an annual Hounsfield memorial lecture in 2004. The lecture has been designed to give an opportunity for a world leading researcher in imaging science to review the latest developments in imaging science.

G N Hounsfield passed away on August 12, 2004 from a chronic and progressive lung disease but his name is immortalized in the Hounsfield scale, a quantitative measure of radiodensity used in evaluating CT scan images. The scale is defined in Hounsfield Units (HU), running from air at −1000HU, through water at 0HU and up to dense bone at +1000. Hounsfield was unmarried and unattached and had no children. He left all his money to fund engineering research and scholarships.

The introduction of CT as a diagnostic medical tool has not only revolutionized radiology but it has also proved to be a major breakthrough in the field of medicine. The first human head scan was done in September 1971 at Atkinson Morley’s Hospital in Wimbledon with the Radiologist, James Ambrose. The patient had a suspected brain cyst at uncertain location. Dr Ambrose recalled that the scan gave him a clear indication of the whereabouts of the cyst and that he and Hounsfield felt like footballers that had just scored the winning goal.

On one occasion when Hounsfield was lecturing at a Neurological Postgraduate Course at the Albert Einstein College of Medicine, New York, on Monday May 15 1972, where he showed the first clinical images, only about a dozen people stayed to hear his extra lunchtime lecture. However these people realized the significance of what they had seen and the news spread rapidly.

Within a few months Hounsfield had developed a machine that could produce detailed cross-sections of the brain in four and half minutes. In October 1972 a machine was displayed to an audience of 2000 at the Chicago meeting of the Radiological Society of North America. By 1973 the first CT scanners were being used clinically first for the brain and then after modifications for whole body imaging. In 1974, a total of 60 of these machines were in clinical operation throughout the world and when Hounsfield was delivering his Nobel lecture in 1979 there were already more than 1000 CT scanners operating in different hospitals of the world.

What is CT and Why CT

CT measures the attenuation of finely collimated X-ray beams passing through sections of the body from hundreds of different angles; and then, from the evidence of these measurements a computer is able to reconstruct images of the body’s interior. Although CT scanning is usually performed transversely, digital processing of information can produce sagittal and coronal sections as well. The combination of transverse sectioning procedure and scanning with finely collimated X-ray beams produces images of significantly better quality than that available with other imaging methods.

The first CT scans were limited to examinations of the brain. Then in the mid 1970s, body CT was introduced. CT was initially reserved for the desperately ill and seriously injured. However, as the speed of CT increased, single breath-hold examinations of the entire chest or abdomen could be obtained in one exposure and pediatric patients could be examined without sedation. As a result, the clinical applications of CT expanded rapidly.

Body CT proved to have remarkably high sensitivity and specificity. CT assumed a central role in the evaluation of the common acute abdominal illnesses: bowel obstruction, appendicitis, renal calculi and diverticulitis. CT could reveal pulmonary emboli, decreasing the need for pulmonary angiograms and isotopic lung scans. CT had found a role in “everyday” illness.

Today physicians do not hesitate to order CTs for their patients whenever diagnoses were in doubt. It quickly became evident to all that CT reduced diagnostic uncertainty. And furthermore, radiologists using CT were often able to accurately identify alternative diagnoses at the same time that they reliably excluded original clinical diagnoses. These attributes have made CT indispensable. Indeed, CT has become essential for the present-day practice of medicine and surgery. The main reason why clinicians are ordering a CT more frequently, is that they have limited tolerance for diagnostic uncertainty. They will do whatever it takes to reduce the risks of living with uncertainty.

Recent Advances in CT

There has been a tremendous advancement in CT technology in recent years. Until recently Helical CT was a
A major breakthrough in CT technology and now it has become an indispensable modality in every radiology department. Very recently Helical CT has again been developed into a new technique called Multi-slice CT which is also called Multi-Detector Row CT. Compared to single slice systems multi-slice CT scanners represent a technological milestone with respect to increased volume coverage, shorter examination times, improved image axial resolution and better utilization of X-ray tube output. Furthermore, multi-slice scanning has added new possibilities for faster, better and safer evaluation of many different disease states such as trauma, cardiovascular disease, pediatric, critical care and skeletal diseases. The greatest advantage of all that makes these CT scanners so different is that they can produce isotropic voxels resulting in sagittal and coronal images of equal resolution as that of axial images. Currently there are CT systems, which can produce 4-64 slices of images per exposure or gantry rotation in the market, and a 256 slice/exposure prototype is already in clinical trial.4

Another recent addition specially targeting cardiac imaging is Dual Source CT. Dual source CT images the heart twice as fast as single source CT scanners reducing the ECG pulsing window by more than half. At higher or varying heart rates, the diastolic phase is too short for a single source CT scanner resulting in poor image quality. Dual source CT, on the other hand, delivers sharp and detailed cardiac images in a short diastolic phase and even in the systolic phase.

References
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