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AJNR Am J Neuroradiol 1982, 3 (5) 586-587
http://www.ajnr.org/content/3/5/586.citation

Editorial

Nuclear Magnetic Resonance Imaging

It was in the spring of 1972, when Godfrey Hounsfield and James Ambrose at the annual meeting of the British Institute of Radiology, announced a startling new development called computerized axial tomography. The development, which had been supported by the EMI Corporation and partly by the National Research Council of England, had been taking place in secret for several years. In the summer of 1973, when the first two commercial units were developed and delivered in the United States, one at the Mayo Clinic and the other at the Massachusetts General Hospital, I, with others, declared the development of CT scanning as the "greatest discovery in the imaging field since Roentgen discovered x-rays."

Little did we know at that time how prophetic those words were; for, as it turned out, the marriage of the x-ray beam to the computer brought about by the development of CT scanning, was to be extended to other areas in fairly rapid succession. These include positron emission tomography, nuclear magnetic resonance, digital radiography, and digital subtraction angiography.

Scarcely 1 year after the initial announcement of the development of CT scanning, Lauterbur in New York published a paper indicating the feasibility of producing cross-sectional images using the principle of nuclear magnetic resonance (NMR) [1]. NMR had been described in the late 1940s, and for its discovery Felix Bloch and Edward Purcell received the Nobel Prize in physics in 1952. NMR has been used extensively as an analytic technique in chemistry. The first announcement about the possibility of using NMR for cross-sectional imaging attracted a number of individuals to the field, in the United States and in Europe, particularly in England. Rapid early progress was the result.

Considerably less time has been spent developing computer algorithms for NMR image reconstruction because, for all practical purposes, they had already been developed for CT scanning, and, in fact, a very similar type of mathematical treatment is applied to the NMR acquired data. This is partly the reason why such rapid progress in NMR imaging has been possible. In the short span of some 5 years, since publication of the revolutionary images revealing the anatomic detail in the human wrist by Hinshaw et al. [2], it became possible to achieve the degree of resolution shown in the lead article in this issue [3]. Again, a research branch of the EMI Company (now Thorne-EMI) was at the cutting edge of development before selling its rights to Picker International. However, interest is widespread and, in a manner similar to the early developments in the CT instrumentation, there are a fair number of manufacturing enterprises in the field. Among these are Technicare, Philips, Siemens, Diasonics, General Electric, as well as Picker International. There are other companies that will undoubtedly be coming into the field, possibly in Europe and Japan.

A question that may be asked is, *when* will NMR instrumentation reach sufficient sophistication so that it can be used routinely in clinical diagnosis? It can be stated confidently that we are there already. The quality of the images shown in the article by Bydder et al. in this issue [3] is sufficient proof. The quality of the images already being obtained in the prototype instrument supplied by Technicare, and installed at the Massachusetts General Hospital, is very high, and nearly every pathologic entity demonstrated by CT scanning of the brain has also been demonstrated by NMR in a total of over 150 patients that have been examined. A number of demyelinating lesions in patients with multiple sclerosis that were not shown by CT scanning were demonstrated by NMR. The artifact-free images of the posterior fossa produced by NMR are superior to those produced by CT scanning. Since the prototype unit was installed some 13 months ago, significant progress has been made by Technicare, and judging by the quality of the images shown at recent scientific meetings, made with instruments produced by the manufacturers listed above, considerable and rapid progress is being made. One advantage of NMR over CT is that the magnets, once delivered and installed on the site, do not have to be changed such as was the case with the gantry and detecting systems in CT scanners. The latter were an extremely costly aspect in the evolution of CT scanners, which necessitated that many institutions acquire two or even three instruments in tandem, because progress made the previous models obsolete. With NMR it is possible to change the radiofrequency coils and to modify computer algorithms and electronic components to cause progress to occur while the magnet (the most expensive component) remains.

Another frequent question is whether NMR will replace CT. The answer to that is emphatically *NO*. However, I can already see in examining the brain, that NMR is as good in lesion detection as CT scanning, and if NMR is considered to be less invasive than CT because no ionizing radiation is used, then NMR would be the choice for the initial examination. At present, CT scanning is superior to NMR imaging in characterizing the lesion, but in clinical application, NMR is in its infancy. As more is learned on how to use the various pulsing sequences (saturation recovery, inversion recovery, spin echo, and variations thereof, which show weighted values of the parameters referred to as T1 and T2), our ability to make a specific diagnosis by NMR will undoubtedly improve. We can, therefore, expect diagnostic radiologists to embrace NMR imaging enthusiastically. We can also expect that good clinical data assessing the capabilities of NMR vs. CT scanning will become available within the next 2–3 years.

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