

## NEWS

### RECENT DEVELOPMENTS IN IMAGING IN MEDICINE

#### 1. ULTRASOUND

By definition ultrasound is sound with a frequency of greater than twenty thousand cycles per second. Actually for medical diagnostic purposes, frequencies in the range of millions of cycles per second are used. The principal features that make ultrasound useful as a diagnostic tool are that, in contrast to audible sound, ultrasound can be directed in a beam; it obeys more easily the laws of reflection and refraction and it is reflected by objects of small size. In ultrasonography short pulses of ultra-sound are beamed into the body and the reflected echoes are picked up to construct an image of the organs. Recent technological developments have enabled to refine the echoes and produce high quality images, and in some cases, even characterise the tissue under study.

In the cardiac application of ultrasound (echocardiography), it is possible to outline not only the valves, myocardium, cardiac cavities, and pericardial space, but also congenital abnormalities such as septal defects. It provides useful information about the anatomy as well as the functional state of the heart (figures 1 & 2).



**Figure 1:** A long axis section of the normal heart as seen in echocardiography. The arrows show the wide open mitral valve.

In obstetrics the introduction of diagnostic ultrasound has been a major development. It is used to monitor foetal growth and to assess foetal maturity. It is also used in the diagnosis of early pregnancy, foetal abnormalities, and the location of the placenta in patients with antepartum haemorrhage. In the abdomen the technique can show the biliary passages and

the gall bladder. In fact, ultrasound has been recognised as the method of choice in the screening of a patient with jaundice. In the kidney ultrasonography can identify tumours, cysts and calculi. The pancreas can also be visualised in many patients. Imaging of the blood vessels particularly the aorta, is useful in diagnosing aneurysms and dissection. Ultrasound is also used to assess the blood flow in vessels, making it possible to identify areas of narrowing and their severity.



**Figure 2:** A long axis section of the heart in a patient with mitral stenosis as seen in echocardiography. The mitral valve orifice (arrows) is seen to be narrow and the valve leaflets are markedly thickened.

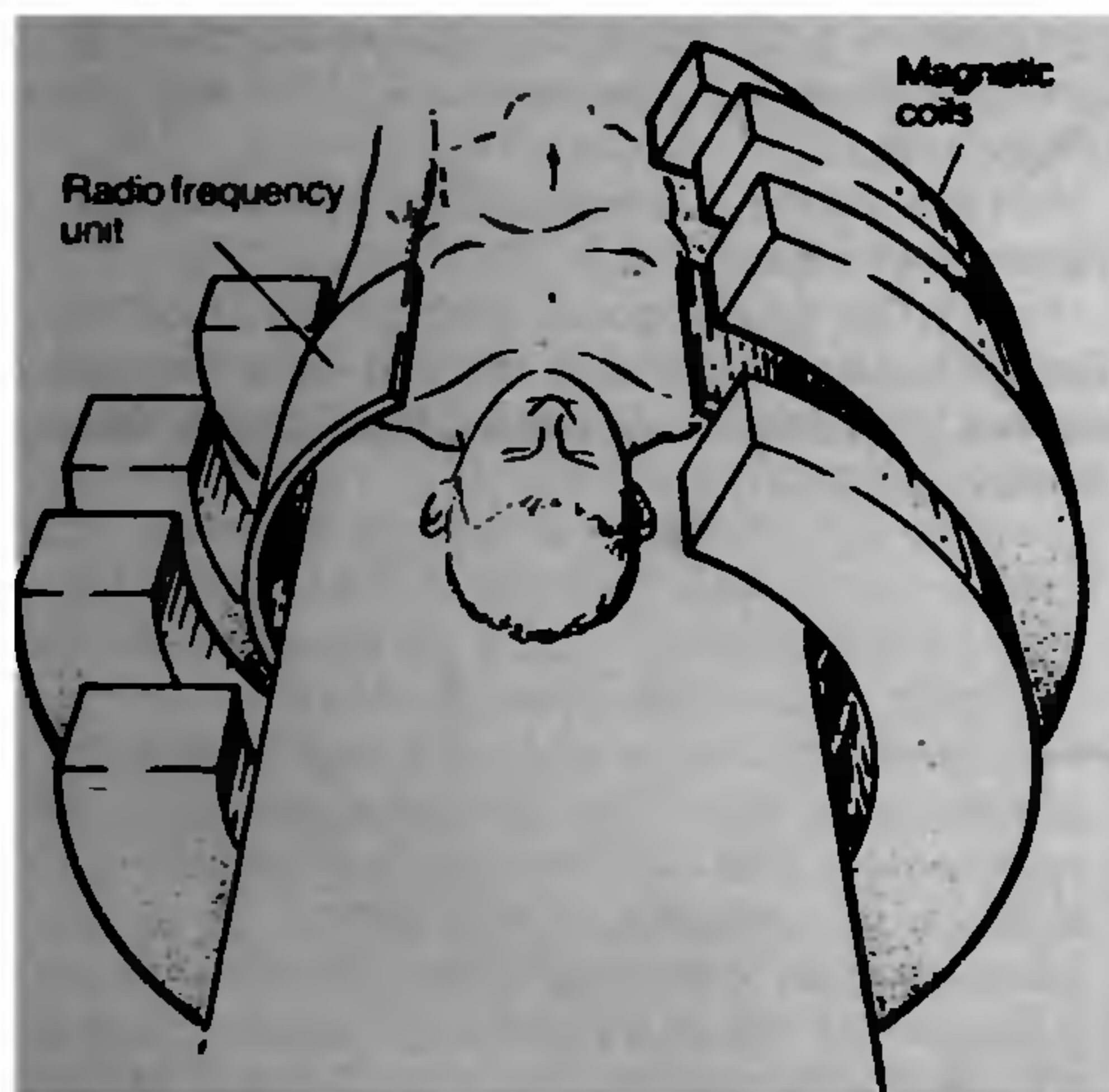
Thus ultrasonography is a very important and helpful mode of getting information in clinical medicine, and often the method of choice for initial screening of a patient. The greatest advantage of this method is that it is a completely harmless, noninvasive procedure which is well tolerated even by sick patients. Only if ultrasonography fails to provide the necessary information, further invasive radiological studies such as angiography or tomography are indicated. Moreover, medical ultrasonography is still a growing science and further developments may obviate the need for many other cumbersome investigations.

#### 2. NUCLEAR MAGNETIC RESONANCE

NMR can penetrate bony structures without attenuation and can be used to visualise organs in any part of the body including areas which are relatively inaccessible to conventional radiography, such as the spinal cord. Moreover, in NMR, soft tissue and tumours with a high density of mobile protons give strong

signals as compared to dense structures like bones, which give weak signals. This behaviour is in contrast with that of conventional X-rays which are scattered weakly by protons, and hence poor definition of soft tissue images. Characterisation of the tissue is also possible with NMR, thus enhancing its diagnostic potential.

In the brain, NMR can differentiate clearly, between white and grey matter, together with the changes caused by the disease. In the heart, cardiac muscle can be imaged by NMR. In liver diseases, NMR provides detailed information not available by other standard techniques, and can differentiate between different types of liver cell damage. Since this is a recently introduced technique, a full assessment of its potential and its utility in clinical medicine is still to be made. Several studies are now underway to compare it with other methods of diagnosis. Like echocardiography, NMR has the advantage of being a harmless noninvasive procedure and does not use ionising radiation.



**Figure 3.** Nuclear Magnetic Resonance. The magnetic field causes alignment of the protons in the tissue. Radiofrequency signals are applied to obtain NMR images.

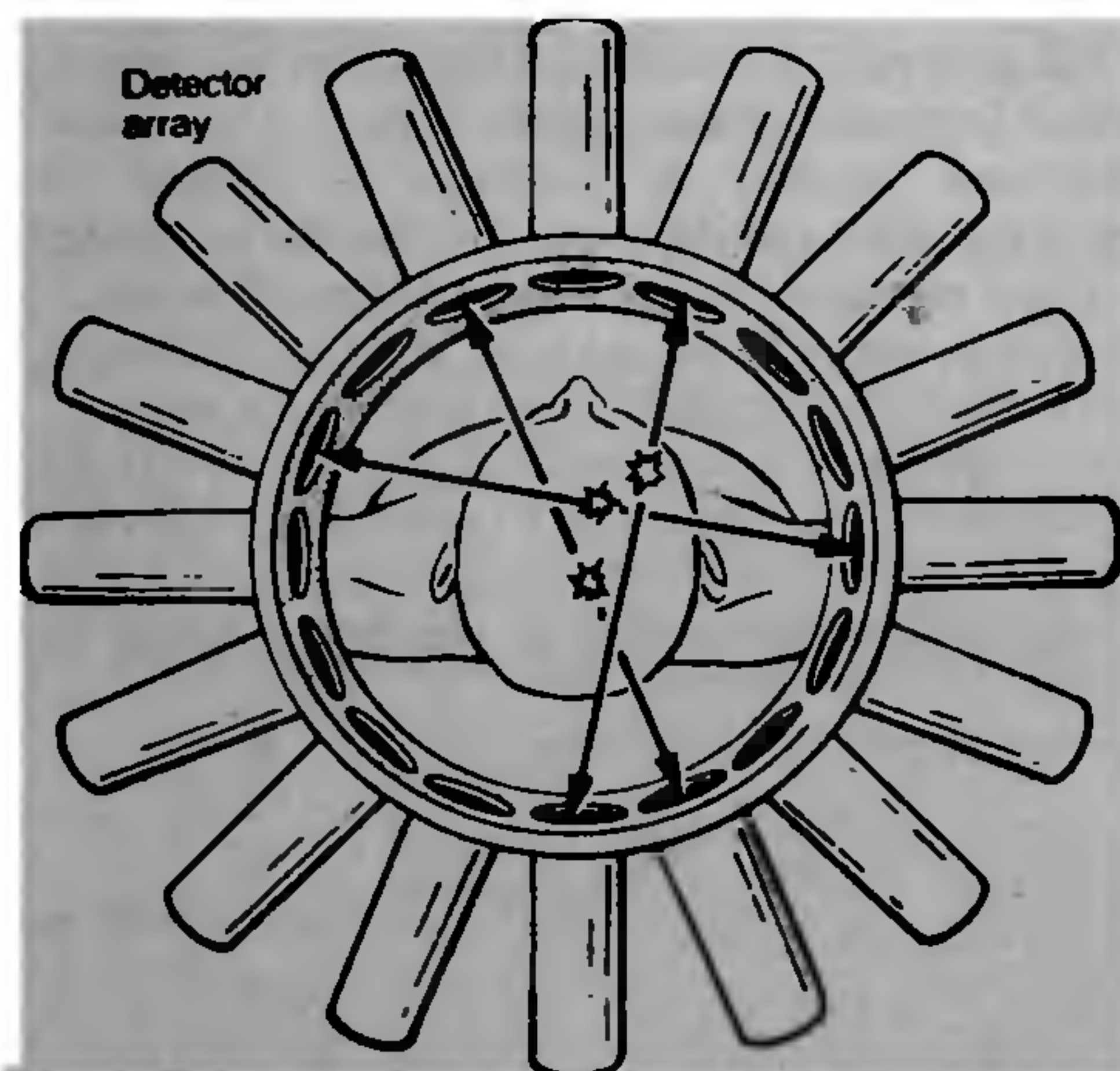
The major drawbacks of NMR imaging are the high cost of the equipment and its bulky size (figure 3). Both these limitations will possibly be overcome by advances in technology.

### 3. POSITRON EMISSION TOMOGRAPHY

Positron Emission Tomography (PET) is a new and rapidly developing method of medical imaging. This method uses radionuclides which disintegrate with the emission of positrons. By measuring the intensity of

the emission, the computer reconstructs the radionuclides, location and reactions with the tissues. Positron emitters include isotopes of carbon, oxygen and nitrogen, the three components of all living matter. By tagging natural substances such as sugars, amino acids and fats with these isotopes, PET can identify chemical reactions in the body. Thus PET can reveal the biochemical functions of the cell.

In practice, small amounts of the tagged chemicals are injected into the patient who lies inside a ring of detectors (figure 4). As the chemicals circulate through the tissues of interest, the radionuclides decay by emitting positrons. Each positron collides with an electron, producing two photons that fly off in opposite directions and are recorded by the PET detectors. Photomultiplier tubes amplify these signals from photons and convert them to electrical impulses which in turn are constructed into an image by a computer.



**Figure 4.** Positron Emission Tomography. The ring of detectors around the subject record the emission of photons from the tissue caused by the decay of injected radionuclides.

At present, PET is still in the experimental stage, but the potential uses of this method are already impressive. Brain function can be analysed by PET scanning of the uptake of tagged glucose analogs. It has been used to study the brain tissue in patients with schizophrenia, Alzheimer's disease, and senile dementia. Blood volume can be calculated by using tagged carbon. Labelled platelets have been used to show atherosclerotic occlusion of vessels. PET is also very useful for imaging the heart and lungs. Besides measuring the total and regional blood flow in the heart, PET can also produce scans of heart muscle chemistry. Altered

biochemical pattern has been used to identify abnormal tissue or reduced blood flow in an organ.

PET at present, has certain draw backs: i) Difficulty in making pharmaceuticals with a high radiological activity and short half life. ii) Image resolution is still to be refined. iii) Radiation hazard to the workers

and patients.

R. SUBRAMANIAM

Sree Chitra Tirunal Institute  
for Medical sciences and  
Technology, Trivandrum 695 011

---

## ANNOUNCEMENT

---

### ALL INDIA SEMINAR ON LOAD MANAGEMENT

The Electrical Engineering Division of the Institution of Engineers (India) will be organised the above mentioned Seminar at Vadodara on 18 and 19 November 1983 and the topics for discussion include: 1. Load management strategies, 2. Case Studies, 3. Economic aspects and financial benefits, 4. Results from major load management experiments and projects in operation, 5. Communication systems for load management programmes, 6. Classified load forecasting techniques as applied to load management, 7. Use of unconventional sources of generation based on

solar energy and windmill as load management tools. 8. Computer-aided techniques, 9. Multiobjective optimisation procedures, 10. Various customer side meter load management techniques, 11. Any other related topic.

It is proposed to invite specialists to present keynote papers in this field.

For further details, please contact: Shri J. S. Negi, Organising Secretary, The Institution of Engineers (India), Vadodara Local Centre, Race Course Circle, Vadodara 390 007.