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Ultrasound in Lund – three world premieres

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In the historical section of the monograph *Ultrasound in Medical Diagnosis*, printed in 1976, one can read that a substantial part of the early development of the ultrasound-echo method took place in the little university town of Lund in Sweden. It is not without pride that the lundensians Inge Edler and Hellmuth Hertz comment upon this in a later review article. They also describe what happened in Lund in the 1950s which they thought contributed in a decisive way to diagnostics in cardiology, neurosurgery and obstetrics and gynaecology. Apart from the cardiologist Edler and the physicist Hertz the pioneers were the neurosurgeon Lars Leksell and the obstetrician Bertil Sundén. Hertz and his pupils were to a high degree responsible for the technical development and the application in all three specialities.

Examination of the heart – first done on 29 October 1953

During the late 1940s and the early 1950s surgery of the heart was started in Lund. The first actors were Helge Wulff and later the new professor in Lund Philip Sandblom. He was an expert in congenital heart disease in children. From operations in children the step was short to correct cardiac abnormalities in adults, first the constricted mitral valve was dilated forcefully by inserting a finger through it. The results were often good but there was a diagnostic problem. In some patients the symptoms were not simply because of a small valve opening. There was also a leakage of blood 'backwards', mitral insufficiency. This condition of course could not be improved by forced dilatation. Instead, this might make the condition worse. There was thus a great need for improved diagnostics before operation.

This was where Inge Edler entered the scene. He had started his career in internal medicine in Malmö but in 1950 he moved

to Lund where he became responsible for the preoperative heart evaluations. He immediately focussed his interest on the possibilities of making a quantitative diagnosis of mitral stenosis and to determine the existence of mitral insufficiency. Edler's nurse was married to a physicist, Jan Cederlund. Hence it was natural for Edler to ask Cederlund if the radar technique developed during World War II could be used for examination of the heart. Cederlund forwarded the question to his friend Hellmuth Hertz, also a physicist. He said No, but rang up Cederlund after a couple of days and asked for the name of the doctor. Hertz had figured out that it might be possible to use ultrasound. In this way the fruitful collaboration between Edler and Hertz started (Fig.1).

Hellmuth Hertz was born in Berlin. His father Gustav was a physicist and had received the Nobel Prize for physics in 1926, together with the American James Franck. The uncle of Gustav was Heinrich Hertz; his name was used for the unit of frequency e.g. in radio waves. Thus the young Hellmuth had an important heritage in physics. During World War II he was taken prisoner by the Americans in North Africa and was transferred to the US. After the war Hellmuth did not want to return to Germany, neither did he want to stay in the US. Through studies of mathematics he got contact with his father's friend James Franck in Chicago. Franck contacted another Nobel laureate, Niels Bohr in Copenhagen, who in his turn talked to Prof. Torsten Gustafson in Lund. He was a physicist who was good at recognizing talent and arranged for a 1-year scholarship for Hellmuth. This was in 1947. After that Hellmuth Hertz worked as a junior assistant in physics, under Prof. Sten von Friesen.

It was not by chance that Hertz suggested that ultrasound should be tried out in diagnostics. As part of his training in

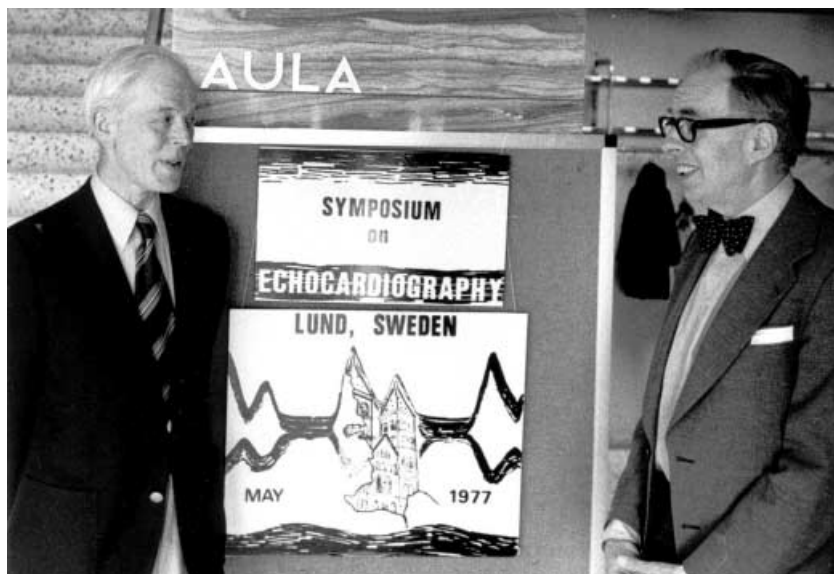


Figure 1 Inge Edler and Hellmuth Hertz in a happy mood welcoming international colleagues to a symposium on echocardiography in Lund in 1977.

physics he had just plodded his way through the 'bible of ultrasound', *Der Ultraschall* by Ludwig Bergmann. After establishing contact with Edler, Hertz immediately went to Kockum's shipbuilding yard in nearby Malmö. He knew that there was an ultrasound equipment used to test welding-seams in ships. A sound impulse of high frequency (ultrasound) was sent through the material. If there were irregularities inside echoes were formed and reflected back to the outside where they could be detected.

Hertz put the ultrasound probe over his heart and immediately saw an echo that moved in pace with the heart! He was allowed to borrow the machine to Lund over a weekend in May 1953. To their fascination Edler and Hertz could observe echoes from their own hearts as well as from patients. But the machine was not suitable in its present form to be able to record the movements of the echoes, it must be modified and supplied with a film camera.

Soon after this Hellmuth Hertz got married and travelled on a honeymoon to Germany. There he left his wife Birgit for a couple of hours to visit Mr Gellinek, one of the directors at Siemens Reiniger in Erlangen. Hellmuth's father had worked there 18 years before. Gellinek quickly grasped the importance of the heart observations and Hertz was allowed to borrow an ultrasound machine for 1 year. A couple of months later this machine arrived in Lund and never left the town.

The 33-year-old assistant at the Department of Physics and the 42-year-old cardiologist started a scientific collaboration that was to last for more than 30 years. Somewhat surprisingly, they were quite different types of personality. Hertz was impulsive and insisted upon the immediate trial of new ideas. Edler (Fig. 2), on the contrary, was quiet and more reflective, in fact more practically than scientifically oriented. Maybe their different personalities are reflected in the fact that they relatively seldom published together. In the cardiological literature Edler most often appeared alone, even if the article contained some

physics. The opposite held for Hertz, who only put his name on articles where his own contribution was the dominant one.

Anyway, in the autumn of 1953 the new Siemens machine could be tested. It had been supplied with an addition that recorded the movement of the heart echoes. The film camera had been built in the workshop of the Physics department. On

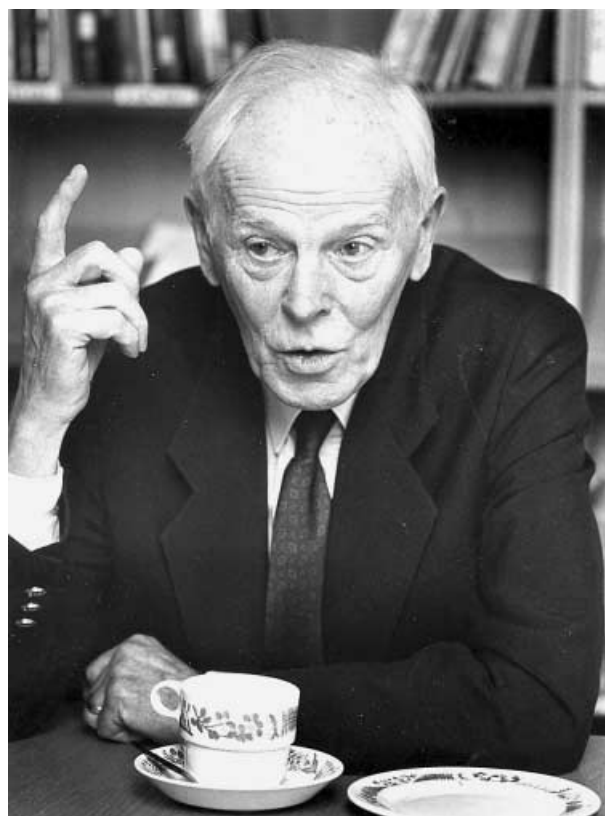


Figure 2 Inge Edler pointing out something very important.



Figure 3 Lars Leksell recording the first echoencephalogram on 16 December 1953.

29 October 1953 the first moving pictures were recorded from the heart. The first echoes came from the hind wall of the left ventricle and from another structure, initially thought to be the wall of the left atrium. An article was published in the Proceedings of the Royal Physiographical Society in Lund in 1954 – a cardiological classic (Edler & Hertz, 1954).

Later on Edler and his cardiological co-workers, mainly Arne Gustafson, could establish that the most important echo, the second one mentioned above, did not come from the atrial wall but from the anterior (the foremost) leaflet of the mitral valve. The crucial experiments were made in the kitchen of a closed ward for internal medicine. Calf hearts were used for model experiments. Heart and valve movements were obtained by a pump. Simultaneous filming of the ultrasound echo and the moving mitral valve showed that they 'belonged together'. Further confirmation was obtained in man using ingenious autopsy experiments.

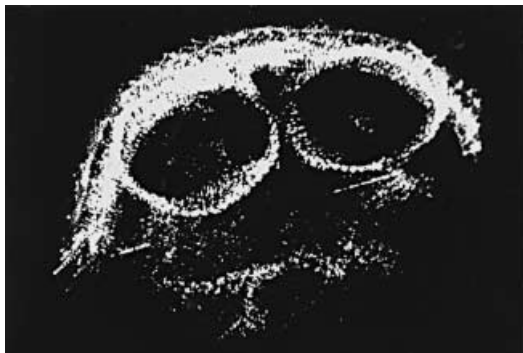


Figure 4 The first echo picture of twins in the uterus, taken by Bertil Sundén in 1962.

Recording the movements of the anterior mitral valve became a cornerstone in the preoperative evaluation of candidates for mitral valve surgery. Edler's vision had come true. The ultrasound method also became useful for detecting blood clots or tumours in the left atrium and for demonstrating the presence of fluid in the pericardial sac.

The subsequent development of echocardiography was dramatic. Soon it was possible to obtain two-dimensional pictures and to visualise in detail the movement patterns of valves and heart walls. Apart from Lund the greater part of this development took place outside Sweden. Swedish cardiologists and thoracic surgeons were used to more sophisticated invasive techniques and thought that the echocardiographic pictures were unclear and difficult to interpret. An exception was the paediatric cardiologist Nils-Rune Lundström who came to Lund and immediately realised the value of an entirely non-invasive technique when investigating small children. And in due time the method was generally accepted also in Sweden. At a recent poll among colleagues Inge Edler was named the greatest cardiologist in Sweden during the 20th century, in competition with full-time professors.

Also Hellmuth Hertz had a great career. As professor of 'electrical measurements' at the new Institute of Technology in Lund he obtained a basis for developing many areas of applied physics. Together with talented junior co-workers he created new techniques for two-dimensional echocardiography and for using the Doppler effect for measuring the rate of blood flow. Unfortunately Hertz did not receive any support grant from the Swedish Board of Technical Development. The advisors felt that the method lacked medical and commercial interest. This refusal was a long-lasting disappointment for Hertz. Thereafter his developmental work was instead concentrated on the so-called ink-jet writer which was exploited industrially outside of Sweden.

Edler and Hertz were of course nominated for the Nobel prize several times but they had to be satisfied with the prestigious Lasker Award. The motivation for the prize was rather impressive: 'For pioneering the clinical application of ultrasound in the medical diagnosis of abnormalities in the heart probably the most important non-invasive tool for cardiac diagnosis since the electrocardiography machine'.

Examination of the brain first done on 16 December 1953

Attempts to use ultrasound in the field of neurosurgery were made early. The transmission of sound through the brain was studied but echoes were not recorded. In Lund the neurosurgeon Lars Leksell started to register echoes soon after Edler and Hertz. He used their equipment and also obtained advice which is gratefully acknowledged in his first paper of 1955 (Fig. 3).

To his surprise Leksell found that it was possible to register ultrasound echoes from the interior of the brain whereas other examiners had found that the skull bones absorbed too much of the sound. That Leksell was successful, probably because of the

fact that he examined children with thin skull bones. The interesting echo came from the midline and it was assumed that it came from the epiphysis. In some illustrative cases Leksell showed that the midline echo was displaced to one side if the patient had an intracranial bleeding on the other side. The first patient was a 16 month-old boy who was examined on 16 December in 1953, just 7 weeks after the first heart patient examined by Edler and Hertz. The work of Leksell was carried on by Stig Jeppsson who wrote a doctoral thesis on the subject.

Echoencephalography was for a long time a handy routine method for the examination of patients with suspected intracranial bleeding. In due time it was replaced by computer-assisted tomography (CAT).

Ultrasound in obstetrics and gynaecology

One day Prof. Alf Sjövall, head of the department of obstetrics and gynaecology, returned from the doctors' luncheon room and reported to his colleagues of a conversation with Lars Leksell, the neurosurgeon. Sjövall had been convinced that ultrasound would be useful also in obstetrics and gynaecology. The young resident Bertil Sundén was ordered to test this. In May 1958 he made some trials with Leksell's equipment, without any obvious success. Soon after that, in June, Ian Donald in Glasgow published a new method for ultrasound examination of the abdominal cavity. Alf Sjövall immediately sent Bertil Sundén to Scotland and during some memorable weeks he was introduced into the new technique. Sundén obtained a grant from the Swedish Medical Research Council to buy the new Scottish wonder. It weighed almost 700 kg and it took some real effort to install it on the top floor of the clinic building.

Sundén now started to work intensely with the new machine. First, he could show convincingly that examinations with the current technique had no harmful effects, at least not in rats. Both fertility and offspring were quite unaffected. Then Sundén made a survey of the use of ultrasound in his speciality (Fig. 4). Obstetrical problems were the most near-lying (Sundén, 1964). Examination with X-rays was potentially harmful to the foetus. Ultrasound examination proved to give valuable information for the diagnosis of early

pregnancy, the position of the foetus, twin pregnancy and some malformations. Sundén was able to take the first ultrasound pictures of twins; this was in 1962. Soon ultrasound examination became a routine.

Why Lund?

It may be asked why this powerful development of ultrasound in three widely different medical specialities took place in the Medical faculty of Lund. It was (of course) not the result of some sort of planning. On the contrary, the development is characterized more by random meetings between persons. But it was not any type of person. One recalls the statement from a biography on Louis Pasteur: 'In the fields of observation, chance favours only the mind that is prepared'. It has also been noted that the University hospital in Lund was rather small and that most of the doctors took their luncheon in a special room. This is a nowadays overlooked and underestimated link in the communication between different specialists in the care of patients as well as in research.

But in a historical perspective one must still conclude that there were two main factors in the development. First the presence of chiefs that gave talented young workers considerable freedom to follow new leads, and second but not least the existence of biomedically oriented physicists with Hellmuth Hertz in the lead. With his knowledge, enthusiasm and generosity he provided invaluable help not only theoretically but also in practicalities. It may be mentioned that the first ultrasound machine of Bertil Sundén had electrical shielding made by used tobacco tins.

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