ECHOCARDIOGRAPHY: A PERSONAL REFLECTION

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Ulrrasound cardiography was a term introduced in the early 1950s in Lund, Sweden, when Ors. Inge Edler, Swedish cardiologisc, and physicist Carl Helmuth Hertz began to investigate what information could be obtained about the beating heart when high-frequency sound waves were passed through their own chest wall. The rwo men borrowed a commercial ultrasound "reflecroscope" - developed from sonar technology daring back œ World War I and used for material resting after World War II - from Siemans Corporation, where Hercz's father had been the director of their research laboratory and a Nobel laureate.[1-2] The earliest ultrasound signals were generated with a piezo crystal at 2.5 megahertz (MHz) frequency pulsed at 200 per second and were then recorded as they reflected back from surfaces of different density. While the initial term morphed over time, through ultrasound cardiogram, cardiac ultrasonography, cardiac reflected ultrasound, cardiac echography, "echocardiography" eventually was proposed by the American Institute of Ultrasound in Medicine and officially accepted by the American Society of Echocardiography (ASE). A meticulous history of acoustics dating back œ Roman times and the cardiovascular uses of ultrasound is provided in the 6th edition of ***Echocardiography*** published by Dr. Harvey Feigenbaum in 2004.[3]

Figure 1. A Smith Kline Ekoline ultrasound machine, circa 1964. Temple University Hospital, Philadelphia, Pa.

When I first met Dr. Edler in the early 1960s, he told me that he thought ultrasound might help clinicians better define candidates with rheumatic heart disease and mitral stenosis who were amenable to surgical intervention.[4] His premise was that the technique might permit him to recognize left atrial expansion in patients with rheumatic heart disease and thus determine whether micral stenosis or regurgitation was the predominant lesion. In the 1950s, mitral valve commissurotomy was in its infancy and diagnostic cardiac catheterization techniques were rudimentary. Proper selection of patients for a commissurotomy procedure was crucial fur a successful outcome, and a noninvasive technique for better patient selection would be of greac importance.

My introduction œ cardiac ultrasound occurred in 1963 through Dr. Claude Joyner, a practicing cardiologist working at the University of Pennsylvania. He and Dr. John Reid, an engineer who also had an interest in ulrrasound, built a reflectoscope and were extending che early work of Dr. Edler and ocher European ultrasound investigators. They were also exploring other cardiac applications including attempts to identify the location of pulmonary emboli by reflected ultrasound waves, work that subsequently proved fruitless.

Philadelphia was a hot bed of activity at that time, with Ors. Joyner and Reid at the University of Pennsylvania, Dr. Bernard Sigel at Hahnemann Medical College, Dr. Bernard Ostrum at Albert Einstein Medical Center studying the abdominal aorta, and our own group at Temple Medical School, all working independenrly. In those early days, echo data was recorded via Polaroid photographic images recorded as the images crossed an oscilloscopic screen, severely limiting the analysis and the amount

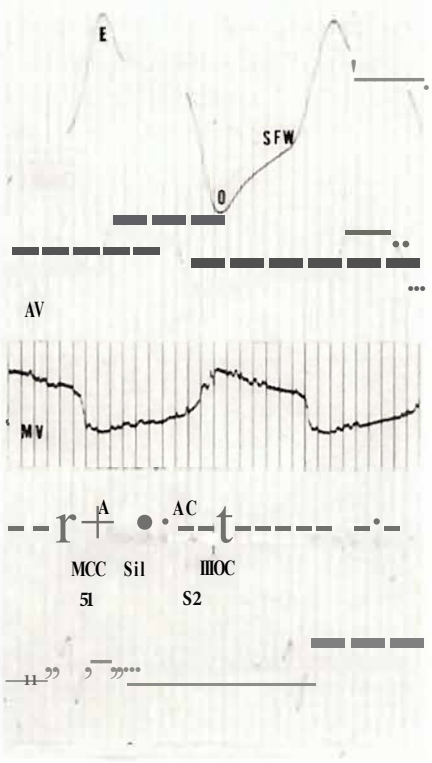

Figure 2. Mitral and aortic prosthetic valves with apexcardiogram, phonocardiograsm and ECG.

of information obtained (Figure 1). Hertz had developed an inkjet recording system printed on a paper strip chart recorder on which he recorded the A-mode (analog) signal with an E C G and phonocardiogram. With the help of the Electronics for Medicine company, we were subsequently able co improve our recording system by recording simultaneously the analog ultrasound signal, pressure readings, and phonocardiographic and apex cardiogram signals in varying combinations on direct paper recorders (Figure 2). These recordings proved imminently powerful in teaching students, residents, and fellows the physiologic parameters of the cardiac cycle.

I was fascinated by the potential for a cardiac ultrasound signal co record valve motion, among other things. By the mid-1960s, Edler, Feigenbaum, and ochers had recorded echoes from the posterior left vemricular wall and identified pericardia! effusions, left aerial masses, aortic valve stenosis, and mirral valve stenosis.5 As director of the Cardiovascular Clinical Research Center at Temple Universi$_{ty}$ Medical School, I was able w obtain an ultrasound machine manufactured by Smith Klein Instruments depicted in Figure I - one of several makers at chat time.

Our early work was directed coward the study of valvular heart disease, both native and prosthetic valves.[6] Dr. Jose Gimenez and I in collaboracion confirmed chat the analog reflected ultrasound signal accurately tracked prosthetic valve motion (micral valve and aortic valve) when compared co X-ray images (Figure 3).[7,8] Dr. Feigenbaum at the University of Indiana Medical Center, working independently in 1963 and later, would spearhead for many years the United States' involvement in cardiac ultrasound for diagnostic, research, and educational purposes. Indeed, in January 1968, he organized the first course in the United States devoted to diagnostic ultrasound and cardiovascular disease at Indiana University School of Medicine and the Krannerc Institute of Cardiology in Indianapolis. He was one of two course directors, the ocher being the chairman of his department, Dr. Charles Fisch. The faculty included Ors. Inge Edler, Claude R. Joyner Jr., Bernard J. Ostrum, Richard L. Popp, John M. Reid, Bernard Sigel, Donald E. Scrandness Jr., and yours truly. Approximately 50 people anended chat meeting. Among chem was Dr. Ray Gramiak, who presented images of intracardiac chambers following intravascular injection of indocyanine green, the first echo contrast scudies.9 I vividly recall the excitement generated about the potemial for echocardiography co study LV function - potential fulfilled by Feigenbaum and Dodge ar the Universi$_{ty}$ of Alabama in subsequent years of research iniriared after chat meeting and published in the Archives of Internal Medicine.[10]

Shortly after that meeting in Indianapolis, I made tencative plans co spend a year on sabbatical with Dr. Edler in Lund, Sweden, co further explore the application of echocardiography in heart disease. But circumstances led instead co my moving to Houston, Texas, and the Texas Medical Cencer as a Clinical Assistant Professor of Medicine at Baylor College of Medicine and The Methodist Hospital (TMH) and St. Luke's Episcopal Hospital (SLEH) in che practice of cardiology with Dr. Don W. Chapman and his associates.

At that time, a neurologist ar T M H was using reflected ultrasound co detect the midline of che brain, the theory being that any shift in the midline echo suggested che presence of a brain tumor. We borrowed his machine to begin our early work at T M H. Subsequently, with che help of the Anderson Clayton Foundation in Houston, a Smith Klein ultrasound instrument was purchased - and thus was born the first cardiac ultrasound laboratory in the Southwest, established at The Methodist Hospital in Houston in 1969. le became imminently clear char for this technique to become useful on a volume basis, the lab needed a technician trained co understand acoustic principles and co obtain che requisite data. Ms. Jean Gaffney (now Mrs. Ray Nelson), a medical assistant in our office in 1968,

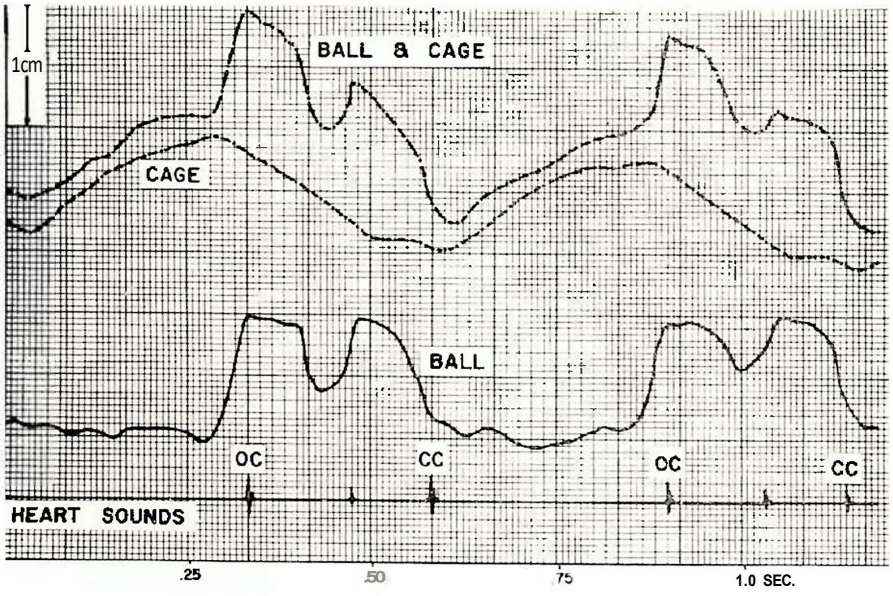

Figure 3. Displacement time curve of mitral ball and cage traced frame by frame from cine film with heart sounds superimposed. Bottom trace represents ball motion alone, using base of cage as a fixed reference point. OC = opening click. CC = closing click.

volunteered to learn the essentials. Between us, we began teaching che technique to other people and institutions in our geographic area and in the mid-1970s held a national echo conference in Houston. Gaffney's technical and managerial skills honed over many subsequent years ultimately earned her the role of manager of all the cardiovascular diagnostic laboratories at The Methodist Hospital.

In 1970, Dr. Henry McIntosh arrived at Baylor College of Medicine as chairman of the Department of Medicine. He established for the first time a cardiology section within the department and set up an echocardiographic unit at TMH run initially by Dr. Ted Wright and subsequendy by Dr. Mohammed Attar, our first echo trainee. The two laboratories operated independencly for several years until Dr. Miguel Quinones returned from his tour of service in 1977 and rejoined the Baylor faculty. Prior to his military service, Dr. Quinones had engaged in research wich Dr. James Alexander at Baylor, studying left ventricular funccion with a special interest in echocardiography. When he returned and rejoined the Baylor faculty at TMH, it seemed natural to join our two laboratories. He remained co-director of the laboratory for a number of years until Dr. William Zoghbi, the current director, joined che laboratory in 1985. Their research in establishing parameters for measuring LV function and intracardiac pressures, for evaluating valvular heart disease, and as a training program in the discipline of echocardiography has firmly escablished the laboratory in che forefront of national and international research and training programs.

In 1977, Dr. Antonio Gotto, then chairman of the Department of Medicine, called me one day requesting information about the comribucions of Ors. Edler and Hertz *in* echocardiography and their worthiness to receive the Albert Lasker Clinical Medical Research Award for their work. The

Figure 4. Ors. Inge Edler and C. Helmuth in Lund, Sweden, May, 1977.

information provided led to them receiving that award in New York City in 1977 at the Annual Award Dinner of the Lasker Foundation, which my wife and I were privileged to attend. A grand retirement party for Dr. Edler was held in Lund that same year and was attended by many of his European and American colleagues (Figure 4).

Echocardiography is an amazingly versatile cechnology. In every decade since its introduction, various disciplines have made innovations to enhance its application - from A-mode, M-mode, two-dimensional, Doppler, transesophageal contrast, color flow Doppler, three-dimensional contrast echo to incravascular ultrasound. There is no reason to believe future innovations will be any less exciting as those past and present. Best of all, it is among the most cost effective of competing technologies. Modern cardiologists cannot practice their profession without access to high-quality echocardiography.

In the introduction to this issue, Dr. Zoghbi portrays the principles for establishing an Imaging Center at The Methodist Hospital principles established by a remarkable, congenial, and collaborative chemistry among investigators. These principles will be beneficial to sustain The Methodist Hospital goals of providing service of superior value and quality as it relaces to patient care and research. I am particularly proud of chose in our echocardiography laboratory who have, over the years, contributed to the advances in clinical practice. The review by Dr. Sherif Nagueh in our journal (Vol. 2, No. 3) on strain and strain rate echocardiography, and now the review by Or. Little in chis issue regarding new approaches in the clinical application of three-dimensional echocardiography, represent yet other milestones for chis institution.

EPILOGUE

Looking back on my professional career, I feel especially privileged to have known well Ors. Edler and Hertz and to have enjoyed firsthand their wonderment and pleasure in receiving their just rewards for introducing to the rest of us an extraordinary technique for the study of cardiovascular disease - a technology still likely in its infancy. Although my sabbatical

co Sweden was shore-circuited, I did visir Lund on a number of occasions. Dr. Edler's grandson spent a semester at school in Houston with my youngest son of similar age; my son in turn spent a summer with the Edler family in Lund. I am personally gratified char my intuition and good fortune early in my career allowed my involvement in the very early days of echocardiography, and that my life after moving to Houston and being caught up in a busy teaching and practice environment allowed me che time to collaborate for many years with my colleagues who became principles in the advancement of this technology.

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