doi:10.1093/eurheartj/ehab264

Braunwald's Corner

Transseptal left heart catheterization: birth, death, and resurrection

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In 1957, I was the Senior Fellow in the busy cardiac catheterization laboratory of the National Heart Institute (now the NHLBI), a division of the National Institutes of Health in Bethesda, MD, USA. It was the dawn of open-heart surgery and a very exciting, transformational period for cardiology. Cardiac catheterization played a critical role in the diagnosis and assessment of the severity of various congenital and valvular diseases in potential surgical candidates. A key limitation was the great difficulty, risk, and often the inability to catheterize the left atrium and ventricle.

Although cardiopulmonary bypass had been developed, it was still primitive and risky. Many surgeons, including ours at the Institute, preferred the use of systemic hypothermia for simple operations, such as the closure of an atrial septal defect (ASD). If the defect was small, it could be closed with several stiches during the few minutes that hypothermia allowed for open-heart procedures. One of my colleagues in the laboratory, the late John Ross, Jr[1] and I developed a technique for measuring the size of an ASD. We advanced a catheter from the femoral vein through the inferior vena cava and into the right atrium. In the presence of an ASD its tip could usually be manoeuvred into the left atrium. We mounted a small balloon at the tip of the catheter, filled it with radiocontrast material, and with the catheter tip in the left atrium, pulled it back until the balloon became engaged in the defect. A simple X-ray allowed measurement of the diameter of the defect; this assisted our surgical colleagues in selecting the surgical technique to be used.

I performed this procedure uneventfully in five patients. Ross carried out the next one; it was his first and it too proceeded smoothly. A cardiologist visiting from Argentina was very impressed and asked Ross how often he had successfully advanced the catheter tip into the left atrium. '100% of the time' Ross replied. (He was, of course, quite accurate.) The visitor then wondered if a thin needle advanced through the catheter could puncture an intact atrial septum and thereby gain access to the left atrium.

The birth

Ross and I discussed this suggestion at dinner that evening, and we both were quite excited by it. The NIH had an excellent machine shop and we agreed that Ross would work with the mechanics in the shop to construct the needle and test it first in dogs[2] and then in cadavers. Our first patient, a 28-year-old man with atrial fibrillation and severe mitral regurgitation, exhibited giant 'v' waves in the left atrial pressure pulse (*Figure 1*). In May 1959, we reported our experience with the first 13 patients without any complications.[3]

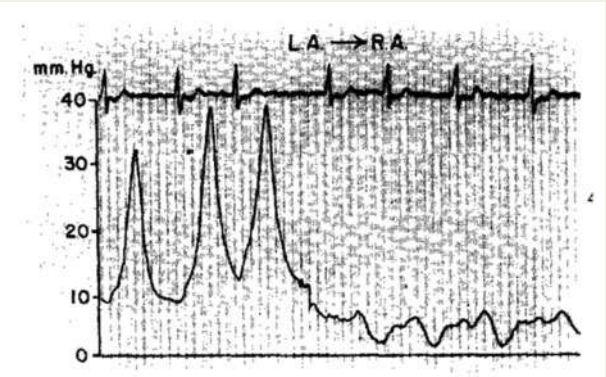

Figure 1 Pressure tracing from the first patient undergoing transseptal left atrial puncture. The patient had atrial fibrillation and severe mitral regurgitation with tall *v* waves in the left atrium. The needle was withdrawn into the right atrium. Reproduced with permission from Ross *et al.*[3]

We began to use transseptal left heart catheterization (TSLHC) immediately in our laboratory, and we enlisted the aid of a surgical fellow, Ned (Edwin) Brockenbrough to continue to improve the needle and catheter.[4] We adapted TSLHC for use in infants and children[5] and by advancing a large bore catheter over the needle and into the left ventricle, we carried out left ventricular angiography.[6] The technique was relatively safe; by 1962, we reported on 450 patients without a fatality.[6] We employed TSLHC extensively for physiological and pharmacological studies,[7] as summarized by Ross.[8]

During the 1960s, we hosted dozens of visitors from around the world to observe the evolving technique and it was widely used in many countries during that decade. TSLHC was relatively safe in other hands as well. In a prospective registry of 1765 TSLHC carried out in 16 laboratories between 1963 and 1965 the most serious complication

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was atrial perforation, which occurred in 43 patients (2.4%) leading to 4 (0.2%) deaths.[9]

The death

During the early 1970s, three new techniques were developed, which greatly reduced the need for TSLHC: (i) two-dimensional echocardiography; (ii) the perfection of percutaneous retrograde left ventricular catheterization and angiography; and (iii) the ease of measuring left atrial pressure indirectly with the flow-directed Swan-Ganz catheter. TSLHC fell into disuse and died a quiet death.

The resurrection

However, the technique was resurrected in 1984 with the development of balloon mitral valvuloplasty.[10] Subsequently, it has been widely and extensively employed by clinical electrophysiologists in the ablation of atrial fibrillation,[11] of accessory pathways, and of a variety of atrial as well as ventricular arrhythmias. TSLHC is now among the most frequently employed percutaneous procedures in the management of structural heart diseases. It plays a key role in mitral valve disease, including insertion of the MitraClip device for the treatment of mitral regurgitation, mitral valve replacement, and repair of paravalvular mitral leaks. Other applications include percutaneous closure of the left atrial appendage, closure of ASD and of patent foramen ovale. TSLHC is also used to supply oxygenated blood from the left atrium which is pumped into the arterial system of patients in cardiogenic shock.

The current technique still usually employs the 'Brockenbrough' needle, described in 1960,[4] although electrocautery and radiofrequency needles are helpful in difficult cases.[12] In addition to or instead of fluoroscopy, transesophageal and intracardiac echocardiography are now often used to guide the needle and avoid inadvertent puncture of either atrium.[13]

I offer three 'take home messages' from the experiences described above.

(1) What may seem like a random event, such as a visitor asking a casual question, can have a profound impact.
(2) When a technology or drug outlives its usefulness, do not discard it. Place it on a shelf; it might prove to be useful another day and under other circumstances.
(3) Training in medicine and cardiology takes far too long today. Ross and I were in our twenties when we began our work that led to TSLHC. Our youthful, unbridled enthusiasm, and perseverance were critical to the development of the technique.

Conflict of interest: E.B. receives research grant support through Brigham and Women's Hospital from AstraZeneca, Daiichi-Sankyo, Merck, and Novartis and consulting for Amgen, Boehringer-Ingelheim/Lilly, Cardurion, MyoKardia, NovoNordisk, and Verve.

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