Newer Techniques of Transseptal Left-Heart Catheterization

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In April 1958, the author first succeeded in catheterizing the left atrium of a patient percutaneously by piercing the interatrial septum from the groin with a long, curved, 17-gauge needle and advancing the ensheathing 7-French plastic catheter over the needle and into the left atrium. Fine polyethylene tubing could then be threaded through the transseptal catheter without any danger of amputation, in order to obtain left ventricular pressures.

The shortcomings of this original technique were the poor-quality pressure tracings obtained through the fine intraventricular catheter and the frequent inability to cross the mitral valve opening. Attempts to maneuver the curved polyethylene transseptal catheter into the left ventricle were hindered by the frictional resistance of the septum.

This difficulty has been overcome with the use of clear Teflon tubing which has a very low coefficient of friction. The left ventricles of 10 patients have been catheterized quite simply and safely by utilizing the following revised instrumentation and technique.

The Catheter and Its Percutaneous Introduction

A 70-cm. long, 14-gauge, clear Teflon catheter (O.D. 2.30 mm., I.D. 1.75 mm.) was used (fig. 1) proximally, it was flanged to accept a special adapter; distally, it was tapered to hug the transseptal needle. A C-curve was imparted to its terminal 12 to 15 cm. by autoclaving it with an inlying length of copper wire which was appropriately bent. One or two small side holes can be punched with a 20-gauge cannula on the convex side of the curved tip within 0.5 cm. of the distal opening so as to diminish catheter whip during the injection of contrast medium; too many side holes invite plugging by fibrin and possible embolization. The 3.5-cm. long special adapter is a combination of a Tuohy-Borst adapter and a plastic catheter adapter with a side arm for irrigation and dye injections. A transseptal needle, a guide, or a smaller catheter can be passed through it; tightening the proximal screw cap allows pressure measurements and irrigation to be performed through the side arm.

Because of previously reported wire breakage, Seldinger's armamentarium has been redesigned as follows (fig. 2):

The Needle

The metal cannula of the PE-205 Seldinger needle was initially replaced by Teflon in order to diminish the hazard of kinking or cutting the wire; because of difficulty in using this flexible plastic cannula in obese patients, it is now reinforced by a 15-gauge, thin-walled cannula up to its terminal 3 to 5 mm. The femoral vein is punctured with an inner 17-gauge needle; after the skin is nicked with a scalpel blade (no. 11); for femoral artery puncture, a 17-gauge compound arterial needle with interchangeable blunt stylet is preferred.

The Guide-Wire

The guide, which is sealed with Teflon, is made of fine wire joined distally to a small length of tough, braided wire which provides a very flexible leading tip; metal links are threaded on the distal part of the guide so as to make it easily visible under fluoroscopy. A year's experience with the use of Teflon guides and needles for venous and arterial catheterization has shown this combination to be tough, serviceable, and extremely well tolerated by vessels.

The catheter is introduced into the right femoral vein by the well-known percutaneous catheter replacement technique of Seldinger

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and advanced up the inferior vena cava to the right atrium. A Teflon catheter is similarly inserted into the femoral artery and advanced to the sinus of Valsalva. An inlying guide reaching to its tip makes it radiopaque.

Transseptal Needle and Puncture of the Interatrial Septum

The transseptal needle is 17-gauge and 75-cm. long; its terminal 25 to 30 cm. has a gentle curve which can be made more acute, if desired, with appropriate bending by hand. A fine stylet, made of 23-gauge wire and capped with a gold bulbous tip (fig. 1), is locked within the transseptal needle to provide it with a safe leading blunt tip; the needle is then threaded through the catheter. The flexible stylet is designed so that it does not straighten the curve of the needle; its gold tip facilitates fluoroscopic visualization of the needle extremity.

The needle, with its obturator in place, is advanced until its tip protrudes from the catheter. Under fluoroscopic monitoring, the curved needle is then turned posteriorly and to the left; exploratory up and down motions are made against the interatrial septum to determine a safe puncture site. The septum transmits a soft and yielding sensation to the hand through the needle, whereas the aorta is perceived as firm and pulsatile. When the needle seems to be in the right location and away from the aortic catheter, its point is bared by unlocking the stylet; the septum is pierced with a short, quick, jabbing motion. The Teflon catheter is then pushed over the needle into the left atrium and the needle is completely withdrawn.

Directing the Catheter Into the Left Ventricle

The clear Teflon catheter is made radiopaque by filling it with contrast medium or reinserting a guide wire within it. It can then often be maneuvered under fluoroscopy into the left ventricle if the mitral valve is not too diseased. If the valve cannot be crossed, the use of a spring guide has been found to be of great help. It consists of siliconized, 17-gauge, helical spring tubing with a sliding curved stylet with a terminal C-curve (fig. 1). The spring guide and its stylet are advanced to the tip of the heart catheter; the curved-tip

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Figure 2

A. Tapered Teflon cannula reinforced by a metal cannula. C. Inner needle B protruding from Teflon-tipped cannula A. D. Teflon-coated, flexible-tip guide wire.

Figure 3

A and B. The maneuverable guide is introduced to the tip of the transseptal catheter. C. The catheter and spring are advanced over the inner curved stylet into the left ventricle. R.A., right atrium; L.A., left atrium; R.V., right ventricle; L.V., left ventricle; I.V.C., inferior vena cava.

A stylet is then held in a fixed position while the ensheathing spring and catheter are guided, under fluoroscopy, in the direction of the left ventricle. Since the stylet can be rotated, advanced, or retracted, a great number of exploratory controlled motions can be made along the valve margins until an opening is found (fig. 3).

When the mitral valve cannot be crossed by the transseptal catheter, an atrioventricular gradient can nevertheless usually be obtained by maneuvering the retrograde aortic catheter through the aortic valve. The stenotic aortic valve can also be studied by this dual-catheter approach: in this case, it is the aortic catheter which cannot cross the valve, whereas the transseptal catheter can be passed easily into the ventricle.

A more complete study of the left heart can be readily performed through the large-bore transseptal catheter by means of cineangiocardiography. This has been found useful in evaluating chamber size, valve aperture and mobility, regurgitant flows, and congenital defects. The arch of the aorta can also be studied by transseptal ventriculography when it is inadvisable or difficult to insert a retrograde catheter, such as in coarctation or possible dissecting aneurysm.

Discussion

The original technique described in this paper has been adapted and modified by Brockenbrough, Braunwald, and Ross using radiopaque catheters and a specially designed needle, with excellent results in a large series of patients; Steinhart and Gorlin have also subsequently devised similar methods.

I have found clear, thin-walled, Teflon tubing to be much easier to maneuver than the thicker, stickier, radiopaque, polyethylene catheter. A similar technique using smaller-gauge, clear Teflon may be very useful in pediatric catheterization. Preliminary experience with a radiopaque Teflon catheter reveals that, unfortunately, it becomes soft and loses its preset curve fairly quickly at body temperature; an inner curved stylet with a blunt
tip has been useful in guiding it into the left ventricle.

The most critical stage of transseptal catheterization is the puncture of the interatrial septum, since there is a slight risk of mistakenly piercing the aorta or the free wall of the right atrium. Two precautionary measures diminish this danger: (1) a preliminary palpatory exploration of the septum with the styled transseptal needle; and (2) delineating the base of the aorta by placing a catheter and guide at the sinus of Valsalva, as suggested by McIntosh.9

Once the catheter is in the left atrium, further manipulations to advance it into the left ventricle are probably associated with the same risks and difficulties as are found in right-heart catheterization. Indeed, a combined total of over 1,000 transseptal catheterizations has been performed to date, by various authors,6,8–15 with very little morbidity. The transseptal technique is probably the safest and most flexible approach to the diagnostic exploration of the left heart.

Summary

1. Teflon tubing is ideally suited for transseptal catheterization because of its low coefficient of friction.
2. Catheterization of the left ventricle can be easily performed with a maneuverable spring guide.
3. A Teflon-tipped cannula and a tough, flexible, Teflon guide are used for percutaneous catheter insertions.
4. Safety measures used in transseptal puncture are described.
5. Simultaneous percutaneous insertion of a retrograde Teflon aortic catheter and the transseptal catheter permit transvalvular gradients to be obtained even when a diseased mitral or aortic valve cannot be crossed.

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