A Percutaneous Technique for Catheterization of the Pulmonary Artery without Fluoroscopy*

STURE BEVEGÅRD, BENGT JONSSON, AND INGVAR KARLÖF

From the Laboratory of Clinical Physiology, Thoracic Clinics, Karolinska Sjukhuset, Stockholm 60, Sweden

The measurement of pressures in the chambers of the right side of the heart or pulmonary artery and withdrawal of blood samples for gas analysis provide invaluable information for the study of patients with cardiac or pulmonary disease. If these patients are severely ill, it may be a risky procedure to move them to the catheterization laboratory, and a technique which allows these measurements to be made at the bedside, has been developed, and is described.

TECHNIQUE

A femoral or cubital vein is entered percutaneously with a Courmand needle (No. 160) and a catheter is inserted by the Seldinger technique (1953). Following insertion of the needle, a nylon cord (diameter 0.7 mm.) is passed into the vein. The needle is thereupon withdrawn and two teflon catheters are successively passed over the nylon cord guide, after enlarging the skin puncture with a small knife blade (Fig. 1). The vein may thus be entered with a catheter of larger diameter than the needle. The nylon cord and the inner teflon catheter are withdrawn after advancing the larger teflon catheter approximately 20 cm. into the vein. A polyethylene catheter (PE 50, outer diameter 1.0 mm. or PE 60 outer diameter 1.2 mm.) is then passed through the teflon catheter. The polyethylene catheter is connected to a pressure transducer and is advanced, the position of its tip being confirmed by observation of the pressure pulse on an oscilloscope or recorder. A special adaptor (Fig. 2) is used to flush the teflon catheter to keep its lumen free of blood.

An outer catheter of teflon is preferred, because it is easy to pass through the tissues and can be sterilized, for use again, by boiling. The tips of the catheters must be adapted carefully, so that there are no sharp edges which might prevent the catheters passing easily through the skin, subcutaneous tissues, and vessel wall. This may

be accomplished by stretching the catheters at a temperature of approximately 300°C. until their diameters are reduced so that their lumina accommodate precisely the nylon guide and the inner catheter, respectively. The tip may be further smoothed with emery paper and its distal end flanged with a heated instrument to fit an adaptor.

A polyethylene catheter which has been stretched, reduced somewhat in size for about 5 cm. just before the tip, and thereby rendered more flexible, may "float" with the blood-stream (see Fig. 3). It may thus be introduced into the desired location more easily. This relates especially to size PE 60. Some difficulty may be experienced in withdrawal of polycythæmic blood through PE 50 catheters.

When catheters with small lumina are employed for pressure measurements, it is essential to have a tight connexion to the manometer. Since a Luer connexion is not satisfactory, a needle is soldered to the stopcock, which is attached to the manometer, using a rubber packing, and the catheter is fitted snugly over the needle.

COMMENT

During the years 1963–1965, this technique for percutaneous cardiac catheterization was used in 196 patients, and the pulmonary artery was entered in 187 patients and the right ventricle in 8. Although the pulmonary artery might have been reached in each instance after additional manipulation, this was not necessary in all patients. In one patient the catheter could not be introduced into the right ventricle.

There have been no complications with this method. Ventricular ectopic beats may occur when the right ventricle is entered, and this has been ascribed to loops of catheter within the chamber. Ectopic beats stop when the pulmonary artery is reached. It might be expected that such a thin and flexible catheter would become knotted within the heart, but this has happened only once, and in any case is of no consequence, since it is small enough to be easily withdrawn though knotted. If the catheter should

Received February 18, 1966.

* This investigation was supported by a grant from the Swedish National Association against Heart and Chest Diseases.

FIG. 1.—Nylon cord guide with adapted inner and outer teflon catheters.

FIG. 2.—Catheter adaptor. (1) Metal screw with central opening for polyethylene catheter (PE 50 or PE 60); (2) and (4) metal rings; (3) rubber cuff; (5) 2-way adaptor; (6) screw-on metal adaptor; and (7) teflon catheter. When the metal screw is tightened the rubber cuff is compressed. This results in an air-tight connexion and permits accurate registration of pressure through both the teflon and the polyethylene catheters.

FIG. 3.—Polyethylene catheter which has been stretched close to the tip, and attachment of the catheter to a needle soldered to the stopcock in order to secure tight connexion.

knot about chordæ tendineæ this could be more serious, but it has not occurred. Neither has this been a complication of transseptal left heart catheterization with PE 50 catheters. When the pulmonary artery is not entered soon after reaching the right ventricle, the catheter should be withdrawn to the atrium and advanced again.

Several additional features of this technique are noteworthy. This catheter may easily be introduced percutaneously into the femoral vein of patients whose superficial veins have been spoiled by earlier procedures. While the small flexible catheter may be less traumatic for the heart than a Cournand catheter, it cannot be "wedged" in the pulmonary artery for evaluation of left atrial pressure where this

information is required. Transseptal catheterization may be carried out under fluoroscopic control, using an instrument described earlier (Bevegård, Jonsson, and Karlöf, 1961, 1963).

An example of the use of this method for bedside right heart catheterization is provided by consideration of the early post-operative course of patients operated upon for complete correction of tetralogy of Fallot. Ventilatory complications requiring the use of a respirator, pulmonary opacities on radiological examination, and persistence of a systolic murmur may raise the question of patency of the ventricular septal repair or residual right ventricular outflow obstruction. Physiological parameters accessible by this technique for right heart

FIG. 4.—Mobile unit for percutaneous cardiac catheterization without fluoroscopy.

catheterization may contribute substantially to accurate clinical assessment.

As a consequence of the success of this method for percutaneous cardiac catheterization, a special mobile unit has been assembled, consisting of a trolley 100 × 70 cm., containing two manometers, a recorder, oscilloscope, appropriate sterile equipment, solutions, and catheters (Fig. 4), which is kept in readiness for immediate use.

SUMMARY

A technique is described for catheterization of the pulmonary artery without fluoroscopy, which is

therefore useful as a bedside procedure. This method was used in 195 patients and no complications were seen.

REFERENCES

- Bevegård, S., Jonsson, B., and Karlöf, I. (1961). Percutaneous technique for transseptal left heart catheterization via the right femoral vein. *Scand. J. clin. Lab. Invest.*, **13**, 439.
- , —, and — (1963). A modified instrument for percutaneous transseptal catheterization of the left atrium. *Scand. J. clin. Lab. Invest.*, **15**, 436.
- Seldinger, S. I. (1953). Catheter replacement of the needle in percutaneous arteriography. A new technique. *Acta radiol. (Stockh.)*, **39**, 368.