Catheterization of the Left Side of the Heart in Man

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The technic employed in catheterization of the left heart in man is described. A catheter is introduced into the left ulnar artery and passed through the brachial, axillary and subclavian arteries into the arch of the aorta. With the tip of the catheter at the root of the aorta, we have succeeded in entering the left ventricle only in patients with free aortic insufficiency due to syphilis. Failure to pass the aortic valves in normal subjects is discussed.

Since the earlier work of Cournand and Ranges, Stead and his associates, Michael and Sharpey-Schafer, and others, catheterization of the right ventricle and pulmonary artery in man has become a standard procedure which not only supplies valuable data in the accurate diagnosis of congenitally malformed hearts, but which is also applicable to the study of a variety of problems in the cardiovascular field. A considerable experience with catheterization of the right side of the heart prompted us to try the procedure on the left side.

Catheterization of the left side of the heart presents obvious problems not encountered on the right side. The catheter must move retrograde against arterial pressure while arterial vasospasm may be so marked that the catheter cannot be passed forward. After reaching the aortic root it must be moved through the orifice into the left ventricle against the blood column and in that short ejection interval (0.22 second) during which the aortic valves are open.

The exact position of normal aortic leaflets during ventricular systole in the intact heart is not known. If the pressure difference in the left ventricle and aorta were the only factors concerned the valves would lie snugly against the intima of the aorta, but other subsidiary forces may actually move the valve toward a position of closure during the ejection phase.

As Wiggers has stated, “Among these accessory forces, two deserve consideration: (1) the production of a turbulent flow with the formation of eddies behind the valves, thus supplying the force by which they may be partially closed during the process of ejection, and (2) the negative pressure which develops in the axial stream when a jet is suddenly stopped. Into this area of negative pressure, fluid is drawn from the sides much as water into the wake of a ship and the valves are carried with the blood.”

That the normal aortic orifice may not be “wide open” during systole is suggested by the fact that to date we have been unable to bypass the valves and enter the left ventricle in five normal subjects. The axial aortic pressure probably forces the catheter tip to the side, and as it moves toward the orifice it enters the sinus of Valsalva. In a person with free aortic insufficiency, particularly that due to syphilis, the possibility of entering the left ventricle would appear to be much better than in the normal subject and this has proved to be the case.

Technic

The ulnar artery was selected for the introduction of the catheter because of its size; it is readily accessible and if necessary may be ligated with impunity. The artery is exposed at the juncture of its upper and middle third which is 8 to 9 cm. distal to the medial epicondyle of the humerus. Here the artery is just beneath the flexor carpi ulnaris muscle and lies on the flexor profundus digitorum with the ulnar nerve parallel and medial. With the left arm supinated, the operative field is infiltrated with a 1 per cent solution of procaine. A 2-cm. incision is made parallel to the median border of the flexor carpi ulnaris and carried through

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the skin and superficial fascia. The dissection is made obliquely inward toward the ulna and the nerve and artery are readily exposed. The periartrial tissue is now infiltrated with a 1 per cent solution of procaine and the vessel completely isolated. Proximally and distally to the site of the opening are placed two small umbilical tapes to control hemorrhage.

A catheter corresponding in size to the artery (usually a no. 6 intracardiac catheter) is selected, and a stylet is inserted according to the technic of Bing,4 taking care that the stylet is about 2 mm. from the catheter tip. The catheter is then well lubricated with sterile olive oil and filled with a 0.01 per cent solution of heparin in normal saline. A continuous flow of the heparin solution (20 to 30 minims per minute) is maintained through the catheter by means of a specially designed electric pressure pump, except at such times as pressures are being recorded or blood samples are being withdrawn. A 3 to 4-mm. longitudinal incision is made in the arterial wall through which the catheter is introduced and under the fluoroscope passed at once through the brachial, axillary, and subclavian arteries and into the arch of the aorta. In some cases we were able with one motion to pass the catheter from the ulnar artery into the cavity of the left ventricle. The quicker and smoother the catheter is moved forward, the less difficulty one has with vasospasm and, once the catheter is completely withdrawn, further attempts to reintroduce it are usually unsuccessful. Failure to pass the catheter beyond the junction of the subclavian artery with the aortic arch occurred in 20 per cent of our patients with aortic insufficiency, but having entered the ascending aorta to the level of the aortic valves, failure to pass the orifice into the cavity of the left ventricle has occurred in only three instances. When the catheter tip reaches the aortic root the heparin solution is replaced by the patient's heparinized blood until the cavity of the left ventricle is entered.

After the desirable data are recorded, the catheter is withdrawn and the incision in the ulnar artery is closed with interrupted 0–0 Deknatel sutures. The fascia and skin are closed with interrupted, black silk sutures and a light pressure dressing is applied. In one patient we were unable to repair the ulnar artery and were forced to ligate it but no untoward effects resulted. Immediately following catheterization the patient is given 75 mg. heparin intramuscularly every six hours for three days.

**Results**

In 11 patients with syphilitic aortic insufficiency we have succeeded in reaching the cavity of the left ventricle with no untoward complications. Figure 1 shows the position of the catheter in both the left and right side of the heart.

![Fig. 1.—An x-ray photograph showing the position of the catheter in both sides of the heart.](http://circ.ahajournals.org/)

In one patient with rheumatic aortic insufficiency, during the attempt to move the catheter into the left ventricle, the subject suddenly complained of substernal pain and the electrocardiogram which was being recorded showed the abrupt appearance of ventricular fibrillation. The catheter was immediately withdrawn. Nine cubic centimeters of 1 per cent solution of procaine with 0.5 cc. of a 1:1000 solution of adrenalin were injected directly into the heart without effect on the cardiac mechanism. The heart was then exposed and massaged. This resulted in the restoration of a sinus rhythm, but the ventric-
ular contractions were feeble and fifteen minutes after the onset of ventricular fibrillation the heart ceased beating. At autopsy, the heart weighed 550 grams and exhibited a rheumatic scarred mitral and aortic valve, the latter being fused and retracted. A careful search was made for any evidence of trauma to the root of the aorta, the aortic valves, or coronary ostia, but none was found. The ostium of the left coronary artery was anomalous in that it was situated 3 mm. above the normal site. The circumstances under which the patient expired naturally led to the assumption that the catheter had entered and partially or completely blocked the ostium of a coronary artery, presumably the left coronary, resulting in ventricular fibrillation. Histologic sections of the myocardium showed active rheumatic inflammation with many Aschoff bodies which probably lowered the threshold for the induction of ventricular fibrillation in this heart.

In a patient who died four days after catheterization from congestive failure, a careful search post mortem revealed no evidence of trauma of the aorta, aortic valves, or endocardium of the left ventricle. In one patient, premature ventricular contractions and in another, short runs of ventricular tachycardia occurred, but in both, a sinus rhythm was restored by moving the tip of the catheter.

**Summary**

A method for the catheterization of the left ventricle in man is described. The left ventricle was entered in 11 patients with syphilitic aortic insufficiency with no untoward results but one patient with rheumatic aortic insufficiency and active rheumatic myocarditis succumbed from ventricular fibrillation.

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