A Simplified Method for Left Heart Catheterization including Coronary Arteriography*

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A simplified method for performing retrograde left heart catheterization is described which utilizes a family of preshaped catheters via brachial artery cut-down. A single closed-tip catheter was the sole catheter utilized to accomplish complete left heart studies including coronary artery cineangiography, ventriculography and sortography in 50 or our last 100 cases. A second, specially shaped, open-tip catheter was used in an additional 46 cases, and a third in four. The aortic valve could be crossed readily, and ventriculography was accomplished with a minimum of premature ventricular contractions. Coronary arteriography could be performed safely with a closed-tip catheter in the majority of our patients. Left heart study with these catheters caused minimal arterial trauma, a low incidence of complications, and shortened catheterization times.

Retrograde left heart catheterization has become a widely used technique for the evaluation of cardiovascular function and disease. Since the early work of Zimmerman and co-workers and Limon and associates, a large and diversified area of application has been established. The indications have been extended to include patients with valvular and congenital heart disease, and to a large number of patients with coronary artery disease. As in the case of any widely used technique, one must constantly strive to make the procedure safer, less traumatic to the patient, and more easily performed. Three basic techniques are now in use when coronary arteriography is part of the study: (1) the transbrachial cut-down technique advocated by Sones, (2) the percutaneous femoral technique advocated by Judkins, and (3) a combination of features of both techniques. We present our experience with specially designed catheters used to study the arterial circulation, the left ventricle, and the coronary arteries via the brachial cut-down route safely. Our last 100 such studies are summarized herein.

Material and Method

The technique described herein has been utilized in 534 patients. The last 100 consecutive patients are analyzed in detail.

The patients, 100 men, ages 24 to 78 (mean age 52), are described. Their diagnoses were as follows: fifty-seven with arteriosclerotic cardiovascular disease, 17 with chronic rheumatic valvulitis, six with chest pain and normal coronary arteriograms, five with various congenital anomalies, four with congestive cardiomyopathy, four with Wolff-Parkinson-White syndrome, two with calcific aortic stenosis, one with pericarditis, one with hypertensive cardiovascular disease, two with idiopathic hypertrophic subaortic stenosis, and finally, one patient with traumatic left ventricular dysfunction. The clinical classification (New York Heart Association) of this group of patients was as follows: 5 were class I; 25 were class II; 48 were class III; and 22 were class IV.

The left heart study is always begun with a closed-tip No. 7 or No. 8 catheter, 80 cm long, having a specially designed curve and two sets of side holes (Fig 1). This catheter is introduced through a brachial arteriotomy, and pressures are recorded in the brachial artery and the aorta. The left ventricle is then entered. Once in the left ventricular

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cavity, pressure recordings and angiography are carried out. This catheter has a single preshaped curve which makes its passage through the innominate artery on the way to the aorta relatively simple. The aortic valve can be crossed with minimal manipulation even in patients with aortic regurgitation or stenosis. The left atrium can be occasionally entered in a retrograde fashion; this was not attempted in every case. When indicated, the catheter is then withdrawn to the aortic root where aortography is performed. Selective opacification of the coronary arteries is attempted by the Sones technique using this same catheter. If both coronary arteries are not entered after a short period of manipulation, a second catheter selected from a family of preshaped catheters (Fig. 2) is used. This family of catheters have both side- and end-holes; they are tapered down like the Sones catheter but with a special preshaped curve in three different sizes similar to catheters used by the percutaneous femoral approach by Amplatz and co-workers. Selection of the size of the preshaped catheter is dictated by information as to the location of the coronary ostia obtained from manipulations with the closed tip catheter. The catheter is kept in the proximal part of the coronary ostia for short periods of time, never allowing it to enter deeply into the coronary arteries, to avoid interruption of blood flow. Occasionally when a given ostium cannot be entered in one of the oblique positions, the catheter is placed in the ostium in the other opposite oblique and the patient is then rotated under fluoroscopic control. After hand injection for coronary opacification, the catheter is removed and the brachial arteriotomy is repaired with a purse string suture. Regional heparinization and proper restoration of forward and retrograde flow is established prior to closure. In addition, transseptal left heart catheterization with the use of the Brockenbrough technique is performed when mitral stenosis is suspected. The left atrium was never entered retrograde when mitral stenosis was present.

**RESULTS**

The last 100 consecutive left heart studies, all including coronary arteriography, were analyzed. In every case the left ventricle was entered with the closed-tip catheter first used. In all cases, selective coronary arteriograms were attempted with the closed tip catheter.

The right coronary artery was successfully opacified in 92 cases through use of the closed tip catheter. In four of these 92, opacification was suboptimal, and a specially shaped open-tip catheter was used in addition. In the remaining eight cases, the closed-tip catheter could not be positioned properly and a preshaped open-tip catheter was used.

The left coronary artery could be opacified with the closed-tip catheter in 78 patients. In 23 of these, opacification of the left coronary artery was considered to be less than optimal because not enough contrast material entered the vessel. The open-tip specially formed catheter was used for additional injections. In 22 patients, the left coronary artery could not be entered at all with the closed-tip catheter, and a preshaped open-tip catheter was then used and all the studies were successfully completed.

Table I summarizes the types of catheters used for all angiography. In 50 percent of the cases studied, right and left coronary artery injections and ventriculography were accomplished quickly and without significant technical difficulty with the use of a single closed-tip catheter. In the remaining 50 patients, either the right or left coronary artery could not be adequately opacified with the initial catheter and a second preshaped open-tip catheter was used in 46 of these cases, and a third catheter in the remaining four. In all 100 cases, both coronary arteries were entered and opacified in the various oblique views routinely used.

The average time required for complete left heart catheterization and angiography was less than one hour. No major complications occurred such as myocardial infarction, coronary artery embolism or thrombosis, central nervous system seizures or stroke, ventricular tachycardia or fibrillation. Two pyrogenic reactions occurred. This small incidence of pyrogenic reactions probably reflects, in part, the small number of catheters used, because of a lowered risk for the introduction of catheter contamination products.

At the close of the procedure following withdrawal of the catheter, free flow was obtained from both the proximal and distal segments, and the arte-
riotomy closed with a 6-0 Tevdek purse-string suture. Before leaving the laboratory all patients showed good distal pulsation. In only two cases was revision of the arteriotomy required because of diminished peripheral pulsation later in the day.

**DISCUSSION**

The use of a single catheter for left heart studies has the advantages of minimal trauma to the arterial tree and shorter catheterization times. In one-half of the cases presented, only one catheter was required to obtain all the desired data; in 46 cases, two catheters; and in four cases, three catheters. The fact that coronary arteriography can be performed with a closed-tip catheter has not been generally appreciated. Catheterization with the use of the brachial approach for complete left and right studies, eliminates the inconvenience of using separate sites (the arm and the leg) and also avoids the complications associated with multiple catheter changes, guide wire introductions and aortic or femoral occlusive disease when the femoral route is chosen. The use of the classic Sones catheters for complete left heart studies has the disadvantage that for left ventricular angiography and aortography open-tip catheters may induce multiple premature beats and possible intramyocardial injections. The induction of premature beats interferes with proper interpretation of the angiograms and makes the measurement of left ventricular volume difficult. As an alternative, an additional angiocatheter has been widely used, but this technique requires a minimum of two catheters for left heart study, when in fact, one might suffice (Fig 1). It has been stated that coronary catheters should have a "blunt buttoned-nose configuration" to avoid internal injury.\(^9\)\(^{10}\) This injunction must now be questioned since we have performed in our laboratory an excess of 3000 coronary artery injections on 534 patients since 1969, with closed-tip catheters without evidence of internal injury to arterial structures (Fig 3 and 4). It has also been said that coronary catheters should be devoid of side holes to permit accurate observation of tip pressures,\(^9\)\(^{10}\) but we have encountered no difficulty with either pressure measurements of unrecognized coronary ostial occlusion with the closed-tip catheter described, possibly because the side holes are so near the tip. In the total group of 534 patients studied with this technique, no deaths have occurred as a result of the study. One patient showed evolutionary changes of acute anterior wall infarction the day following catheterization. He recovered and was discharged three weeks later. Ventricular fibrillation occurred in 2.3 percent of cases in the entire group and was

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*In the 100 cases studied, 18 aortograms were performed. RCA: Right coronary artery LCA: Left coronary artery

**REFERENCES**


**Figure 3.** Frame taken from a 35 mm cineangiogram of a left coronary artery in 45° left anterior oblique, injected with the specially designed closed-tip angiocatheter.

**Figure 4.** Frame taken from a 35 mm cineangiogram of a right coronary artery in 30° right anterior oblique view injected with the closed-tip catheter.
successfully treated with D/C countershock in each instance.

In this study, the closed-tip catheter utilized is soft, elastic and demonstrates excellent torque control. It sits comfortably in the coronary cusps and does not slap or injure the aortic leaflets. Segmental spasm of the coronary arteries, presumably caused by catheter irritation, is not observed with this catheter since the injection of contrast material is made at the ostium, rather than inside the coronary artery. Aortography was performed in 18 patients, and ventriculography was successfully carried out in all cases in this series. Entering the left ventricle in a retrograde fashion was easy, as the catheter readily passed across the aortic valve. This maneuver was facilitated by the catheter's having a preshaped curve. During ventricular injection, catheter recoil was absent. Premature ventricular contractions were rare; factitious mitral regurgitation did not confuse the clinical picture; and no intramyocardial injections occurred.

It is generally recognized that the incidence of brachial artery thrombosis is related to the time needed to successfully perform left heart catheterization. Moreover, the experience of physicians involved daily in cardiac catheterizations suggests that the number of catheters used plays a significant role in the amount of arterial trauma which takes place during the procedure, increasing the difficulty of the arteriotomy repair and the incidence of local hematoma and secondary infections. However, the incidence of these complications has not been specifically correlated with the number of catheters utilized. The fact that we accomplished the entire left heart procedure with one catheter in 50 percent of our cases, and with two catheters in another 46, probably in part, accounts for our exceptionally low rate of complications. Our earlier experience with this technique does not differ from the data presented here. Precautions needed with the classic Sones technique should be employed when this technique is utilized.

All studies were performed by cardiologists with extensive experience in cardiovascular catheterization and assisted by cardiology fellows in training, who were given progressive responsibility in the performance of the angiography, according to their individual ability. Some fellows reached the point of performing the whole study themselves under direct supervision.

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