PERCUTANEOUS RETROGRADE LEFT VENTRICULAR CATHETERIZATION

AN ANALYSIS OF 130 CASES

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Precise diagnosis in cardiology not only determines rational medical management but also is the basis for success in any form of surgical correction. Various diagnostic procedures have been evolved to meet the demand for accurate assessment of left-sided heart lesions. Of these, perhaps the most commonly used, and certainly one of the most useful, is retrograde aortic and left ventricular catheterization.

In this procedure a catheter is introduced into the femoral, brachial or subclavian artery, either percutaneously or by direct surgical arteriotomy, and is passed in a retrograde fashion to the aorta and into the left ventricle. Pressures can thus be recorded in these sites and systolic gradients measured across the aortic valve (Fig. 1) or within the left ventricle (Fig. 2). Mitral valve diastolic gradients (Fig. 3) may also be accurately determined by simultaneous pressure recordings in the left ventricle and left atrium, the latter chamber being reached by a separate transseptal catheter. Cine-angiocardiography provides a visual assessment of the degree of aortic or mitral regurgitation (Fig. 4), and enables the state of the valve cusps, left ventricular cavity and aorta to be studied; shunts at ventricular (Fig. 5) or ductal level may be demonstrated.

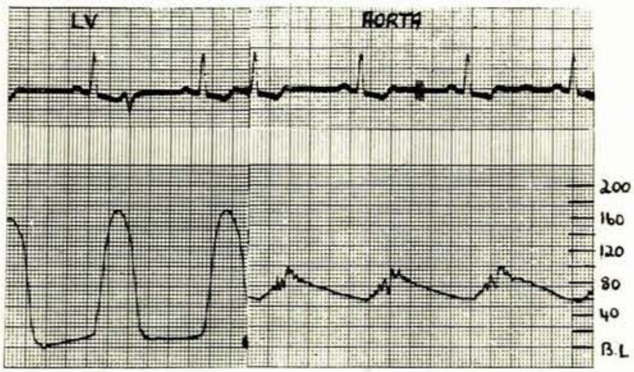

Fig. 1. Left ventricular and aortic pressure tracings in aortic valvular stenosis, showing a systolic gradient of 70 mm.Hg. Pressures in mm.Hg. BL = base line.

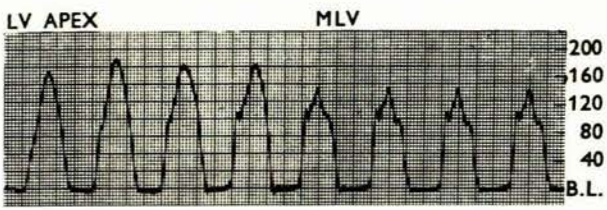

Fig. 2. Left ventricular tracing in a case of obstructive cardiomyopathy. Pressures in mm.Hg. BL = base line. A pressure gradient is shown between mid left ventricle (MLV) and the left ventricular apex.

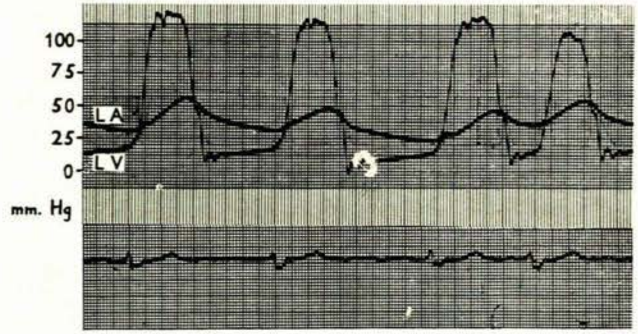

Fig. 3. Superimposed simultaneous left atrial (LA) and left ventricular (LV) pressure tracings in tight mitral stenosis. There is a high left atrial pressure and a holodiastolic gradient across the mitral valve. Note the absence of 'a' waves owing to atrial fibrillation.

This report describes our experience with 130 consecutive percutaneous transfemoral retrograde catheterizations. These were performed during the period May 1962 - February 1965. We wish to draw particular attention to the complications of this method, in our own and other series.

Method and Material

Kifa Ödman-Ledin catheters of various sizes were used—No. 1 (red) for small children, No. 2 (green) for older children and No. 3 (yellow) for adults. In the latter part of the

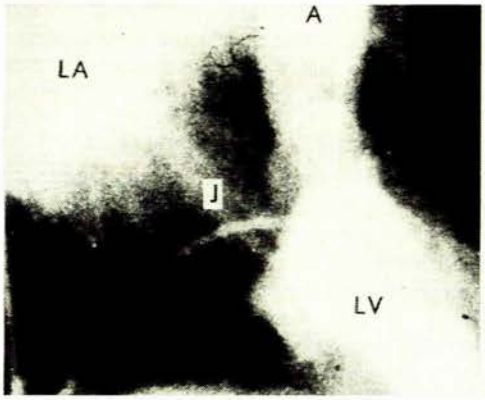

Fig. 4

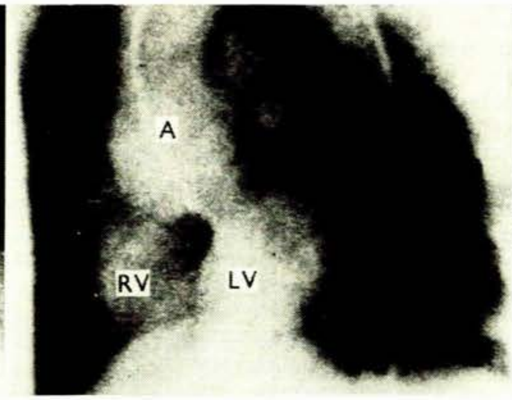

Fig. 5

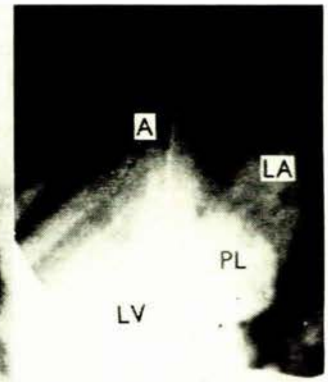

Fig. 6

Figs. 4 - 6. Single frames from cine-angiocardiograms. A = Aorta, LV = left ventricle, LA = left atrium, RV = right ventricle.

Fig. 4. Left ventricular dye injection, right anterior oblique position. Marked mitral regurgitation is shown by a jet (J) of dye filling the left atrium.

Fig. 5. Left ventricular injection, left anterior oblique position. The right ventricle fills through a ventricular septal defect.

Fig. 6. Left ventriculogram, left anterior oblique position. Massive dilatation of the posterior leaflet (PL) of the mitral valve is seen. There is associated mild mitral regurgitation.

series the smoother and more pliable No. 4 (grey) catheter was used exclusively for adults. These catheters have an end hole; 4 additional side holes were made and the distal 4 inches were formed into a gentle curve. The Seldinger technique[1] was employed for the introduction of the catheter percutaneously into the right femoral artery slightly below the inguinal ligament. Prior insertion of a stiff teflon transseptal catheter over the spring guide wire in order to pierce the artery facilitated the introduction of the retrograde catheter by obviating the tendency for its soft tip to splay. The guide wire was often helpful in effecting passage of the catheter through the aortic valve. In cases where the catheter could not be made to cross a stenotic aortic valve, where full mitral valve assessment was necessary, or where simultaneous aortic and left ventricular tracings were desirable, the Brockenbrough transseptal method[2] was used for gaining access to the left atrium and left ventricle. Our experiences with the transseptal technique are the subject of a separate communication.[3] The mode of compression of the femoral artery after removal of the catheter is of importance:[4] gentle pressure over a site a short distance above the puncture wound was maintained until no bleeding ensued after release.

Patients' ages ranged between 3 - 63 years. The diagnoses are summarized in Table I. Two-thirds were cases of multi-

TABLE I. DIAGNOSES IN 130 RETROGRADE TRANSFEMORAL CATHETERIZATIONS

	No. of cases
Rheumatic mitral and aortic valve disease	86 (66%)
Isolated aortic stenosis	7 (5%)
Obstructive cardiomyopathy	11 (9%)
Mitral posterior leaflet dilatation	6 (5%)
Miscellaneous	20 (15%)

valvular rheumatic heart disease. Isolated aortic stenosis of either congenital or rheumatic origin was present in 7 patients. The recently recognized entity of obstructive cardiomyopathy[5,6] is a not uncommon disease in Johannesburg,[7] and retrograde left ventricular catheterization is often necessary for confirmation of the diagnosis and assessment of the degree of left ventricular outflow obstruction. There were 11 such cases in this series. Massive dilatation of the posterior leaflet of the mitral valve was shown angiocardiographically in 6 patients (Fig. 6). This condition, which is associated with mild mitral regurgitation, has also only recently been described.[8] A miscellaneous group of 20 patients comprised complicated atrial and ventricular septal defects, coarctation of the aorta and left-to-right shunts at aortic level.

Success Rate

The ability to pass the catheter through the aortic valve was limited largely by the degree of narrowing at this site. Of 118 attempts to cross the valve, 92 were successful, but only 2 of the successes occurred when the aortic valve systolic gradient was above 30 mm.Hg. Most of the 26 failures occurred when tight aortic stenosis was present, but in 4 instances the gradient was mild (between 10 and 30 mm.Hg) and there was no gradient in 3. The reason for the failures with mild or absent gradients probably lies in the pliability of the catheter which limits control of its tip. Determination of aortic valve gradients was thus often dependent upon the transseptal method of gaining access to the left ventricle. In one instance direct left ventricular puncture was used.

Complications

The complications encountered appear in Table II. There was one death. This occurred in a young man with severe mitral valve disease and atrial fibrillation. Both femoral arteries had previously been cannulated at open-heart surgery, and the subsequent fibrosis necessitated a

TABLE II. COMPLICATIONS OF PERCUTANEOUS TRANSFEMORAL CARDIAC CATHETERIZATIONS

Complications	*Authors* Present series (130 cases)		Sellers et al.[10] (700 cases)	Peckham et al.[15] (142 cases)
	No.	%	%	%
Death	1	0·8	0·4	0
Occlusion of femoral artery	8	6·1	3·9	2·1
False aneurysm of femoral artery	2	1·5	0	
Extravasation of dye	2	1·5	2·9	
Intramural passage of catheter	1	0·8	0	
Significant arrhythmia	0	0	2·9	
Perforation of LV or LA	0	0	0·3	
Perforation of aortic valve cusp	0	0	0·1	

higher puncture than usual of the femoral artery. After withdrawal of the catheter the usual brisk external haemorrhage was easily controlled by digital pressure. Four hours later the patient was pale, the blood pressure was 90/60 mm.Hg (which had been the level during catheterization), and the heart rate 90 per minute. The jugular venous pressure was normal. His condition was attributed to circulatory failure consequent upon a poor myocardium, the precatheterization sedation and the syndrome of hypotension following left atrial puncture—which may be prolonged for a considerable period following transseptal catheterization.[9] Ten hours after catheterization his condition deteriorated and there was slight tenderness in the left upper quadrant. There was no clinical or radiological evidence of pericardial or pleural fluid accumulation. His haemoglobin was 14 G per 100 ml. and at no time was his heart rate above 90 per minute. He died 20 hours after catheterization, and necropsy revealed a large retroperitoneal haemorrhage. The exact source of bleeding could not be found, but it was presumed to be the external iliac artery.

The commonest complication was femoral arterial occlusion, which occurred in 8 patients (6%) of age range 9 - 48 years. Seven such occlusions followed the use of the No. 3 yellow catheter in a total of 71 cases, whereas in the last 47 adults of the series, in whom the No. 4 grey catheter was used, no occlusion occurred. Two patients developed false aneurysms of the femoral artery. Both these cases had moderately severe aortic regurgitation, and it is likely that the high pulse pressure was a causative factor. About 3 weeks after catheterization, when it had become evident that these aneurysms were not regressing, they were removed surgically with excellent results. Intramural passage of the catheter occurred once. This was recognized when there was obstruction to free advancement at the level of the second lumbar vertebra, and the procedure was abandoned, without further complications.

Extravasation of radio-opaque dye into the myocardium is a well-recognized complication of angiocardiography,[10,11] and is particularly liable to occur through an end-hole catheter. However, it rarely gives rise to untoward effects, and electrocardiographic changes are usually transient. It should be obviated by first ensuring by means of a hand-injected test dose of dye that the catheter tip is lying free in the ventricular cavity.[11] This complication occurred twice in the present series, on both occasions when the injection was made unusually high in the left ventricle. There were no apparent ill-effects.

DISCUSSION

Femoral catheterization for pelvic, abdominal and thoracic aortography appears to carry a considerably lower extracardiac complication rate than does retrograde cardiac catheterization by the same route. In his review of 1.000 cases, of which only 18 were cardiac catheterizations, Halpern[12] reported no deaths and a 0·4% incidence of arterial occlusion. Other complications were significant haematomata, intramural passage of the catheter, fractured guide wire and false aneurysm formation. Kottke *et al.*[13] found that 5·6% of 195 patients undergoing abdominal or thoracic aortography by the Seldinger technique developed femoral thrombosis; complications other than those listed above included perforation of the aorta and intramural injection of dye. Lang[14] surveyed 11,402 percutaneous femoral, brachial and carotid arteriograms performed in a number of clinics. The death rate was 0·06%, thrombosis occurred in 0·4%, perforation of a major vessel in 0·3% and intramural injection of dye in 1·19%.

By contrast, retrograde catheterization for cardiac investigation appears generally to carry a higher risk. Our complications are compared with those in 2 recently published series in Table II.[10,15]

The initial comparatively high incidence of femoral arterial thrombosis in the present series prompted an appraisal of possible aetiological factors. Catheter stiffness was the major one: no thrombosis occurred after the change to the more pliable and smoother grey catheter. Previous cannulation had been performed in one of the 8 subsequently thrombosed vessels as well as in the case which bled fatally, and we now regard previous arterial surgery as a contraindication to percutaneous catheterization at the same site. Excessive manipulation of the catheter, its presence within the arterial lumen for a prolonged period and too vigorous and sustained compression after withdrawal were all probable factors in causing thrombosis. Surprisingly, advancing age and severe aortic stenosis were not predisposing factors. Thus only 2 of the 8 cases had aortic valve gradients of more than 30 mm.Hg —an incidence roughly corresponding to that for the whole series. Catheter thickness and stiffness, degree of manipulation and the duration of the procedure doubtless account for the higher incidence of arterial complications in cardiac than in abdominal or thoracic aortic investigations.

We believe that the diagnosis of femoral arterial occlusion should be delayed for 3 - 4 hours. The limb is seldom in jeopardy, and occasionally an absent femoral pulse will return during this period. Continuous intravenous heparin infusion was used in our cases since this may help to prevent extension of already formed thrombus. There may well be a place for the use of fibrinolysin in these circumstances, but its introduction to the relevant site (the external iliac artery) would require catheterization of the opposite femoral artery. Three of our 8 patients underwent thrombectomy within 12 hours (Mr. H. Gaylis), with excellent results. Of the remaining 5, one died shortly after open-heart surgery, 2 have no symptoms and 2 have intermittent claudication after moderate exertion.

SUMMARY

Experience with 130 consecutive percutaneous transfemoral retrograde aortic and left ventricular catheterizations is presented. The uses of this procedure are mentioned and its complications are discussed. One death and 8 instances of femoral arterial occlusion occurred. It is concluded that this is a well-established and valuable procedure in cardiac investigation, but, like all methods of left heart catheterization, it carries appreciable risks.

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