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Selective Coronary Arteriography by Spot Film Roentgenographic Technique: Its Feasibility and Limitation

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Introduction

Selective coronary arteriography is the method of choice for visualizing the anatomical structures and pathological changes of the coronary artery tree in living subjects. It is helpful particularly to clarify the diagnosis of patients who have angina pectoris, because it gives clinically valuable information that is not available from any other source.

The technique of selective catheterization and injection of each coronary artery in turn, combined with cineangiography, was introducted by Sones and Shirey[1] and it is the most widely used method in the United States of America today. However, selective coronary arteriography may be performed by various techniques[2~7].

The purpose of this paper is to relate our experience with the spot film roentgenographic technique in conjunction with the viceoangiocardiographic method.

Material and Method

Selective coronary arteriography by a spot film roentgenographic technique was used in the eighteen patients who were suspected to have ischemic heart disease, viral myocarditis or primary myocardial disease. Two of these patients underwent emergency coronary arteriography.

Following the administration of mild sedatives and antibiotics, a cutdown was performed in the right antecubital fossa in the usual fashion. A No. 8 F–80 cm Sones Type I coronary catheter was passed retrograde via the right brachial artery into the left ventricle. Pressures were measured on pullback from the left ventricle into the aorta. Left ventriculogram was obtained in the right aeterior oblique projection using 40 mℓ of 80% Angio-conrey (DAIICHI). This was recorded on video tape recorder (EV-315 X, SONY), which made functional analysis possible.

After the administration of nitroglycerin, the right and left coronary arteries were selectively opacified in multiple right and left anterior oblique projections by manual injection of 10–15 mℓ of 60% Conrey (DAIICHI). Coronary arteriograms were recorded on a video tape recorder as well as on spot films. The electrocardiogram and pressure at the tip of the catheter were monitored during procedure. At the completion of the

procedure, the right brachial artery was closed with 5-0 Tevdek to maintain blood flow.

The spot film technique was based on the use of the manual spot film device with a 9 inch image tube (Fig. 1). A size 10×12 inch, 6 to 1 ratio grid cassette with Fuji KX film was placed in a cassette holder beneath the image tube. All films were exposed in a single plane with a vertical beam. The time exposure factor used was 1/50 second. The usual kilovoltage ranged from 80 to 90 at 350 mA, with a three phase generator. A 1.2 mm focal spot with a Rotanode DRX-91BCPW (TOSHIBA) X-ray tube was used. Informations on the master video tape (1 inch) was dubbed on the cassette video tape (3/4 inch) via the video cassette recorder (SVO-172RC, SONY) for permanent storage (Fig. 2).

Results

In reasonably skilled hands the tip of the Sones chtheter can be placed in both coronary arteries and spot films are exposed at the end of a manual injection. Although the total number of the patients is small, the right and left coronary artery have been visualized by direct roentgenographic technique in all cases. Thirty minutes to one and half hours were required to complete the study, because coronary arteries should be selectively catheterized each time after positioning the patient for various projections.

In our experience, the quality of the films obtained was adequate. The reasonably accurate informations for assessment of coronary artery pathology, as well as for demonstration of anatomical variations were obtained from the films (Fig. 3). Blurring does occur due to systolic cardiac motion, but only in a surprisingly small percentage of the films. The picture is clear enough to deliniate the collateral channels of 100 μ in diameter (Fig. 4). Left ventriculograms, obtained from the recorded video tape, were of good quality for functional analysis (Fig. 5).

In this series there were no deaths during or immediately after coronary arteteriography. Ventricular fibrillation occurred in three patients due to injection of the contrast media into the right coronary artery. External defibrillation was successful and the patients recovered without sequelae. Complication due to the arteriotomy, per se, include one thrombosis of the brachial artery, which required catheter thrombectomy. No embolic episode nor acute myocardial infraction was encountered.

Discussion

In our experience, selective coronary angiograms obtained by a direct spot film technique give us the reasonably accurate and diagnostic information. High quality selective spot film roentgenograms are the rule as seen in the pictures presented. Movement blurring did occur in a small percentage of the patients but was kept to a minimum, possibly because the film was exposed when the patient performed the Valsalva maneuver and the contrast medium caused a sinus bradycardia[4]. Because of these two factors resulting in diminishing large and rapid movements of the heart, the existing generator and control apparatus can be arranged for satisfactory spot film roentgenograms. The use of the rapid changers can be avoided. The spot film method

has practical advantages of direct roentgenography, including finer film detail and standard processing, filing and copying. A spot roentgenographic film can be processed quickly. This technique is helpful in the circumstance when emergency coronary angiography is required.

However, this roentgenologic technique does not replace cine photofluorography. Cine coronary angiography is essential in studying the dynamics of the coronary flow and functional property of the coronary artery such as spasm and myocardial bridge which mimic organic lesions. The video tape recorder may be useful for separation of the overlapped coronary arteries or for demonstration of coronary artery spasm or myocardial bridge. A complete coronary study always requires left ventriculography to estimate myocardial contractility, and to exclude the possibility of the ventricular aneurysm, mitral regurgitation, intramural thrombi or other intracardiac lesions. Functional analysis of the opacified coronary arteries and left ventricle is possible in some extent by video tape recorder system, however, the resolution of the pictures obtained is still limited from the technological standpoint.

Because of mechanical limitations of the equipment, the spot film technique has potential hazards. The safety of the selective coronary arteriography depends on constant visualization of the catheter tip, which is not possible technically in this method. A relatively large amount of contrast media in one injection into the coronary artery seems to be responsible for high incidence of ventricular fibrillation. Relative instability of the catheter position necessitates repeated injections into the coronary arteries, resulting in an increased total amount of contrast media. Furthermore, the positioning of the patient for various projections on the flat table by a physician's assistance is really time consuming. The Cooperative Study[8] indicated that an increased duration of the procedure was associated with an increased risk to the patient.

Selective catheterization of left and right coronary arteries with cinefluorographic recording has been introduced by Sones and Shirey in 1959[1]. The opinion, that this is the most satisfactory method for coronary arteriography, has been frequently expressed in the literature[9~12]. Personal experience, in the Sones' laboratory of two years duration, strongly confirms this conclusion. For maximal utilization in the approach to clinical problems, coronary arteriography must be not only safe, but also dependable. Selective coronary arteriography should not be performed with equipment that is incapable of consistently producing films of adequate diagnostic quality[12]. Large field (8 or 9 inch) image intensifiers and 16 mm motion picture cameras should not be used for this purpose. At present, the best commercially available systems combine 6 inch image intensifiers with 35 mm cameras equipped with cinemascope gates and 100 mm focal length lenses. X-ray generators capable of providing 60 square wave pluses of 1 to 10 msec duration per second should be used[13].

It has been emphasized by Sones and Shirey[1], that inept performance, inadequate instrumentation, and overimaginative or undiscerning interpretation, provide the means of opening a Pandora's box of misinformation which may plague the physician, harm his patients, and retard evolution of a better understanding of human coronary artery disease.

Summary

Selective coronary arteriography was attempted via the brachial artery utilizing direct roentgenography by spot film technique and videofluorography. The films, obtained by this method, gave us reasonably accurate information for the assessment of cronary artery pathology. Left ventriculograms were recorded on a video tape recorder, which permitted the functional analysis of the opacified ventricles.

However, the spot film technique has its inherent disadvantage, and this may be associated with a risk to the patient. The safety of the coronary arteriography depends on constant visualization of the catheter tip, which is not possible in this method. A large amount of contrast media is required for a diagnostic visualization of the coronary arteries. The positioning of the patient for the various projections on flat table by a physician's assistance is really time consuming.

In our opinion, cinefluorographic recording is of prime importance not only for the safe performance of selective coronary arteriography, but also for the accurate assessment of coronary artery disease. (Received, May 28, 1975)

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Explanation of Figures

Fig. 1 Photograph shows X-ray and video tape recording systems for selective coronary arteriography by spot film technique.

Fig. 2 Video tape recording system and cassette tape for permanent storage.

Fig. 3 A Selective right coronary arteriograms obtained by the spot film technique in a 20 years old male. Right anterior oblique projection (Left) and left anterior oblique projection (Right). The right main trunk (RMT), conus branch (C), right ventricular branch (RV), posterior descending branch (PD) and posterior left ventricular branch (PLV) are well seen.

Fig. 3 B Selective left coronary arteriograms in the same patient. Right anterior oblique projection (Left) and left anterior oblique projection (Right). The left main trunk (LMT), left anterior descending (LAD) and left circumflex (LCX) as well as septal perforators (S) and diagonal branches (D) are well demonstrated. The sinus node artery (SN) and the A-V node artery (AVN) arise from the left circumflex and the right coronary artery, respectively.

Fig. 4 A Selective right coronary arteriograms in a 45 years old male. Right anterior oblique view (Left) and left anterior oblique view (Right). Opacification of the left anterior descending artery (LAD) to the point of obstruction is demonstrated via septal collaterals (SC) from the posterior descending branch (PD) and via collaterals from the right ventricular branch (RV).

Fig. 4 B Selective left coronary arteriograms in the same patient. Right anterior oblique view (Left) and left anterior oblique view (Right). Total occlusion of the left anterior descending artery (LAD) at its origin is demonstrated (Arrow). Distal segments of the first and second diagonal branches (D1 and D2) are faintly visualized via the small collaterals from the high lateral branch (HL) and the lateral branch (L) of the circumflex (LCX).

Fig. 5 Polaroid photographs of the left ventricle from the television monitor, which are indicating end-diastole (a) and end-systole (b) of the heart cycle. For the puropose of functional analysis, end-systolic silhouette is shown by interrupted lines and end-diastolic silhouette by a solid line. Arrows indicate the akinetic area of the apex. LVEDP and EF stand for left ventricular end-diastolic pressure and ejection fraction, respectively.

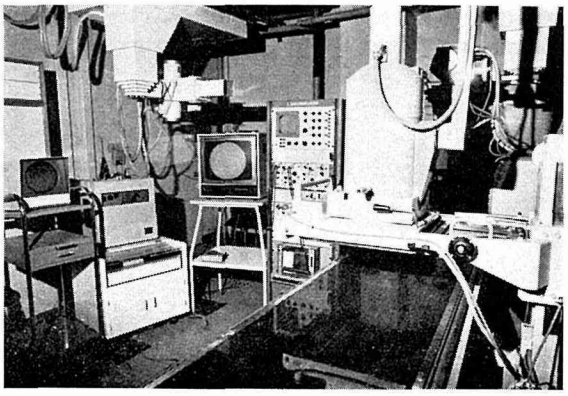

Fig. 1

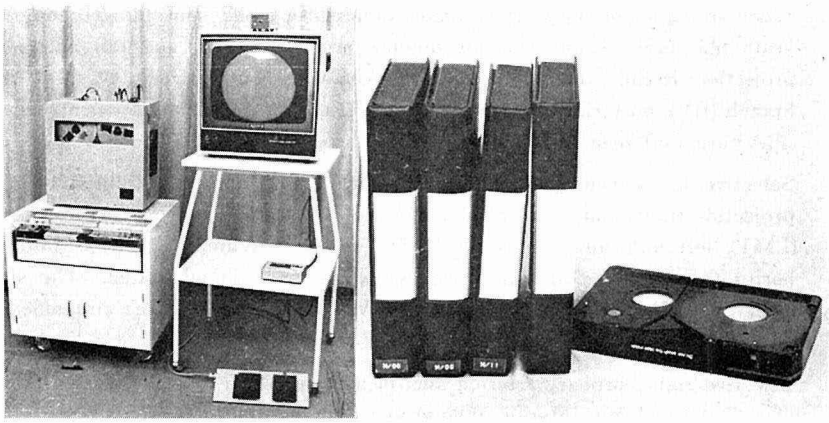

Fig. 2

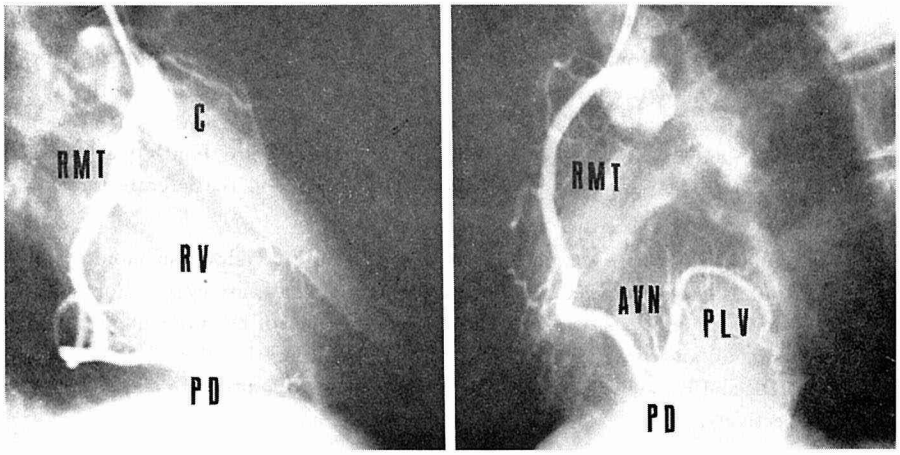

Fig. 3 A

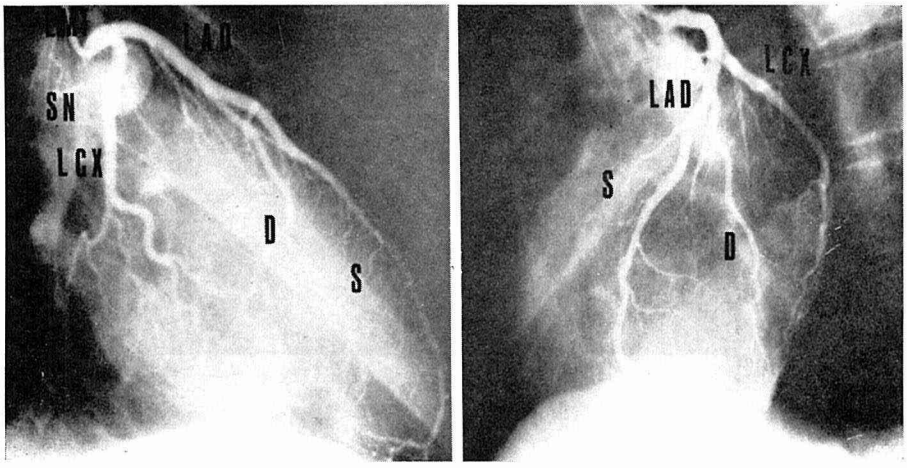

Fig. 3 B

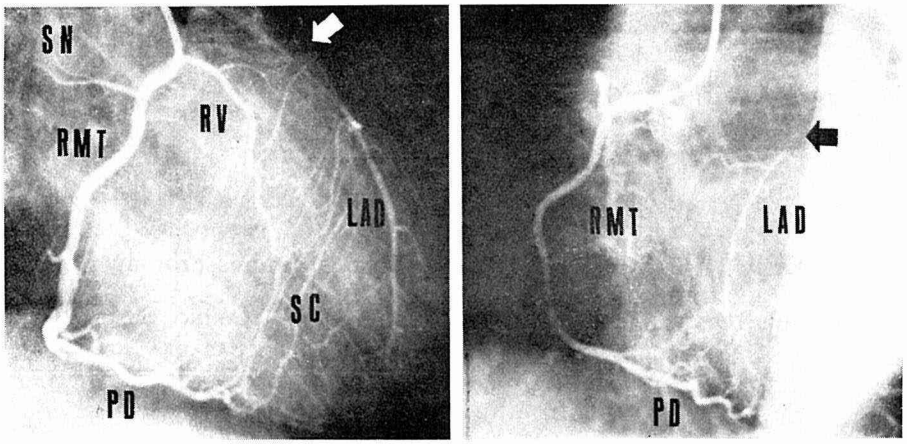

Fig. 4 A

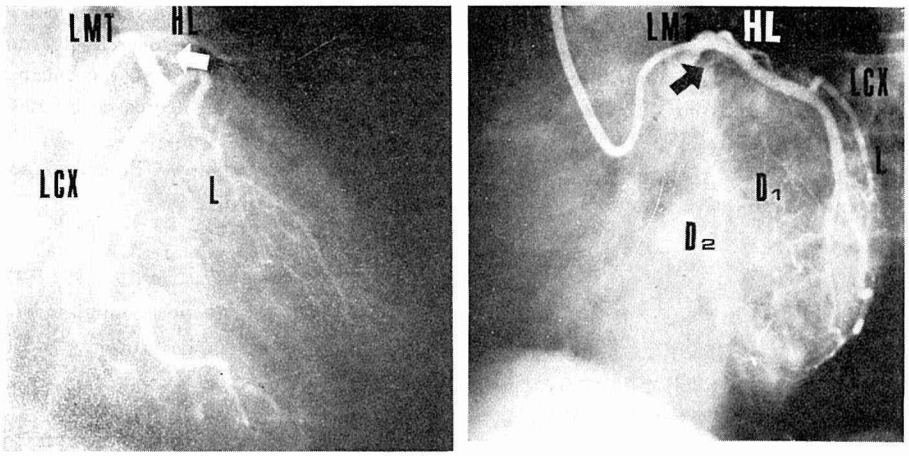

Fig. 4 B

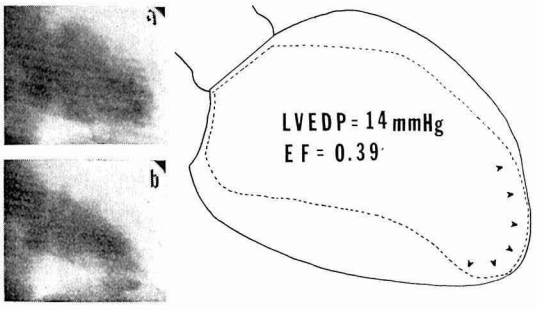

Fig. 5