Perforation of Heart during Cardiac Catheterization and Selective Angiocardiography

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CARDIAC catheterization and selective angiocardiography are frequently performed in any cardiac diagnostic unit. Minor complications, such as arrhythmias, are not uncommon, but major complications are quite rare. This case is reported to show that perforation of the heart may occur in the course of these investigations, but may not necessarily lead to serious after-effects.

Case Report

The patient, K.K., a 3-year-old boy, was admitted to the General Infirmary at Leeds in January 1962 for investigation of his congenital heart disease, with moderate dyspnea and cyanosis on effort. Physical examination showed normal development. There was no cyanosis at rest, and the fingers and toes were not clubbed. The peripheral pulses were normal. Inspection of the neck revealed a moderate venous "a" wave. The chest was normal in shape and the heart was rather quiet to palpation although right ventricular pulsation could just be felt to the left of the sternum. On auscultation there was a moderately loud ejection systolic murmur in the pulmonary area that had its peak early in systole. The second heart sound was single.

The chest radiograph showed a normal-sized heart, a right-sided aortic arch, and some pulmonary ischemia. The electrocardiogram was interpreted as showing sinus rhythm, right axis deviation, and considerable right ventricular hypertrophy.

The clinical diagnosis made on the basis of these findings was Fallot's tetralogy.

On January 26, 1962, under rectal thiopental anesthesia, cardiac catheterization was performed from the right long saphenous vein with a no.-6 Cournand catheter. The findings indicated a diagnosis of infundibular pulmonary stenosis, atrial septal defect, and ventricular septal defect.

To complete the investigation, the Cournand catheter was then replaced by a no.-7 National Institute of Health catheter for the performance of selective angiocardiography from the right ventricle. Several attempts were made to maneuver the catheter tip into the apical region of the right ventricle, but this aim could not be achieved and the catheter was finally left about the junction of the body and infundibulum of the right ventricle with its tip close to the left border of the cardiac silhouette. The pressure tracing obtained here was distorted as compared with the recording with the catheter free in the right ventricle (fig. 1) probably from partial obstruction of the sideholes by myocardial trabeculae. Despite this distortion it was thought safe to inject the contrast medium. Accordingly, 19 ml. of 76 per cent sodium methylglucamine diatrizoate (Urografin) were injected with a Gidlund syringe under a pressure of 5 Kg. per cm.². Several extrasystoles occurred during the injection and immediately thereafter the ST segments were depressed (fig. 2). In our experience, these events are unusual. The radiographs showed (fig. 3) extravasation of opaque medium into the ventricular muscle and into the pericardial sac, spreading along the proximal portions of the pulmonary artery and aorta under the pericardial reflections. Details of the cardiac anatomy were obscured to some extent by this extravasation, but pulmonary infundibular stenosis, right aortic arch, and probable ventricular septal defect were observed.

The patient became pale, the pulse rate was 160 per minute, the blood pressure was 70/40 mm. Hg, and return of consciousness was slow. He was kept under close observation, and over the next 10 hours the pulse rate decreased to 130 and the blood pressure rose to 110/70. A chest film 5 hours after injection (fig. 4) showed the cardiac outline to be slightly increased, and a pool of opaque medium was present along the inferior border of the heart. Another film 10 hours after injection was the same, but 24 hours after injection the opaque medium disappeared and an electrocardiogram at that time showed that the ST segment was no longer depressed and there was no evidence of infarction.

The clinical course over the next week was uneventful and the patient was discharged 8 days after the original test. The radiograph taken on the day prior to discharge is shown in figure 5. The
cardiac outline was similar to that before angiocardiography. The patient has been placed on the waiting list for operation.

Discussion

It is generally recognized that complications cannot be entirely avoided during and after cardiac catheterization and angiocardiography. Their incidence is usually less than 2 per cent and often much lower. Thus Kjellberg et al.\textsuperscript{1} had one death in 425 cardiac catheterizations and three deaths in 340 angiocardiograms. They state that, even with rapid injections, the jet of contrast medium is so weak that it is deflected by the intracardiac blood flow, and that they have not seen any endocardial damage that could be ascribed to the jet or to the impact of the catheter. Escher et al.,\textsuperscript{2} however, recorded the case of a 24-year-old woman with isolated infundibular pulmonary stenosis in whom cardiac catheterization and selective angiocardiography resulted in perforation of the right ventricle near its apex. They concluded that the perforation probably occurred during the insertion of the relatively sharp-tipped and rigid NIH catheter, and that another factor responsible for the accident was that the catheter was additionally advanced a short distance on two occasions after its initial positioning as the arms of the patient were raised above the head. In this case cardiac tamponade occurred leading to emergency thoracotomy from which the patient made a satisfactory recovery.

A similar case is reported by Hilbish and Herdt.\textsuperscript{3} Here the roentgenogram actually shows a bulge in the region of the tip of the catheter and the conclusion reached is that the catheter must have perforated the myocardium, though on this point there is no general agreement. Thus Dow and Taylor\textsuperscript{4} attach more importance to the high-velocity jet, when injection is made under high pressure, than to penetration by the catheter as the factor largely responsible for perforation of the myocardium.

In our case the catheter tip was at the junction of infundibulum and body of the right ventricle, so that its position for selective angiocardiography was not ideal. In addition, there was evidence in the form of the distorted pressure tracing (fig. 1) that the side-holes of the catheter were not perfectly free and since the most proximal hole in the catheter was 1 cm. from the tip, we conclude

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Right ventricular pressure tracings (in mm. Hg); (a) catheter tip free in the ventricular cavity; (b) catheter in position for injection of contrast medium.}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{Lead II of electrocardiogram. Tracings before injection of contrast medium (a), during (b), and after injection (c). Ventricular extrasystoles occur during the injection, and ST-segment depression is seen after it.}
\end{figure}
CARDIAC PERFORATION DURING CATHETERIZATION

Figure 3
(a) Anteroposterior and (b) left lateral projections 3-1/2 seconds after the start of injection of contrast medium, showing the position of the catheter tip high in the right ventricle. The opaque medium is present in the right ventricle, in the myocardium, and in the pericardium.

Figure 4
Posteroanterior chest roentgenogram taken 5 hours after selective angiocardiography. Contrast medium can be seen along the inferior border of the cardiac silhouette.

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Figure 5
Posteroanterior chest roentgenogram taken 7 days after selective angiocardiography. The cardiac outline is similar in size and shape to that before angiocardiography.
that the tip must have been well embedded in the myocardium.

A study of serial films shows that the smoothly curved course of the catheter was flattened during part of the cardiac cycle and at this time the straightening effect must have tended to drive the tip forward into the myocardium. The mechanism for the perforation thus appears to us to have been essentially similar to that postulated for the case of Escher et al., i.e., perforation by the catheter rather than by the jet of contrast medium.

It is well known that small stab wounds in the heart usually seal spontaneously, and no special explanation is needed to account for the lack of further complications.

In retrospect, we believe that the distortion of the right ventricular pressure tracing should have been regarded as a warning sign that the side-holes were not free and that it should have led us to re-position the catheter before injecting the contrast medium. Possibly in this way the perforation might have been avoided.

Summary
A case is reported in which cardiac catheterization and selective angiocardiography led to perforation of the heart without any further complications.

It is suggested that distortion of the pressure tracing indicates partial obstruction of the catheter holes and that it should serve as a warning sign not to proceed with the injection of contrast medium, but to re-position the catheter first. Furthermore, inspection of the electrocardiogram immediately after the injection may give an early indication of myocardial disturbance in the form of ST-segment depression.

Acknowledgment
We wish to thank Mr. G. H. Wooler for permission to publish this case.

References

Medical Etymology
Another type of change clearly gives us a picture of the status of medical lore in a given period. Take, for example, the word trachea which was an adjective and meant nothing but rough. It is in the feminine to agree with the word arteries with which it was originally combined. In the time of Aristotle it was believed that the arteries contained air, hence their name, air tubes. Aristotle called the arteries smooth—but he considered the windpipe a rough artery. What better could tell us of the state of physiology in that epoch?—O. H. Perry Pepper, Opuscula Medica. (Reprinted from Transactions & Studies of the College of Physicians of Philadelphia, 4 Ser., 18: 31, April, 1950).

Circulation, Volume XXVIII, October 1963
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_Circulation._ 1963;28:585-588
doi: 10.1161/01.CIR.28.4.585

_Circulation_ is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1963 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circ.ahajournals.org/content/28/4/585

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