Aneurysm of the Right Ventricle Caused by
Selective Angiocardiography

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VENTRICULAR aneurysm has not been reported to our knowledge as a complication of selective angiocardiography. We have observed two cases, both of the right ventricle, confirmed at subsequent surgery. The first patient presented interesting objective signs permitting preoperative diagnosis, but the second case was unsuspected prior to operation. In the first patient there were also unusual difficulties experienced during surgery, due, we believe, to the site of the aneurysm. The two cases are reported, together with a review of our technic and experience with selective angiocardiography.

Case Reports

Case 1

G. G., a girl aged 17 years, was investigated for total corrective surgery for tetralogy of Fallot in November 1963.

At the age of 7 years an anastomosis of the left subclavian to the pulmonary artery had been performed. Six years later severe disability had returned and the anastomosis had ceased to function. In October 1961, a blind pulmonary valvulotomy and infundibular resection were performed through a small ventricular incision. Following relief of the obstruction the pulmonary artery pressure was found to be 50/16 mm. Hg with a right ventricular pressure of 84/0 mm. Hg. Postoperatively transient pulmonary edema occurred. She recovered well with reduced disability and cyanosis only on exertion.

At reinvestigation in 1963, the hemoglobin was 15 Gm. per cent and the arterial oxygen saturation 92 per cent. Pressure measurements revealed a gradient of 70 mm. Hg between the right ventricle and main pulmonary artery, and a further gradient of 25 mm. Hg at the bifurcation of the main pulmonary artery into right and left branches. A coarctation of the main pulmonary artery was suspected. A no.-8 NIH angiographic catheter was advanced to the pulmonary artery, withdrawn into the ventricle, and left positioned in the outflow tract for selective angiocardiography. A clear right ventricular pressure tracing was obtained.

A preliminary film taken after a test injection of 5 ml. of the 76-per cent Urografin was satisfactory. It was followed by an injection of 50 ml. of Urografin. The duration of injection was recorded and timed at 0.8 second. Several extrasystoles were observed on the simultaneously recorded electrocardiogram. The patient was unaffected by the injection, but ST depression in lead II was noted shortly afterwards. The films showed that the contrast material had been injected into the wall of the right ventricle. Dye had passed immediately into a coronary vein and thence to the coronary sinus (fig. 1A). A plain film 15 minutes later showed no residual dye.

Later in the same day cyanosis was noted and over the next few weeks variable cyanosis was manifest, on occasions being very severe. A marked pulsation became evident in the second and third left intercostal spaces, and a faint opacity appeared in the plain chest x-ray in the region of the pulmonary conus, raising the suspicion of an aneurysm.

In January 1964, operation was undertaken under cardiopulmonary bypass. Prior to surgery the hemoglobin was 19.0 Gm. per cent and arterial oxygen saturation was 76 per cent. An aneurysm, 3 by 2 cm., was found anterolaterally overlying and partly obstructing the right ventricular outflow tract (fig. 1B). Whenever the sternum was fully retracted the blood pressure fell precipitously. The oxygen saturation fell from 78 per cent to 50 per cent. Full retraction could not be maintained until, after considerable difficulty, total cardiopulmonary bypass was commenced.

The aneurysm consisted of a false sac with organized blood clot, and a small hole 2 mm. in diameter leading into the right ventricular outflow tract about the level of the crista supraventricularis. When the ventricle was opened, characteristic obstructing muscle bands were found despite the previous good result. These were resected and the ventricular septal defect

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was closed with a patch. The pulmonary artery admitted the index finger as far as the bifurcation. After closure of the right ventricle, the wall of the aneurysmal sac was partially excised, the remaining portion being used to buttress the incision.

Pressure measurements made on the operating table showed a residual systolic gradient of 25 mm. Hg between right ventricle and pulmonary artery. Temporary heart block required artificial pacing for some 4 hours and a prophylactic tracheostomy was performed because of hypotension associated with residual hypothermia. After normal body temperature was restored, recovery was uneventful.

Case 2

H.B., a boy aged 5, was investigated in October 1963. A diagnosis of pulmonary valve stenosis and atrial septal defect with a small right-to-left shunt was made. The right ventricular anatomy was outlined by means of selective angiography with the use of an NIH catheter positioned in the body of the ventricle. A small amount of dye was extravasated into the wall of the lower part of the ventricle (fig. 2A), several ectopic beats were noted during the injection, but no other side effects occurred. At operation, in February 1964, in addition to the expected lesions, a small expansile aneurysm of the anterior wall of the right ventricle was noted 2 cm. in diameter with a small hole 2 mm. in diameter leading to the body of the right ventricle (fig. 2B). The aneurysm was excised and the hole was closed. Correction of the basic defects and subsequent recovery were uneventful.

Selective Angiocardiography

In this unit 87 selective right ventricular injections of contrast material have been made for angiocardiography. With rare exceptions NIH blocked end hole angiography catheters have been used. A dose of 1.0 mL/Kg. to a maximum of 50 ml. of 76-per cent Urografin has been given. The dye has been injected under pressure with use of a metal syringe driven by compressed air. The pressure has varied between 80 and 120 pounds per square inch and has enabled the dye to be injected in 0.75 to 1.5 second with 7F to 9F catheters. The injections have been recorded for timing purposes together with arterial pressure and lead II of the electrocardiogram.

Injections of dye into the wall of the right ventricle have occurred with three of the 87 right ventricular injections; two of the cases are described above. The third case was in a child with...
pulmonary valve stenosis. The injection was followed by a transient conduction disturbance and chest pain lasting 15 minutes. The films showed a small amount of extravasation of dye into the myocardium and a check x-ray 15 minutes later showed no residual dye. At subsequent operation, no myocardial defect was seen. Thus, in summary, conduction disturbance occurred in one, ectopic beats in two, and a subjective sensation of chest pain occurred in one. No residual dye was noted 15 minutes after injection in any of the three cases.

In all of the above cases clear pressure tracings were obtained prior to injection and test injections of dye were made without any noticeable effect.

Discussion

Selective angiocardiology is performed in different ways and the incidence and cause of complications must be considered in relation to technic.

In this unit with rare exceptions blocked end hole, multiple side hole NIH catheters have been used. Other catheters used include either the Cournand or Lehman type with a single end hole or the Rodriguez Alvarez catheters similar to the NIH catheters. Serious complications have been unusual with either of these two main types of catheters. However, when considering the incidence of injections into the wall of the ventricle there appears to be a difference in the incidence with single end hole catheters as compared to catheters with multiple side holes with or without open end holes. Kjellberg and associates, using single end hole catheters, state that in 738 examinations no case of endocardial or myocardial damage occurred. Bagger and associates, using principally single end hole catheters, reported four cases of myocardial injection out of 1,375 examinations. On the other hand Bookstein and Sigman have reported 13 cases of myocardial injection using multiple side hole catheters with open or closed ends in a series of 248 examinations. In the present series three cases of myocardial injection have occurred in 87 examinations.

![Figure 2](http://circ.ahajournals.org/)

A, left. Selective right ventricular angiogram in case 2, showing a small collection of dye in the wall in the body of the ventricle as indicated by the arrow. The catheter may be seen to lie in the body of the ventricle. B, right. Photograph taken at operation showing the aneurysm, indicated by the arrow, in the body of the ventricle.
When single end hole catheters are used, clear pressure tracings and normal test injections cannot be obtained if the catheter orifice is obstructed. However, with multiple side holes clear pressure tracings and a normal test injection may be obtainable even if the tip of the catheter is embedded in the wall of the ventricle.

Multiple side hole catheters have been used to diminish recoil and achieve better mixing of contrast material and blood. Despite these considerations the difference in the incidence of myocardial injection of dye suggests that single end hole catheters are safer for ventriculography.

Positioning of the catheter tip in the body rather than the outflow tract of the ventricle has been recommended. It is possible that injection into the wall of the ventricle is less likely in this situation because more obvious mobility of the catheter tip may be observed. The fact that in our series the tip was located in the outflow tract in one case and the body in two indicates that it can occur in either situation.

Other factors that may be related to these complications include the quantity of dye and speed with which it is injected. These factors condition the velocity of the jet of dye. This may be important in cases of myocardial perforation; however, in our cases the collection of dye within the wall suggests that the catheter was actually embedded. The immediate opacification of a coronary vein and the coronary sinus in case 1 also occurred in four cases of Bookstein and Sigman. They also concluded that the catheters had actually been embedded.

Ventricular aneurysms are not uncommon after myocardial infarction. They have also been reported after incision of either the left or right ventricle. One report describes aneurysm formation after infundibular resection without ventricular incision. There appear to be two common factors predisposing to the occurrence of aneurysm: damage to the wall of the ventricle and high pressure within the ventricular cavity. The small hole in the endocardium found at surgery in both cases seemed explicable by catheter penetration rather than a high pressure jet. The previous infundibular incision may have weakened the wall in the first case. However, the development of the aneurysm in relation to the investigation was unquestionable.

In case 1, the occurrence of severe arterial desaturation during surgery together with hypotension was very striking. The low arterial carbon dioxide tension suggested that ventilation was adequate, and the spontaneous improvement after cessation of manipulation and retraction made it seem likely that the aneurysm was obstructing right ventricular ejection and facilitating an increase in the right-to-left shunt. Although the diagnosis was suspected preoperatively, the difficulties experienced during surgery suggest that exact diagnosis and delineation by means of venous angiocardiography might have been worth while.

**Summary**

Two cases are reported of aneurysm formation in the outflow tract and body of the right ventricle following selective angiocardiography. The technic and complications of angiocardiography in our hands have been reviewed, and it is concluded that there is no absolute means of preventing injections of contrast material into the wall of the ventricle, if multiple side hole catheters are used. It seems probable that single end hole catheters are safer than multiple side hole catheters for selective ventriculography.

The first patient developed a marked pulsation in the second and third left intercostal spaces together with changes in the plain x-ray that permitted a preoperative diagnosis of aneurysm. The second case was diagnosed at operation. The first patient developed variable cyanosis preoperatively, and during operative correction arterial desaturation together with hypotension. These changes were attributed to outflow tract obstruction by the aneurysm.

**References**


Reports of Medical Cases, With a View of Illustrating the Symptoms and Cure of Diseases

By Richard Bright—1827

In this case we have another decided instance of anasarca with coagulable urine connected with disorganization of the kidneys. The long continuance of the symptoms before the patient became the subject of treatment, the very scanty secretion of urine and its coagulable nature, and the comparative freedom from disease either in the thorax or the liver, led me from the first moment I saw him to anticipate that he would not recover: and the belief that the kidneys would be found the marked seat of disease, induced me to pay attention to the progress of the symptoms, though the case was not under my own care. The result fully justified my expectations: and the peritoneal inflammation and more acute pleuritic attack which appeared to hasten his dissolution, afford but fresh proofs of the disposition which exists in this disease to severe inflammatory afection of different structures, but more particularly of the serous membranes.—Original Papers of Richard Bright on Renal Disease. Edited by A. Arnold Osman. London, Oxford University Press, 1937, p. 19.
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