Pericardial Tamponade Following Percutaneous Left Ventricular Puncture

By Richard J. Botham, M.D., G. G. Rowe, M.D., and W. P. Young, M.D.

A case of pericardial tamponade following percutaneous left ventricular puncture for the assessment of aortic stenosis is presented. Technical factors pertinent to the etiology of the complication are discussed. Emphasis is placed on the fact that current enthusiasm for percutaneous ventricular puncture should be tempered with an awareness of the associated complications that may ensue and require immediate definitive therapy in an environment well equipped for their management.

Credit for the first successful systematic study involving percutaneous left ventricular puncture in man must go to Ponsdomenech and Nunez, who reported its use in 1951 for contrast visualization of the left ventricle and aorta. Following their initial study, a number of other investigators have successfully employed percutaneous ventricular puncture for contrast visualization of the left ventricular chamber, aorta, and aortic and mitral valves.

Sir Russell Brock and his co-workers in 1956 proposed and utilized percutaneous left ventricular puncture in the assessment of aortic stenosis. Recording synchronous left ventricular and brachial artery pressures proved to be a highly satisfactory means of establishing the systolic pressure gradient across the aortic valve for evaluation of the severity of aortic stenosis. Similar successful studies have been reported subsequently by other investigators.

In reviewing the available literature concerning percutaneous left ventricular puncture we were unable to find a single incidence of mortality in human subjects following this procedure. The collective series that we were able to cull from the cases reported in the literature to date totaled 348 (table 1).

The reported morbidity following this procedure has also been less than one would initially anticipate. Gregg and associates reported a single incidence of ventricular fibrillation in their series that occurred following an injection of Diodrast almost directly into the coronary ostia. The patient underwent cardiac massage and had an uneventful recovery from the procedure. Syncope, pneumothorax, cardiac arrhythmia, hemoptysis, and renal pain and hematuria (presumably from an embolus) have also been reported following percutaneous left ventricular puncture.

The purpose of this report is to present a case in which cardiac tamponade developed following percutaneous left ventricular puncture. We wish to emphasize that, while the procedure is a useful and valuable adjunct in the objective evaluation of aortic and mitral valvular disease, the associated complications, when they occur, may require immediate definitive therapy in an environment well equipped for their management.

Case Report

E. S. was a 31-year-old white male farmer who had had known heart disease since childhood. Approximately 1 year prior to admission to the University Hospitals he had been advised by his local physician that he should quit farming because of the severity of his heart disease. The progressive and incapacitating symptoms associated with his heart disease had subsequently caused his release from a number of jobs and, at the time of his admission, he was unable to get employment of any kind. Primary symptoms elicited in the history were those of dyspnea, palpitation, chest pain, and hemoptysis.

Minimal exertion was sufficient to initiate dyspnea, and the patient therefore attempted to move about slowly. Palpitation was frequently present at rest and was aggravated by excitement.

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TABLE 1.—A Collective Series of 348 Cases of Percutaneous Left Ventricular Puncture and the Associated Mortality

<table>
<thead>
<tr>
<th>Author</th>
<th>Mortality</th>
<th>No. of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brock et al. 6</td>
<td>0</td>
<td>90</td>
</tr>
<tr>
<td>Green et al. 6</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Yu et al. 7</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>Ponsdomenech et al. 1</td>
<td>0</td>
<td>56</td>
</tr>
<tr>
<td>Gilman et al. 6</td>
<td>0</td>
<td>86</td>
</tr>
<tr>
<td>Smith et al. 10</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>McCaughan et al. 4</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>348</td>
</tr>
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Since childhood, he had noted left anterior chest pain which occurred after severe exertion and frequently radiated to the left shoulder. This chest pain had been present almost constantly for 4 days prior to admission to the hospital. On several occasions in the past year, he had coughed up blood-tinged sputum but he denied the presence of a chronic cough or other symptoms of respiratory disease.

Physical examination revealed a regular pulse of 116 per minute and a blood pressure of 124/95 in the upper extremities. There was a palpable left ventricular heave and an aortic systolic murmur with a split second sound which was normal or slightly accentuated. The peripheral pulses were equal, regular, and synchronous, but somewhat diminished in volume. The liver was palpable 3 to 4 cm. below the right costal margin on inspiration.

The chest x-ray revealed the pressure of left ventricular enlargement with dilatation of the ascending aorta. Calcification was not seen in the aortic valve area. The electrocardiogram revealed early left ventricular strain. Other laboratory studies were normal. The impression was one of aortic or subaortic stenosis requiring aortic valvotomy.

A few days after admission, right heart catheterization revealed no significant abnormal findings. It was then thought that percutaneous left ventricular puncture was indicated to substantiate the impression of aortic stenosis, to assess its severity, and to determine whether it was valvular or subvalvular in location.

Accordingly, the following day the patient was taken to the operating room where general anesthesia was induced using Surital supplemented with succinylcholine. After an endotracheal tube was introduced, anesthesia was maintained with nitrous oxide, oxygen, and occasional supplements of small amounts of Surital. A no. 18 gage needle was introduced percutaneously into the left ventricle, the point of entry being just lateral and inferior to the apex impulse, in the manner previously described by Brock. The return of bright red blood and a recording of a ventricular pressure curve revealed that the catheter was in the left ventricle. The recorded ventricular systolic pressure of 125 mm. Hg was not what was expected from the patient's history.

An Afford catheter was then passed through the needle into the left ventricle and advanced across the aortic valve into the aorta. The pressure gradient across the valve also was not what was expected, being recorded as 25 mm. Hg. A pullback pressure tracing taken across the aortic valve revealed that the stenosis was valvular in location with no subvalvular component. It then became evident that technical problems in the measuring and recording apparatus were responsible for the low ventricular pressures recorded. Although these problems were rectified, a delay of 15 minutes ensued during which time the left ventricular needle was left in place. Gradually, during this interval, the patient developed a tachycardia of 120 per minute, with a fall in systolic blood pressure to 70 mm. Hg. The electrocardiogram revealed S-T depression consistent with myocardial ischemia. The needle in the left ventricle was immediately removed. Within 10 minutes there was no audible or palpable blood pressure although the electrocardiogram revealed a heart rate of 50 per minute. Auscultation over the precordium revealed barely audible heart sounds, and it was assumed that the patient had developed pericardial tamponade.

A 7-cm. incision was made immediately in the left fifth intercostal space anteriorly, and the chest was opened. The pericardium was seen to be distended, tense, and discolored by underlying blood. Normal vigorous myocardial contraction was not evident within the distended pericardium. A 4-cm. incision was made in the pericardium and the contained blood was allowed to escape. The remaining blood was aspirated from the pericardial space and totaled approximately 100 to 150 ml. Within 15 seconds following the evacuation of blood from the pericardium, vigorous myocardial contractions were apparent and the systemic blood pressure had returned to nearly normal levels. There was no evidence of bleeding from the puncture site in the left ventricular myocardium.

A Courmand needle was inserted into the apex of the left ventricle, and a shortened Afford catheter was passed again into the ventricular chamber. The left ventricular pressure was recorded as 191 mm. Hg. A needle was then placed in the left femoral artery and synchronous femoral arterial and left ventricular pressures were recorded. The
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systolic gradient across the aortic valve was recorded as approximately 90 to 100 mm. Hg, which was consistent with the patient’s clinical picture.

The postoperative course was uneventful. The intercostal catheter was removed on the first postoperative day and the patient was dismissed from the hospital on the third postoperative day ultimately to undergo aortic valvotomy with the aid of extracorporeal circulation.

**DISCUSSION**

Percutaneous left ventricular puncture to assess the presence and severity of aortic stenosis is a satisfactory procedure which, however, may have significant complications. In a consideration of the etiology of the pericardial tamponade, as occurred in this case, one must reflect on the factors of (1) the site of puncture of the chest and left ventricle, (2) the size of the puncturing needle, and (3) the length of time that the needle remained within the heart.

Considerable discussion has centered about the choice of the proper site for left ventricular puncture as well as for pericardiocentesis. Those who prefer the subxiphoid route claim that this route allows the heart to be punctured at its apex where the chance of coronary artery laceration with associated pericardial tamponade is minimal. They also think that the incidence of pneumothorax is lessened by use of the subxiphoid route. The subxiphoid route has been used by Ponsdomech, Gilman, Gregg, and McCaughan. Brock, Green, and Yu, however, have preferred an intercostal space in close proximity to the apex beat and have encountered no untoward complications directly related to this site of needle puncture. Previous experience with the procedure had led us to believe that use of an intercostal space as a puncture site was quite satisfactory and allowed ready and direct introduction of the needle into the left ventricle. Although coronary artery laceration would be a reasonable explanation for the occurrence of pericardial tamponade, such was not the case in the patient reported herein.

It seems reasonable that use of a large needle for puncturing the left ventricle would have more associated bleeding than would a smaller needle. We have used a no. 18-gage needle for percutaneous ventricular puncture. Our previous experience, and that of Brock and Green, utilizing the same size needles, had led us to believe that bleeding following left ventricular puncture by a needle of this size would not be of significance. Lehman and co-workers in describing the technic utilized by Gilman, reported the use of a no. 15-gage needle in their series without untoward effects directly related to the needle puncture. Ponsdomech, in his original series, used a trocar with an external diameter of 1.7 mm. for ventricular puncture. Nevertheless, it seems appealing to us to inerminate the needle size as being at least contributory to the pericardial tamponade.

Just how much significance can be attributed to the time a puncturing needle remains within the heart is difficult to ascertain. Admittedly, in the case here reported, the puncturing needle remained within the left ventricle considerably longer than is desirable. One can reason that a relatively fixed, rather large bore needle, penetrating a beating ventricular chamber in which the systolic pressure was markedly increased could have enough associated bleeding to cause tamponade if left in place for a long enough period of time. We must therefore consider that the prolonged time factor was of significance in the development of the tamponade.

Lastly, consideration of the management of the tamponade is in order. Although a fair case might well be presented for aspiration of the pericardial space, we think that thoracotomy and pericardiotomy were the procedures of choice. Immediate thoracotomy allowed rapid and total evacuation of the pericardial space. It further allowed direct visualization of the myocardial puncture site. Had persistent bleeding from the puncture site or from a coronary artery laceration been present, it could have been repaired surgically. In addition, if the existing bradycardia had progressed to asystole, or if the pericardial decompression had not resulted in effective myocardial contraction, the thoracotomy would have allowed intermittent manual compres-
sion of the heart to maintain effective circulation.

Although percutaneous ventricular puncture has been performed by various investigators with the aid of local anesthesia only, the use of general anesthesia was certainly of considerable aid in the management of the complication of tamponade herein reported.

We urge strongly that percutaneous left ventricular puncture should be carried out by persons who are aware of and experienced in the management of the complications that may develop. Percutaneous left ventricular puncture should be performed only in an environment well equipped for the immediate and proper management of such complications.

SUMMARY

A case is reported of pericardial tamponade that developed in association with percutaneous left ventricular puncture for the assessment of aortic stenosis. Possible etiologic factors and the management of the complication have been discussed.

SUMMARIO IN INTERLINGUA

Es reportate un caso de tamponade pericardial occurrente in association con percutanea punctura sinistro-ventricular effectuate in le evaluation de stenosis aortica. Es discutite le possibile factores etiologic e le tractamento del complication.
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