Further Evidence that the Pulmonary Capillary Venous Pressure Pulse in Man Reflects Cyclic Pressure Changes in the Left Atrium

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In four cases of atrial septal defect and in one case of mitral stenosis, the pressure pulse was recorded in the left atrium, in the first four cases through catheters, and in the fifth through a needle introduced through the chest wall. The pressure pulse was compared with pulmonary capillary pressure recorded simultaneously or nearly so. Good agreement was found both in shape and height of the two pressure pulses.

The pressure pulse obtained during right heart catheterization through a catheter in the pulmonary artery, when the catheter is wedged in one of the small branches (the pulmonary capillary venous position), has all the characteristics of a venous pulse.1 It has been inferred that the pulse wave thus obtained, in man, gives a fair index of the pulse in the left atrium. Results obtained on dogs, mostly with open chest, have led other authors to dispute these findings. The impossibility of obtaining a pulse wave through a catheter in the pulmonary capillary venous position in man, when the lungs are ventilated with positive pressure breathing,2 makes it improbable that any correct information can be obtained during thoracic surgery. It has not hitherto been possible to obtain the left atrial pressure pulse in cases with intact atrial septum, but several workers have demonstrated the possibility of direct puncture of the left atrium.3

The present report compares the pressure pulses obtained through catheters in the pulmonary capillary venous position and the left atrium respectively (four cases). In the fifth case, the left atrial pressure pulse was registered through a needle puncture.

MATERIAL

Four cases of interatrial septal defect and one case of mitral stenosis were studied. The diagnosis was established, in the cases with septal defect, from the history, x-ray appearance of the chest, and from the findings at heart catheterization. The history and x-ray findings in the fifth case were typical of mitral stenosis, but no murmur could be heard. The left atrium was punctured in order to establish the diagnosis.

METHODS

All pressures were recorded with an electrical capacitance manometer (Tybjærg-Hansen). The pulmonary capillary venous pressures were recorded as previously described. In cases with septal defect, the pressures in the left atrium or pulmonary veins were recorded through the heart catheter, in two cases simultaneously with the pulmonary capillary venous pressure, using two different catheters.

In the case with mitral stenosis, a pulmonary capillary venous pressure recording was made initially while the patient lay on her back. The catheter was then withdrawn to the pulmonary artery and the patient turned over on her right side. Subsequently the left atrium was localized under the fluoroscope with the aid of esophagus electrodes. After local anesthesia, the needle* was introduced 3 to 4 cm. to the right of the spinous process of the thoracic vertebra on the same level as the electrode, which gave the maximum P deflection in the electrocardiogram. The needle was directed slightly medi-ally alongside the spinal column, towards and past the esophagus. When the tip of the needle reached a point roughly 0.5 cm. past the electrode, a few atrial extrasystoles were observed on the electrocardiogram. As the needle was introduced another centimeter, blood could be drawn from the left atrium.

During the following seven minutes, several pressure recordings were made. The patient experienced

* Constructed by Åke Gidlund, M.D.
Table 1.—Hemodynamic Data in Five Cases in which Pulmonary Capillary Venous Pressure Was Compared with Left Auricular Pressure. In Case 602 LA Pressure Was Recorded through a Needle

<table>
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A.S.D. = Auricular septal defect.
M.S. = Mitral stenosis.
M = Mean pressures

* Before morphine-scopolamine administration.
† After morphine-scopolamine administration.

Fig. 1. Top: Simultaneous records of electrocardiogram, pulmonary venous pressure and left atrial pressure. Bottom: Same, except that the pressure pulse was recorded with the catheter in the pulmonary capillary venous position. (Case 228. A.S.D.)

Results

Table 1 lists the blood pressures in the left atrium, right atrium, pulmonary artery and pulmonary capillary veins in the five cases studied. Agreement between left atrial and mean pulmonary capillary venous pressures is close.

Figure 1 illustrates the pulmonary capillary venous and left atrial pressure pulses registered in one of the cases with atrial septal defect.

Figure 2 shows the pressure curves obtained
in the case with mitral stenosis. There is a good agreement between the left atrial and the pulmonary capillary venous pulse wave contour. During pulmonary capillary venous pressure recording, the patient lay on her back and during left atrial pressure recording on her side. Since the position of the recording manometer was not altered accordingly, the mean pressures are not comparable. The time lag between corresponding peaks is about 0.08 second corresponding to a pulse wave velocity of about 2 to 2.5 meters per second. This figure is well within the probable range of pulse wave velocity in a venous system.

**DISCUSSION AND CONCLUSIONS**

The concept that the pulmonary capillary venous pressure pulse reflects events in the left atrium was based on the fact that the pulmonary capillary venous tracing closely resembled a venous pulse. The large presystolic wave found in most cases of mitral stenosis in sinus rhythm gave further support to that concept, as this wave could only be produced in the left atrium. The origin of the pulmonary capillary venous pressure pulse has been challenged by physiologists working with animals.4,5

The tracings obtained in cases of atrial septal defects usually show few characteristics, and the comparison of the pulse waves yields little information. The pulmonary capillary venous pulse usually shows much larger and more characteristic deflections in cases with mitral stenosis or in left ventricular failure. In the present study, a comparison of the pulmonary capillary venous pressure pulse and the left atrial pulse obtained through direct puncture of the left atrium in a case of mitral stenosis demonstrated the great resemblance of the impulses. The pressure pulse obtained through the catheter naturally showed some artefacts.

**SUMMARY**

In four cases of atrial septal defect and in one case of mitral stenosis, the pressure pulse was recorded in the left atrium. In the first four cases this was done through catheters, and the fifth through a needle introduced through the chest wall. The pressure pulse was compared with pulmonary capillary pressure recorded simultaneously or nearly so. Good agreement was found both in shape and height of the two pressure pulses.

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