SEVERAL INTRACARDIAC SHUNTS and aortic lesions arising as a consequence of both blunt and penetrating injuries of the chest have been described. Prior reports have indicated the value of preoperative cardiac catheterization to assess unusual and complex intracardiac abnormalities after such trauma. Echocardiography has provided a new dimension to the diagnosis of congenital intracardiac shunts. The advantages of this technique for detecting traumatic disturbances of cardiac function have not been thoroughly explored.

We describe a right sinus of Valsalva-right atrial fistula secondary to nonpenetrating chest trauma. Noninvasive study with phonocardiography, echocardiography and external pulse tracings reveal the hemodynamic disturbance imposed by this lesion.

Case Report

A 17-year-old white male sustained severe blunt chest trauma in a motorcycle accident which resulted in fractures of the right wrist, left tibia, right patella and multiple bilateral fractures of the costal cartilages. Two days later, the patient developed acute retrosternal chest pain after the subjective sensation of a “pop” in his chest, and he collapsed. After admission to Good Samaritan Hospital, auscultation of the heart revealed a grade III/VI high-pitched systolic murmur along the left sternal border, followed by a loud decrescendo diastolic murmur at the same auscultatory area. The arterial blood pressure was 100/40 mm Hg in both arms, and the peripheral arterial pulses were bounding. The carotid pulse revealed a brisk upstroke, and there were prominent jugular venous a waves. Chest roentgenograms indicated a normal-sized heart with increased pulmonary vascularity. An ECG was normal. Representative phonocardiograms and pulse wave recordings are shown in figures 1A and 2A. The external jugular phlebogram showed large a waves and an attenuated y descent. An echocardiogram disclosed prominent diastolic fluttering of the anterior tricuspid valve leaflet (fig. 3A). Aortic angiography revealed a communication between the right coronary sinus and right atrium (fig. 4). Hemodynamic studies revealed elevation of the right-heart pressures (right atrium: peak a wave 12 mm Hg, peak v wave 10 mm Hg; right ventricle: systolic 35 mm Hg, end-diastolic = 18 mm Hg; pulmonary artery: systolic 30 mm Hg, diastolic 24 mm Hg; left ventricular end-diastolic 22 mm Hg, and mean pulmonary wedge pressures 22 mm Hg). The oxygen saturation in the superior vena cava was 69%, with a significant step-up to 82% at the lower right atrium. Open heart surgery disclosed a 6 mm diameter fistulous tract that opened into the right atrium; this fistula involved the right coronary cusp of the aortic valve just inferior to the right coronary ostium (fig. 5A and B). The aortic side of the tract was ragged, while the right atrial aspect was smooth. There was an incomplete intimal tear just above the aortic valve annulus which was posterior to the left coronary ostium; the latter measured 3 mm in depth and 1.2 cm in length. The aortic tear and fistulous tract were sutured, and the patient had an uncomplicated postoperative course. Repeat phonocardiograms, external
S.G.: 17 M. RT. SINUS of VALSALVA - RT. ATRIAL FISTULA

FIGURE 1. A) Preoperative high-frequency recording of the phonocardiogram in the mitral (MA), tricuspid (TA), pulmonary (PA) and aortic (AA) areas, along with the carotid artery pulse tracing (CT) and lead II (LII) of the ECG. Note the systolic (SM) and diastolic (DM) murmurs at the tricuspid and aortic areas. The carotid pulse tracing shows a brisk upstroke and conspicuous dicrotic notch (DN). 1 and 2 = first and second heart sounds. B) Postoperative phonocardiogram demonstrating absence of the diastolic murmur.

FIGURE 2. A) Preoperative low frequency recording of the phonocardiogram in the mitral (MA), tricuspid (TA), pulmonary (PA) and aortic (AA) areas, along with the external jugular venous tracing (JVT) and lead II (LII) of the ECG. The jugular venous tracing demonstrates a large a wave and attenuation of the y descent. B) Postoperative jugular venous tracing is normal.
Discussion

There is no precedent for a fistula between the right sinus of Valsalva and right atrium arising as a consequence of blunt chest trauma. The susceptibility of this anatomic site for such a defect should, however, be anticipated, since there is ample literature relating to congenital disturbances of heart septation and aortic media separation in the region of the aortic sinuses.\textsuperscript{3,7} The patient we describe had normal cardiac auscultation before this admission, which was well-documented in a previous hospital stay in June 1977. At that time the patient sustained multiple cervical fractures in a swimming pool accident.

Echographic evidence of tricuspid valve fluttering was especially noteworthy. Most ultrasonic studies of aortic sinus disease have been directed to detection of congenital Valsalva aneurysms and their com-

\begin{figure}[h]
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\caption{A) Preoperative echocardiographic recording of the tricuspid valve along with the lead II (LII) of the ECG and reference phonocardiogram. Note the prominent diastolic anterior tricuspid valve (ATV) flutter. B) Postoperative echocardiogram shows absence of tricuspid valve flutter.}
\end{figure}
Complications. Anterior tricuspid valve flutter has been associated with pulmonary valvular insufficiency, and is ascribed to the impact of regurgitant blood within the right ventricle. In patients studied after the Mustard operation for d-transposition of the great arteries and patients with ostium primum or secundum atrial septal defects, tricuspid valve flutter is considered a concomitant of shunted blood. Systolic flutter of the tricuspid valve has been described in congenital left ventricular-right atrial communication, and appeared on the display cathode ray tube (not photographically reproducible) along with early diastolic flutter in a case of ruptured aneurysm of the right sinus of Valsalva into the right ventricle associated with ostium secundum atrial septal defect and tricuspid insufficiency. In this latter subject a discontinuity of the anterior aortic wall near the right sinus was also observed. In the case we describe, we surmise that a jet of blood traversed the aortic fistula during diastole and flowed against the open anterior tricuspid valve leaflet, producing a distinctive flutter that disappeared after surgical repair of the lesion.

Study of the phonocardiograms and external pulse waves corroborated the clinical and echocardiographic findings. The carotid pulse tracing revealed high-amplitude systolic pulsations and a conspicuous dicrotic notch concurrent with systolic and diastolic murmurs on the phonocardiogram. The distinctive findings on the external jugular venous tracing can be explained by expected hemodynamic changes that occurred within the right heart chambers in our case. The giant a waves and shallow y descent were the result of atrial contraction against a fully distended chamber which was receiving blood from both the vena cava and the aortic fistula, which acted in a parallel physiologic fashion.

This case report emphasizes a unique cardiac lesion secondary to nonpenetrating trauma. Furthermore, the usefulness of noninvasive diagnostic studies is demonstrated for the evaluation of hemodynamic alterations produced by such lesions.

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