# Successful Closure of a Left Ventricular-Right Atrial Shunt *

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A DIRECT communication between the left ventricle and right atrium is a relatively uncommon defect. Familiarity with this anomaly has become increasingly important, however, since the preoperative findings may be identical with those of an atrial septal defect. Moreover, the defect may be so small that it is difficult to detect at operation and the validity of preoperative studies might be questioned if the possible occurrence of this anomaly were not considered. In 1949, Perry, Burchell and Edwards [1] reviewed the few cases which had been studied up until that time, all at autopsy. In 1955 Stahlman, Kaplan, Helmsworth, Clark and Scott [2] described two patients in whom surgical closure of the defect was attempted, one with the aid of an extracorporeal pump oxygenator and the other under hypothermia. The first patient died about 16 hours after operation and the second did not survive the operative procedure.

Recently we closed a left ventricular-right atrial shunt under hypothermia and the patient has made an uneventful recovery. Successful correction of this defect has not been previously reported, to our knowledge.

## CASE REPORT

G. J., a 15-year-old negro girl, was admitted to the Hospital of the University of Pennsylvania on Jan. 8, 1956 for study of a congenital heart lesion which the referring physician thought was a ventricular septal defect. Her parents had been told that she had a heart murmur at birth and it had been heard whenever her heart was examined. They were impressed with the fact that she had limited cardio-respiratory reserve and that she had become increasingly handicapped. Special arrangements were made to avoid climbing stairs when she was in the sixth grade because of easy fatigability and dyspnea. For several months prior to admission she had attacks of palpitation, during which the parents noted that her face became pale and her lips seemed to be blue in color. Swelling of the ankles was present on a few occasions. Her parents had considered taking her out of school because she was not able to keep up, physically, with the activities of her classmates.

On physical examination she appeared well and was slightly overweight. There was no cyanosis or clubbing of the fingers or toes. The blood pressure was 130/75 in both arms and slightly higher in the legs. A rough grade 3 systolic murmur was heard over the entire precordium and was loudest along the left sternal border, especially in the 3rd left interspace. It was not continuous and could not be heard posteriorly. A grade 2, blowing diastolic murmur was heard in the pulmonic area. There were no palpable thrills, and no other unusual physical findings.

Chest x-rays and cardiac fluoroscopy showed moderate cardiac enlargement, involving principally the right atrium and right ventricle. The size and pulsations of the hilar vessels were within normal limits. On the ECG, the P-R interval was normal, but there were slight abnormalities of the

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P waves and the QRS complexes. There were S waves in all leads but the medial chest leads did not show tall R waves. These changes were interpreted as representing a form of right ventricular predominance. The hemoglobin was 15.5 Gm. and the hematocrit was 49. All other laboratory studies, including blood urea nitrogen and prothrombin, were within normal limts.

Cardiac catheterization showed a definite rise in the $O_2$ saturation in the right atrium, and a slight elevation of pressure in the right ventricle and pulmonary artery. A defect in the atrial septum or an anomalous pulmonary vein could not be found with the catheter tip, despite thorough exploration. The essential findings on cardiac catheterization were as follows:

| | Pressure | Percentage of Oxygen Saturation |
|---|---|---|
| Left Pulmonary Artery | 38/17 | 77.5% |
| High Right Ventricle | 36–40/5.3 | 77.4% |
| Low Right Ventricle | 44.9/7.3 | 77.9% |
| Right Atrium | 6.9/1.3–3.8 | 79.4% |
| Superior Vena Cava | | 66% |
| Femoral Artery | | 94.3% |

Her parents were told that she had an atrial septal defect and the possibility of surgical repair was discussed with them. The patient and her parents were so impressed with the seriousness of her symptoms that they were quite anxious to go ahead with operation.

The operation was performed on January 18, 1956. Cooling blankets were applied after the patient had been anesthetized and the rectal temperature was carried down to 32° C. The patient was then placed in the lateral position and the right chest was entered through the 5th intercostal space, the 5th and 4th costal cartilages being divided to obtain adequate exposure. The temperature drifted down to 30.2°. The appearance of the right atrium, right ventricle and pulmonary outflow tract was compatible with a diagnosis of atrial septal defect. A systolic thrill was palpable at the junction of the inferior vena cava and right atrium postero-laterally. After a suitable dissection was performed to expose the right atrium and pass hernia tapes around the cavae, digital exploration was carried out through the right atrial appendage. It quickly became apparent that the patient did not have an atrial septal defect of moderate size, as anticipated, and the foramen ovale was completely sealed. Careful systematic palpation was then carried out, and a jet of blood was felt coming through a small opening just cephalad to the coronary sinus with each ventricular contraction. The defect was not large enough to admit the tip of the index finger. This occurred simultaneously with the systolic thrill at the junction of the inferior vena cava and right atrium. In order to obtain additional confirmation, a #12 plastic catheter was passed through the right atrial appendage and guided with the index finger into the defect. When the catheter was advanced for a short distance bright red blood began to spurt from its proximal end under arterial pressure, making it evident that the left ventricle had been entered. A sample of this blood was found to have an arterial oxygen saturation of 97 per cent in contrast to 71 per cent for the right atrial blood.

Since the defect was so small it seemed unlikely that it could be obliterated with certainty by a closed technic. The closure was therefore carried out under direct vision, with the cavae being occluded for three minutes and 20 seconds. When the atrium was opened, bright red blood was seen to spurt from the defect which is shown diagrammatically in Figure 1. A figure-of-eight suture of #0 silk closed the defect completely. After the caval tapes were released there was transient atrial flutter but the blood pressure rapidly returned to pre-occlusion levels and the remainder of the operative procedure and recovery period were uncomplicated. At 6:00 A.M. on the third postoperative day there was an episode of chest pain and

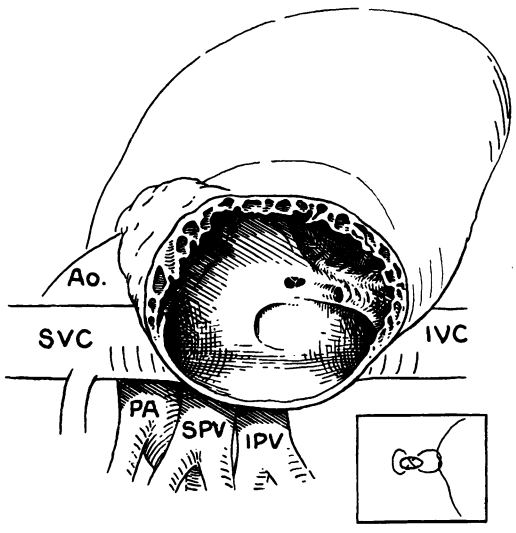


FIG. 1. This shows, diagrammatically, the approximate size and location of the left ventricular-right atrial shunt as seen at operation, with the right atrium open. The defect is the black oval-shaped area cephalad to the coronary sinus. White strands of tissue are seen passing across it. The figure-of-eight suture is shown in the inset.

apprehension which raised the question of a small pulmonary embolism which might have originated from a blood clot on the atrial suture. Intramuscular heparin was administered for 10 days. The remainder of the postoperative course was uneventful and the patient was discharged on the 21st postoperative day. She has continued to feel well since going home and has had none of the symptoms which led to her admission to the hospital.

## COMMENT

This defect was so small that it could be recognized with relative certainty only by very careful palpation. If the possibility of such a small communication carrying a considerable amount of blood were not considered, it might easily have been missed. Palpation of the systolic jet was most helpful in deciding that an abnormal communication had been found.

Lacking autopsy confirmation, it cannot be stated categorically that this patient had a left ventricular-right atrial shunt, rather than a small inter-atrial septal defect. The evidence favoring the former diagnosis seems quite convincing, however, the principal arguments being the harsh quality of the systolic murmur, the severity of the symptoms with such a small defect, the force of the systolic jet palpable within the right atrium, and the passage of the plastic catheter into the left ventricle through the defect.

This patient was somewhat older than the children operated upon by Stahlman, Kaplan, Helmsworth, Clark and Scott.[2] She was in the same age group, however, as some of the patients reported by Perry, Burchell and Edwards.[1] The onset of severe symptoms and of pulmonary hypertension is probably related to the size of the defect and also to its location. If there is significant distortion of the medial leaflet of the tricuspid valve with tricuspid regurgitation, symptoms would almost certainly develop earlier in life. We believe that our patient did not have a significant deformity of the triscuspid valve.

## SUMMARY

A left ventricular-right atrial shunt was successfully closed with a single figure-of-eight suture through a right atriotomy, with inflow occlusion under hypothermia. This defect was so small that it could not be recognized with certainty except by palpating the jet of blood passing through it during systole. The importance of considering this anomaly in patients with presumed atrial septal defects whose operative findings seem atypical has been discussed.

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