Thrombo-Embolic Complications of Ventriculo-Atrial Shunts
Angiocardiographic and Pathologic Correlations*

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There have been several recent reports outlining the numerous complications of the Spitz-Holter or Pudenz-Heyer ventriculo-atrial shunt procedure for hydrocephalus.1,11,13,15,16,18 Notable among these is the necropsy-based report of Emery and Hilton,7 on the cardiac and pulmonary complications in 15 patients. All but 1 of their patients had multiple pulmonary emboli; 5 cases had thrombosis around the distal end of the catheter, 6 had thrombus formation on the wall of the right atrium (partly occluding the tricuspid valve in 2 cases), and 2 had massive pulmonary thrombosis. Similar complications have been noted by others.

After finding a large, unsuspected intracardiac thrombus on the atrial end of the shunt tubing at the autopsy on one of our patients, we felt that angiocardiology would be of value in identifying similar thrombi in patients treated with the Spitz-Holter valve. This paper is the report of the results of angiocardiology performed on 11 children, 10 asymptomatic, of a series of 26 with hydrocephalus. Seven of the 26, including 2 evaluated by angiocardiology, were studied at necropsy. These combined studies uncovered thrombo-embolic lesions in 11 children (42 per cent).

Angiocardiac Evaluation—Clinical Material

Of the 11 children studied by angiocardiology, 6 had myelomeningoceles, 1 had a meningoele, and two had communicating hydrocephalus of undetermined etiology; in 1 the process followed bilateral subdural hematoma, and 1 was associated with an encephalocele. The Holter valve shunt tube had been in place for periods of time ranging from 4 to 28 months. The 1 patient with symptoms prior to study had clinical evidence of intermittent obstruction of the tricuspid valve. The other patients were studied in the course of their readmission to the hospital for the evaluation of an enlarging head, or because on palpation the valve did not appear to be working properly, or for revision of a distal catheter which was too high in the superior vena cava as visualized by the chest x-ray. Three asymptomatic patients were called in for the sole purpose of doing the angiogram.

Angiocardiac Evaluation—Results

The angiocardiac data is summarized in Table 1.

Superior Vena Cava Obstruction (2 patients). In one this was complete and in the other partial. Each had developed marked venous collaterals (Fig. 1).

Thrombi in the Superior Vena Cava (4 patients). In 1 of these a laminated thrombus 5 cm. long was present in the superior vena cava (Figs. 2 and 3).

Thrombi in the Right Atrium (2 patients). In one a large pendulous thrombus could be visualized on the angiogram swinging in and out of the tricuspid valve orifice. This patient had symptoms of intermittent pulmonary blood flow obstruction, i.e., tetrad spells (Fig. 4).

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Lesions visualized in 11 angiograms on 11 patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients with lesions</td>
<td>6</td>
</tr>
<tr>
<td>Superior vena cava obstruction</td>
<td>2</td>
</tr>
<tr>
<td>Thrombi in superior vena cava</td>
<td>4</td>
</tr>
<tr>
<td>Thrombi in right atrium</td>
<td>2</td>
</tr>
<tr>
<td>Thrombi in lung fields</td>
<td>2</td>
</tr>
<tr>
<td>Evidence of pulmonary hypertension</td>
<td>1</td>
</tr>
</tbody>
</table>

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Complications of Ventriculo-Atrial Shunts

FIG. 1. Angiocardiogram following injection into right median basilic vein. The superior vena cava (SVC) is completely obstructed (arrow). Collateral flow is via vertebral veins and the azygous vein (AZ).

**Thrombi in the Lung Fields** (2 patients). One child had marked pulmonary hypertension (70/44 mm. Hg), an enlarged pulmonary artery and the typical “pruned tree” appearance of pulmonary hypertension (Fig. 5). This child currently has intractable right heart failure. Another patient showed no contrast filling of the right lower pulmonary artery indicating occlusion of this vessel. (Fig. 6). Pulmonary artery pressures were normal in 6 other patients.

The patient with intermittent obstruction of the tricuspid valve due to the atrial thrombus underwent cardiotomy with removal of the thrombus. This stopped the attacks, but the patient subsequently died from unrelated complications.

Thoracotomy was also performed on a patient with a superior vena cava thrombus. This proved to be a sessile clot 2.0X0.8 cm. rather firmly attached to the wall of the vessel.

**Autopsy Examination**

Postmortem examination was performed on 7 children who had had a Holter valve in place for periods of time ranging from 16 days to 9 months. All of these patients had myelomeningoceles and all but 1 had an exposed neural plate (rachischisis).

Two of these cases had angiocardiograms performed prior to death. The roentgen findings were confirmed in one. In the other patient, a 6 mm. filling defect in the superior vena cava was not identified at postmortem examination. However, there was a scarred area in the vena cava where the filling defect

FIG. 3. Sessile clot in upper superior vena cava (SVC) partially occluding this vessel. PT = pulmonary trunk.

FIG. 2. Brachial angiocardiogram reveals laminations throughout the extent of the superior vena cava (arrows). RA = right atrium. PT = pulmonary trunk.