The authors present eight cases of an unusual mechanical complication of ventriculoatrial shunts that has not been reported previously. In these eight patients, the metal parts of the valve slipped into the silicone casing. Although the cause is not completely clear, there are simple ways of preventing this from happening.

**Key Words** • shunt complication • valve • hydrocephalus

Considerable technical progress has been achieved with shunts since the first implantation was performed in 1949. Nevertheless, technical defects account for 20% of all shunt complications. The most frequent problems are disconnection of shunt components and valve dysfunction. In 1980, Zander and Campiche observed three cases in which the metal section of a Holter valve had been pulled out of the silicone casing. We have observed the opposite phenomenon over the last 3 years. In eight cases, the distal or proximal metal part of the valve slipped further into the silicone casing. This complication, which to the best of our knowledge has not been reported previously, occurred with both Holter and Hakim shunts.

**Summary of Cases**

Our eight patients were aged 2 to 53 years (Table 1). The valve invagination was observed three times with the Holter system for children, twice with Holter system for adults, and three times with Hakim adult shunts. The period between detection of the invagination and the last proven correct shunt function (indicated by new implantation or x-ray examination) varied from 3 days to 4 years. Five patients were symptom-free, and the invagination was discovered at routine x-ray checks. In six cases the distal part of the valve migrated, in one the proximal part, and in one both parts slipped (Figs. 1, 2, and 3).

The shunts were implanted in three surgical departments using different techniques. In five cases, the valve was connected to the atrial catheter, pulled from the neck incision to the forehead subgaleally through a small incision behind the ear, and then connected to the ventricular catheter. In three cases, the connection between the valve and the atrial and ventricular catheters was made under a large parietal skin flap.

**Discussion**

Displacement of the metal parts of the valve into the silicone tube is uncommon. Zander and Campiche observed three times that the valve had separated, that is, the distal part had been pulled out of the silicone casing. We noted invagination in eight cases: in six the distal section, in one the proximal section, and in one both sections had slipped into the silicone casing. This complication is due to the loose fit of the metal valve in the silicone casing (Fig. 4).

Five of our patients exhibited signs of raised intracranial pressure. This happened with all three patients shunted with Hakim valves, although this type of valve cannot be disconnected from the proximal or distal drain by invagination. On the other hand, the Holter valves were always disconnected by the invagination; in four cases disconnection was from the atrial drain and in one from the ventricular drain (Table 1). Only two of the five patients with Holter valves had signs of raised intracranial pressure; the other three had some preservation of shunt function due to the formation of a fibrous sheath along the shunt.

The separation can be simply explained by the traction forces exerted in the ventricular or atrial catheter end of the valve; however, the cause of invagination remains unclear. There was no evidence of external impact or manipulation in our cases. Tests on the valves after they had been removed led us to
FIG. 1. Complete invagination of a Holter adult valve. The atrial catheter is disconnected and the distal metal part of the valve has slipped into the silicone casing (arrow).

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs)</th>
<th>Type of Valve</th>
<th>Part Invaginated</th>
<th>Primary Disease</th>
<th>Surgical Technique</th>
<th>Time to Detection*</th>
<th>Symptoms of Shunt Malfunction†</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>Holter valve for adults</td>
<td>heart catheter</td>
<td>meningitis, hydrocephalus</td>
<td>subcutaneous lifting of valve</td>
<td>2 yrs 8 mos</td>
<td>none</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>Holter valve for children</td>
<td>heart catheter</td>
<td>communicating hydrocephalus, uncertain</td>
<td>subcutaneous lifting of valve</td>
<td>1 yr 6 mos</td>
<td>increased ICP</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>Holter valve for children</td>
<td>ventricular catheter</td>
<td>meningitis, hydrocephalus</td>
<td>subcutaneous lifting of valve</td>
<td>1 yr 3 mos</td>
<td>increased ICP</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>Holter valve for adults</td>
<td>both devices</td>
<td>myelocoele, hydrocephalus</td>
<td>flap of skin, no lifting of valve</td>
<td>4 yrs 7 mos</td>
<td>none</td>
</tr>
<tr>
<td>5</td>
<td>53</td>
<td>Hakim valve for adults, 60 to 80 mm Hg pressure on outlet</td>
<td>heart catheter</td>
<td>sphenoid meningioma with subdural shunt for subdural hygroma</td>
<td>subcutaneous lifting of valve</td>
<td>3 mos</td>
<td>increased ICP</td>
</tr>
<tr>
<td>6</td>
<td>40</td>
<td>Hakim valve for adults, 60 to 80 mm Hg</td>
<td>heart catheter</td>
<td>hydrocephalus</td>
<td>lifting of valve</td>
<td>3 days</td>
<td>increased ICP</td>
</tr>
<tr>
<td>7</td>
<td>37</td>
<td>Hakim valve for adults, 60 to 80 mm Hg</td>
<td>heart catheter</td>
<td>ependymoma of posterior part of cranial fossa, hydrocephalus</td>
<td>flap of skin, no lifting of valve</td>
<td>4 yrs 6 mos</td>
<td>increased ICP</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>Holter valve for children</td>
<td>heart catheter</td>
<td>communicating hydrocephalus, uncertain</td>
<td>flaps of skin, no lifting of valve</td>
<td>11 mos</td>
<td>none</td>
</tr>
</tbody>
</table>

* The time from implantation or the last proven correct shunt function (determined by x-ray examination) to detection of the invagination.
† ICP = intracranial pressure.
Invagination of ventriculoatrial shunt valves

Fig. 2. Partial invagination of a Hakim adult valve. The distal metal part of the valve has slipped into the silicone housing. Small arrow shows the empty silicone casing; large arrow indicates the metal casing pushed inward.

Fig. 3. Complete invagination of a Holter valve for children. Upper: Lateral view showing the invaginated valve and disconnected atrial catheter. The child had clinically raised intracranial pressure. Lower: The removed valve showing the metal casing within the silicone cases.

Fig. 4. Comparison of the method of fixing the metal casing with old and new Holter valves. a: Old Holter valve, fixed across two grooves with threads. The silicone casing is cylindrical. b: New Holter valve, fixed across one groove by stretching of the silicone casing without threads. The silicone casing is tapered at the end.
believe that a sudden decrease in traction force on a part of the valve (such as by slipping of a taut atrial catheter) can cause the metal part to slide into the silicone casing. Regardless of the pathological mechanism, it should be possible to prevent this complication by improving the connection between the metal valve and the silicone casing, such as with ligatures.

References


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