New Technique for the Creation of an Atrial Septal Defect

Masayoshi YOKOYAMA, M.D.

SUMMARY

A safe and simple surgical technique for the creation of an atrial septal defect was described. This procedure has advantages that ASD can be created without any interruption of the pulmonary circulation and that atrial septum can be seen directly before being excised.

Additional Indexing Words:
Blalock-Hanlon procedure

A surgical treatment in the complete transposition of the great vessels, the Blalock-Hanlon procedure has been widely performed to increase the right-to-left shunt by creating the atrial septal defect (ASD). Transposition of the great vessels is not a rare anomaly as it accounts for 8 per cent of all congenital heart disease.

Most authors admit that the Blalock-Hanlon procedure has shown notable clinical improvements in patients with this congenital anomaly; however, the procedure requires pulmonary veins to be clamped, which may induce postoperative pulmonary congestion or edema in severely ill patients.

Therefore, we devised a new method to create ASD without clamping the right pulmonary veins by using a small vinyl bag inserted into the right atrium.

METHODS

Nine mongrel dogs weighing 8–12 Kg. were anesthetized with intravenous pentothal and an endotracheal tube attached to a respirator was inserted. A right thoracotomy was performed through the forth intercostal space. The pericardium was opened longitudinally posterior to the right phrenic nerve, and was lifted up to the thoracic muscles. The right pulmonary veins were isolated to some extent to make sure of the anatomical location of the left atrium. Starting at the entrance of the inferior vena cava, a purse-string suture with an elliptical shape was placed on the right atrium along the atrial septum (Fig. 1). Through this purse-string suture, the plastic ring with the vinyl bag was introduced into the right atrial

From the Heart Institute Japan Tokyo Women's Medical College, 10 Kawada-cho, Shinjuku-ku, Tokyo.
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177
Fig. 1. Elliptical purse-string suture was placed on the right atrial wall along the lower atrial septum. Four 2-O silk sutures were also placed for the traction of the right atrial wall. Another small purse-string suture was added on the left atrium, through which the probe was inserted to push the atrial septum towards right side.

Fig. 2. Horizontal and lateral view of the instrument. Plastic ring is 0.5 cm. high, 1.8 cm. in long external diameter and 1.2 cm. in short external diameter. The lateral wall of the ring is concave to fit the purse-string suture tightly. Plastic ring has a small handle. Vinyl bag is transparent and 2.5 cm. in depth.

chamber. As shown in Fig. 2, the plastic ring is elliptical in shape, and the vinyl bag is transparent. This small instrument was kept in heparin solution prior to being used.

The purse-string suture on the right atrium was tied tightly after the instrument was placed into the right atrial chamber. A second purse-string suture was placed around the plastic ring in the event it did not fit tightly to the right atrial wall.
The limbus fossae ovalis as it faced the inferior vena cava could be well delineated by the artery forceps through the vinyl bag.

A probe covered with PE tube 240 (Fig. 3) was inserted into the left atrium and served to push the atrial septum to the right side (Fig. 4) to make contact with the vinyl bag. The probe to push the septum towards the right side should be blunt as those with sharp tips or small diameter easily penetrate the atrial septum.

The septum could be seen clearly through the transparent vinyl bag. The atrial septum as well as the probe were clamped by an artery forceps through the vinyl bag. To create ASD, the contents of the vinyl bag (the atrial septum and the tip of the probe) were excised with the plastic ring. Before the resection of the septum, the vinyl bag was filled with saline to prevent air from entering into the right atrium.

The size of the resected atrial septal piece was examined to assess the adequacy of the ASD. If the piece was not big enough, an artery forceps was inserted along the probe into the right atrium as well as the left atrium, and enlarged ASD by tearing the atrial septum.

The instrument was taken out after the purse-string suture around the ring was cut off. The probe in the left atrium was also taken out. The incision in the right atrial wall was clamped and repaired with a running suture. The chest was closed with a chest tube left in place.

Fig. 3. Probe. The metal probe was covered with PE 240 tubing. The tip of the tubing was curved and flattened, to be easily clamped from the right atrial side.

Fig. 4. The instrument was introduced into the right atrium near the septum, while the probe was inserted into the left atrium.
RESULTS

A considerable portion of atrial septum was excised in all cases, varying from 0.8 to 1.4 cm. in diameter (Table I). Even if the resected piece of the atrial septum was about 1.0 cm. in diameter, actual size of ASD was more than 1.5 cm. in diameter. This was attributed to rapid shrinkage of the tissue following removal.

In cases 2 and 3, plastic ring came out of right atrial wall during the procedure, because the purse-string suture around the ring was not tied tightly. A second purse-string suture was placed to insure that the plastic ring would fit tightly to the right atrial wall if the first appeared to fit loosely.

All of 9 dogs operated upon recovered from anesthesia within 9

Table I

<table>
<thead>
<tr>
<th>Case</th>
<th>The size of removed atrial septum</th>
<th>The size of ASD</th>
<th>Fossa ovalis</th>
<th>Thrombi</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.8 × 0.8 cm.</td>
<td>1.0 × 1.2 cm.</td>
<td>excised</td>
<td>none</td>
</tr>
<tr>
<td>2</td>
<td>0.0 × 0.8 cm.</td>
<td>0.6 × 0.6 cm.</td>
<td>not excised</td>
<td>none</td>
</tr>
<tr>
<td>3</td>
<td>1.0 × 1.0 cm.</td>
<td>0.5 × 0.5 cm.</td>
<td>not excised</td>
<td>present</td>
</tr>
<tr>
<td>4</td>
<td>1.4 × 1.0 cm.</td>
<td>1.7 × 1.7 cm.</td>
<td>excised</td>
<td>none</td>
</tr>
<tr>
<td>5</td>
<td>1.0 × 1.0 cm.</td>
<td>2.0 × 2.0 cm.</td>
<td>excised</td>
<td>none</td>
</tr>
<tr>
<td>6</td>
<td>1.0 × 1.0 cm.</td>
<td>1.3 × 1.3 cm.</td>
<td>excised</td>
<td>none</td>
</tr>
<tr>
<td>7</td>
<td>1.0 × 1.0 cm.</td>
<td>0.5 × 0.5 cm.</td>
<td>not excised</td>
<td>present</td>
</tr>
<tr>
<td>8</td>
<td>1.2 × 1.0 cm.</td>
<td>2.2 × 2.2 cm.</td>
<td>excised</td>
<td>none</td>
</tr>
<tr>
<td>9</td>
<td>1.0 × 0.8 cm.</td>
<td>2.0 × 2.0 cm.</td>
<td>excised</td>
<td>present</td>
</tr>
</tbody>
</table>
hours, which suggested no severe air embolism in the brain of the animals. All dogs did well in the postoperative period, and were sacrificed 4 weeks after surgery to examine the size of the ASD.

In 3 cases out of 9, the fossa ovalis was not excised in creating ASD with the result being a small septal opening with diameter of several millimeters. The fossa ovalis was included in the created ASD in the remaining cases, and these showed satisfactory size of ASD, varying from 1.2 to 2.2 cm. in diameter. Thus, the inclusion of the fossa ovalis in the resected atrial septum appeared to be very important in keeping ASD patent for an extended time period.

In cases 3, 7 and 9, thrombi were noted in the cut surface of the atrial septum. In cases 3 and 7, the thrombosis developed so markedly that the created ASD was almost occluded. Case 9 demonstrated a large ASD and several small thrombi on the cut surface of atrial septum. Thrombosis easily started from the cut surface of atrial septum when the latter was thick. Because of the thickness of the atrial septum (2–3 mm.), the removal of the posterior superior portion thereof would not result in a sizable, long-term patent ASD as would be the case following removal of the paper-thin fossa ovalis.

**DISCUSSION**

The creation of ASD has been tried by many investigators in addition to Blalock and Hanlon. Though various ways have been reported, most of them require blind technique to create ASD. Open heart or direct vision must be the most reasonable approach but the patients are usually too sick to survive these procedures. As the Blalock-Hanlon method has seemed to be most ideal clinically, we practiced the original procedure in animals prior to our present experimental series. Thus, some disadvantages of the Blalock-Hanlon procedure might be described as follows: (1) Occlusion of right pulmonary veins must be performed for several minutes at least, although skillful surgeons might insist 2 min. are sufficient. (2) ASD is created only in the posterior-superior part of atrial septum, and it is difficult to excise a portion of the fossa ovalis. Therefore, narrowing of ASD as well as development of thrombosis might occur postoperatively. (3) Even in normal dogs, tachycardia always develops when a large part of right atrium is clamped.

Because of the severity of illness among candidates for this procedure, complete clamping of the right pulmonary veins and partial clamp of the right atrium should be avoided if possible.

Atrial septal defects which consists of slits, regardless of length, heal spontaneously within a short time. Therefore, a part of atrial septum must be excised for the defect to remain patent. And we also believe that healing
and narrowing of the created ASD tend to occur when the defect is made only in the posterior superior portion where the septum is thick. As mentioned earlier, postoperative thrombosis easily starts from the cut surface of the thick atrial septal muscle, but rarely develops from the cut surface of thin fossa ovalis.

Our technique for creating ASD is very simple and easy, and should circumvent most of the disadvantages of the original Blalock-Hanlon procedure.

In our present experiments, the tip of the probe, the atrial septum and a part of the vinyl bag were cut out by scissors. However, using an instrument similar to a "Laminectomy Roger", the atrial septum could be punched out more easily.

References

7. Leeds, S. E.: In the discussion of Swan’s paper.6