Division of Patent Ductus Arteriosus
by "Isthmus Taping Method"

YUZURU KAGAWA, KOICHI TABAYASHI, NAOSHI SATO and
TOGO HORIUCHI

Department of Thoracic and Cardiovascular Surgery,
Tohoku University School of Medicine, Sendai 980

KAGAWA, Y., TABAYASHI, K., SATO, N. and HORIUCHI, T. Division of Patent Ductus Arteriosus by "Isthmus Taping Method". Tohoku J. exp. Med., 1981, 133 (4), 365-370 — "Isthmus taping method" as the safe and simple technique for division of patent ductus arteriosus (PDA), along with surgical and follow-up results were reported. 175 patients with PDA and without other cardiac anomalies were operated by this technique. Most of the patients were operated by junior surgeons as a first step in cardiac surgery. The left chest was entered through posterolateral thoracotomy in the third or fourth intercostal space. Tapes were placed around the isthmus of aorta and PDA. Intercostal arteries were not divided. PDA was divided in-between Potts' clamps. Pulmonary and aortic stumps of the PDA were closed with two rows of continuous over and over suture. Of the 175, one patient (0.6%) with pulmonary hypertension died of postoperative respiratory failure. No surgical hazards of bleeding were noted. No deaths were noted among 131 patients without pulmonary hypertension. Follow-up results in 174 patients up to 14 years were excellent.

Surgical treatment for patent ductus arteriosus (PDA) is now widely accepted as a safe method since first successful surgery reported by Gross and Hubbard (1939). The results are now excellent except for the patients associated with pulmonary hypertension or other congenital cardiac anomalies.

Though the mortality rate of the patients without pulmonary hypertension or other congenital cardiac anomalies is now as low as less than 1.0% (Jones 1965; Epsino-Vela et al. 1968; Iriyama et al. 1976; Tabayashi et al. 1978), it is still difficult to reduce the mortality rate to nil because of potential hazards of surgical bleeding.

Ligation, division, Porstmann's procedure (Porstmann et al. 1967) and transpulmonary closure (Gonçalves-Estella et al. 1975) have been used as the surgical treatment for PDA. Concerning excellent results in recent years, division of the PDA should be utilized as the standard technique to avoid complications such as recanalization (Gross 1947; Krovetz and Warden 1962; Oldham et al. 1964; Jones 1965) or aneurysm (Ross et al. 1961). Furthermore, as surgery for PDA is very often done by junior surgeons as a first step in cardiac surgery, the

Received for publication, July 28, 1980.
most simple and safe technique should be utilized to avoid surgical hazards and postoperative complications.

From this point of view, we have been utilizing the division of PDA with some modifications as a routine technique since 1966 (Horiuchi 1967).

The purpose of this paper is to describe the “isthmus taping method” as the safe and simple technique for division of the PDA along with the surgical and follow-up results.

**Subjects**

Since 1958, surgical treatments for the PDA were carried out for 388 patients which consisted of 123 males and 265 females. The number of the patients according to the age distribution is shown in Fig. 1. The patients associated with complex cardiac anomalies such as tetralogy of Fallot and transposition of the great arteries were excluded. Of the 388, 63 patients were associated with other simple cardiac anomalies such as ventricular septal defect, coarctation of the aorta or congenital valvular disease (Table 1) and were excluded from this study. The remaining 325 patients without other cardiac anomalies (simple PDA) were divided into two groups according to the presence of pulmonary hypertension (PH) with Pp/Ps ratio more than 0.4. Group A comprised 246 patients without PH, and Group B 79 patients with PH (Table 2). As to the surgical procedure, 175 patients (54%) underwent division of the PDA using the “isthmus taping method”. Surgical techniques for other patients were ligation (87 patients, 26%) which was done before 1966, Porstmann’s procedure (61 patients, 19%) and transpulmonary closure (2 patients, 0.6%) for the patients with severe PH and the extremely dilated pulmonary artery.

![Fig. 1. Numbers of the patients according to the age distribution.](image-url)
Surgery for Patent Ductus Arteriosus

TABLE 1. Number of cases

<table>
<thead>
<tr>
<th>Simple PDA</th>
<th>Other cardiac anomalies</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VSD</td>
<td>Co/Ao</td>
</tr>
<tr>
<td>Number of cases</td>
<td>325(4)</td>
<td>36(5)</td>
</tr>
<tr>
<td>Mortality (%)</td>
<td>1.2</td>
<td>14</td>
</tr>
</tbody>
</table>

**TABLE 2. Surgical results according to the presence of PH and types of surgery in simple PDA**

<table>
<thead>
<tr>
<th>Types of surgery</th>
<th>Group A (without PH)</th>
<th>Group B (with PH)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division</td>
<td>131(0)</td>
<td>44(1*)</td>
<td>175(1)</td>
</tr>
<tr>
<td>Ligation</td>
<td>66(0)</td>
<td>21(92)</td>
<td>87(3)</td>
</tr>
<tr>
<td>Porstmann’s procedure</td>
<td>49(0)</td>
<td>12(0)</td>
<td>61(0)</td>
</tr>
<tr>
<td>Transpulmonary closure</td>
<td>0</td>
<td>2(1)</td>
<td>2(1)</td>
</tr>
<tr>
<td>Total</td>
<td>246(0)</td>
<td>79(4)</td>
<td>325(4)</td>
</tr>
<tr>
<td>Mortality rate (%)</td>
<td>0</td>
<td>5</td>
<td>1.2</td>
</tr>
</tbody>
</table>

**PH**, pulmonary hypertension.
Numbers in parentheses indicate numbers of deaths.
* See text.

**Surgical Procedure**

With the patient in right lateral position, the left chest was entered through the left posterolateral thoracotomy in the third or fourth intercostal space. Extrapleural approaches were used for the infants. The parietal pleura was divided along the descending aorta, extending from the left subclavian artery to the point two to three finger breadths below the PDA (Fig. 2A). Anterior

Fig. 2. Taping of PDA.
A: The parietal pleura was divided extending from the left subclavian artery to the point two to three finger breadths below the PDA.
B: Tape was placed around the isthmus of aorta.
C: Heavy black silk was placed around the PDA.
Ao, aorta; LSA, left subclavian artery; PA, pulmonary artery.
Y. Kagawa et al.

Fig. 3. Division of PDA.
A: Two Pott's clamps were applied to the center of PDA.
B: PDA was divided after two additional clamps were applied laterally.
C: In a case associated with short PDA and aneurysmal dilatation of the aortic end, the isthmus was temporarily occluded before applying Pott's clamp.
D: Pulmonary stump of the PDA was closed.
E: In a case of bleeding from the aortic stump, the isthmus was temporarily occluded and a Pott's clamp was applied.
F: Hemostasis was obtained with single mattress suture of #4-0 Prolene.

aspect of the PDA was separated from surrounding structure using sharp dissections. Starting from the upper edge of the PDA, isthmus of the aorta was separated and an umbilical tape was placed around it (Fig. 2B). Pulling this tape gently upwards, posterior surface of the PDA was separated and a heavy black silk was placed around it (Fig. 2C). Pulling the umbilical tape around the isthmus and black silk around the PDA upwards gently, the PDA was separated thoroughly from the surrounding tissue using sharp and blunt dissections. The recurrent nerve was completely visualized after this procedure. Intercostal arteries were not divided. Two Pott's clamps were applied to the center of the PDA (Fig. 3A). PDA was then divided after two additional clamps were applied laterally (Fig. 3B). Temporary occlusion of the ishtmus was helpful when the PDA was short and aneurysmal dilatation of the aortic end of the PDA was noted (Fig. 3C). After division of the PDA, Pott's clamp at the central portion of the pulmonary stump was removed. The pulmonary stump was then closed with two rows of continuous over and over suture of #4-0 Tevdek or Prolene (Fig. 3D). After closure of the pulmonary stump, Pott's clamp was removed and the stump was pressed down gently using a small peanuts sponge. With this procedure, excellent visualization for the closure of the aortic stump was obtainable. The aortic stump of the PDA was closed in the same manner as pulmonary stump. In cases associated with bleeding from the
aortic stump, the isthmus was temporarily occluded using the umbilical tape and a keeper, and Pott's clamp was applied (Fig. 3E). Hemostasis was obtained using single mattress suture of #4–0 Prolene (Fig. 3F).

RESULTS

There were four deaths (1.2%) in all 325 patients with simple PDA. Of 175 patients who underwent division of PDA by this technique, one patient (0.6%) who belonged to Group B died of postoperative respiratory failure (asterisks in Tables 2, 3). There were neither deaths nor surgical hazards of bleeding among 131 patients in Group A.

<table>
<thead>
<tr>
<th>Table 3. Cause of early death</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>LOS</td>
</tr>
<tr>
<td>Respiratory failure</td>
</tr>
<tr>
<td>Cardiac arrest</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

LOS, low cardiac output syndrome.
* See text.

During follow-up period, two recanalizations were noted among the patients who underwent ligation of the PDA. Dislocation of the plugs following infection was noted as the late complication of Porstmann's procedure in two patients. Of the two, one patient died of pulmonary embolization. On the contrary, follow-up results were excellent in the patients who underwent division of the PDA by this technique.

DISCUSSION

Most of division of the PDA by this technique was done by junior surgeons as a first step in cardiac surgery. In this series, mortality rate was 0% in the patients without PH and 5% in the patients with PH. Even in the patients associated with other cardiac anomalies, mortality rate of 0% in the group without PH was in marked contrast to that of 22% in the group with PH. From this finding, it should be emphasized that surgical treatment for the PDA should be done before the occurrence of PH (Rittenhouse et al. 1976).

The most important problem regarding the surgical treatment for simple PDA is now to reduce the mortality rate to nil. For this purpose many attempts have been made for a long time. We utilized ligation of PDA till 1966 and two recanalizations were noted among these patients. From this experience, we are now using division of the PDA as the routine technique.

Mortality rate of the patients operated by this technique was 0% in 131 patients in Group A. One death in 44 patients in Group B was attributable to PH.
From this finding, it could be emphasized that the “isthmus taping method” is a safe technique for the division of the PDA.

References


