An Innovative Thoracoscopic Surgery for Patent Ductus Arteriosus: A Japanese First Case Report

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A 5-year-old girl with patent ductus arteriosus (PDA) was successfully treated by thoracoscopic surgery, which was the first successful case in Japan. The operation was carried out under general anesthesia with the usual endotracheal intubation. Short trocars were inserted through the left intercostal spaces to introduce a flexible video thoracoscope and adequate surgical instruments. After the ductus was carefully dissected and exposed, two titanium clips, 11 mm in length, were applied to interrupt the ductus completely. The continuous heart murmur of PDA disappeared, as confirmed by an esophageal stethoscope. Postoperative course was uneventful and the patient was discharged on the 6 postoperative day. Eighteen months after surgery, no residual PDA shunt was revealed by doppler echocardiogram. The advantages of thoracoscopic surgery for PDA are less postoperative pain and discomfort, early recovery and short hospital stay, and cosmetic preservation. Availability of smaller sized surgical instruments should allow smaller children or newborns with PDA to be treated with this method.

Since laparoscopic cholecystectomy has achieved widespread use, there has been a remarkable progress in endoscopic surgical techniques in the various fields of surgery. The development of improved operative instruments has broadened the indications of endoscopic surgery. We recently performed thoracoscopic surgery in a child with PDA in which the outcome was successful. As this PDA case appears to be the first experience with thoracoscopic surgery in Japan, a detailed case report is presented.

CASE REPORT

The patient was a 5-year-old girl (weighing 24 kg) with PDA who was born prematurely. She developed asthmatic bronchitis repeatedly and had been admitted to the hospital 4 times before the age of 5. Preoperative color Doppler echocardiography revealed PDA. Digital subtraction angiography (DSA) of the left pulmonary artery revealed a left-right shunt, 6 mm in diameter at the maximum, communicating from the descending aorta to the pulmonary artery (Figures 1A and 1B). Cardiac catheterization showed a Qp/Qs ratio of 1.3.

Operation: The patient was placed in the right lateral decubitus position and the operation was performed under general anesthesia with endotracheal intubation. We used an electron thoracoscope 10 mm in diameter (Fujinon), which is flexible only in the front end where a CCD camera is mounted. The operative instruments employed included a short trocar for the introduction of treatment instruments, graspers for endoscopic surgery, scissors, lung retracting forceps, a spatula-shaped high-frequency electrocautery, and a clip applier (Figure 2). Titanium clips 6, 9, and 11 mm in length (closed) were used. A trocar 10 mm (inside diameter) was initially inserted into the left 7th intercostal space on the posterior axillary line and a thoracoscope was introduced through the trocar to perform the operation under visual monitoring of the thoracic cavity. A lung-retracting forceps was introduced through a trocar inserted from a site about 2 cm anterior to the 7th intercostal anterior axillary line, and the lung was retracted anteriorly and inferiorly to expose the entire field of the descending aorta and the aortic arch (Figure 3). To insert a trocar for the introduction of surgical instruments from an optimal site, a needle was inserted into the thoracic cavity and the location of the trocar was determined thoracoscopically (Figure 4). The surgical procedure was the same as that used for open chest surgery for PDA. The mediastinal pleura over the upper part of the descending thoracic aorta was incised and then dissected from the peripheral side of the opening of the arterial duct toward the aortic arch, and the mediastinal pleura was dissected up to the site, allowing the aortic arch and the origin of the left infraclavicular artery to be seen. The hemiazygos vein was then dissected and divided after clipping (Figures 5A and 5B). The left edge of the mediastinal pleura divided over the descending aorta was retracted to the left with a clip forceps to expose the ductus. Using a spatula-shaped electrocautery, dissecting forceps, and a pusher, the anterior side and lower edge of the arterial ductus were bluntly dissected with care to avoid injuring the left recurrent laryngeal nerve running behind the mediastinal pleura. The upper edge of the ductus was dissected with particular care, exposing the entire ductus (Figures 6a and 6b). After the ductus was completely exposed, two 11-mm titanium clips were set onto the ductus so as to interrupt the ductus completely (Figures 7a and 7b). The clips were confirmed to be set over the entire width of the arterial ductus. After clipping the duc-

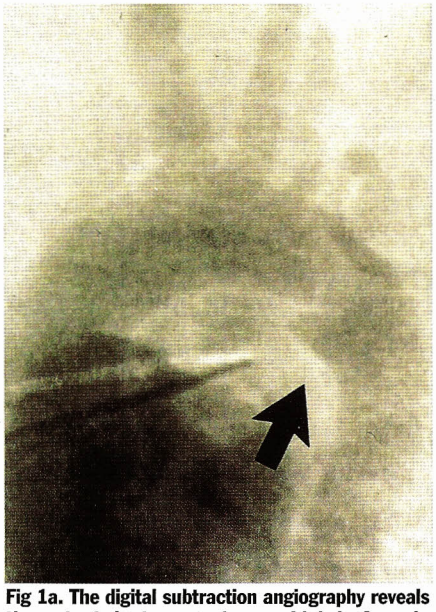

Fig 1a. The digital subtraction angiography reveals the patent ductus arteriosus which is 6mm in diameter.

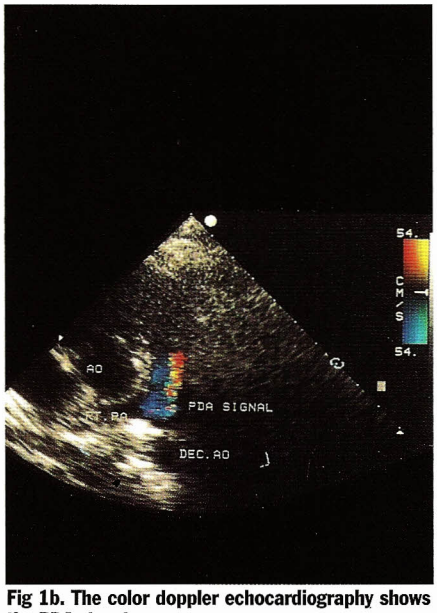

Fig 1b. The color doppler echocardiography shows the PDA signal.

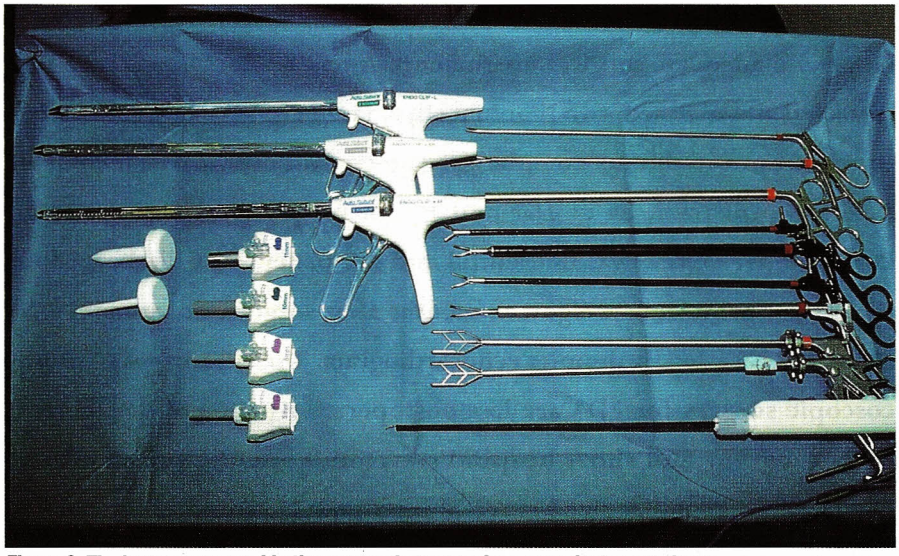

Figure 2. The instruments used in thoracoscopic surgery for patent ductus arteriosus.

tus, the disappearance of the continuous heart murmur associated with PDA was confirmed by esophageal stethoscope. The dissected mediastinal pleura over the descending thoracic aorta was closed with a clip, and a 10-Fr thoracic drain was inserted from the site of thoracoscope introduction. The skin at the sites of the other trocar introductions was sutured with a plastic surgery technique. There was virtually no blood loss during this surgery.

Postoperative course: The patient took an evening meal orally on the day of operation and the thoracic drain was removed the next morning. Her postoperative pain was minor and she could walk on the 1st postoperative day. She was confirmed to be free of the relapse of asthmatic bronchitis postoperatively and was discharged on the 6th postoperative day. Color Doppler echocardiography performed in the 18 months after surgery revealed no residual shunt. Presently (24 months postoperatively), the patient is attending elementary school and is in good health.

DISCUSSION

Traditionally, thoracotomy has been performed in the treatment of PDA. The first non-open chest surgery for PDA was performed in 1966 by Porstmann et al.,[1] initially using a transvascular catheter for closure of the arterial ductus. Transcatheter technique for the closure of PDA has since been performed in Japan as well.[2] Porstmann's method was modified by Rashkin et al.[3] in 1987, and the modified method has been used clinically in the United States, Canada and Japan. However, because transvascular catheter method for PDA involves the risk of release and embolization of the closure plug and residual shunt, there are certain inherent limitations with this technique.[4]

On the other hand, endoscopic surgery has become widespread in various fields of surgery since it is a less invasive technique. We have also successfully performed laparoscopic cholecystectomy in more than 400 patients since July 1990. Recently, we also performed laparoscopic and thoracoscopic surgery in the esophagea, lungs, stomach, duodenum, colon, and adrenal glands. Since December 1990, to prepare for the clinical application of thoracoscopic ductus interruption for the treatment of PDA, we have repeatedly trained on animals. After the study was fully explained to the patient's family members and informed consent was obtained, thoracoscopic surgery for arterial ductus interruption was carried out in a girl patient with PDA on July 25, 1992, the first such procedure in Japan. The first report in the world of the thoracoscopic surgery for PDA in infants and children was published by Laborde et al.[5] in 1992.

The advantages of thoracoscopic arterial ductus interruption include outcomes that are comparable to that with open-chest surgery in the treatment of PDA: minor operative invasion, minor postoperative pain, and quick postoperative recovery compared with open-chest surgery. In addition, this technique avoids a major disfiguring scar, which is significant because this disease is more common in girls and thus helps with cosmetic appearance and psychological development.

Considerable experiences in cardiovascular surgery as well as endoscopic surgery are necessary for surgeons to perform thoracoscopic arterial ductus closure. With the present method, a high-power operative field is seen on a monitor by using a high-resolution thoracoscopic camera, and therefore,

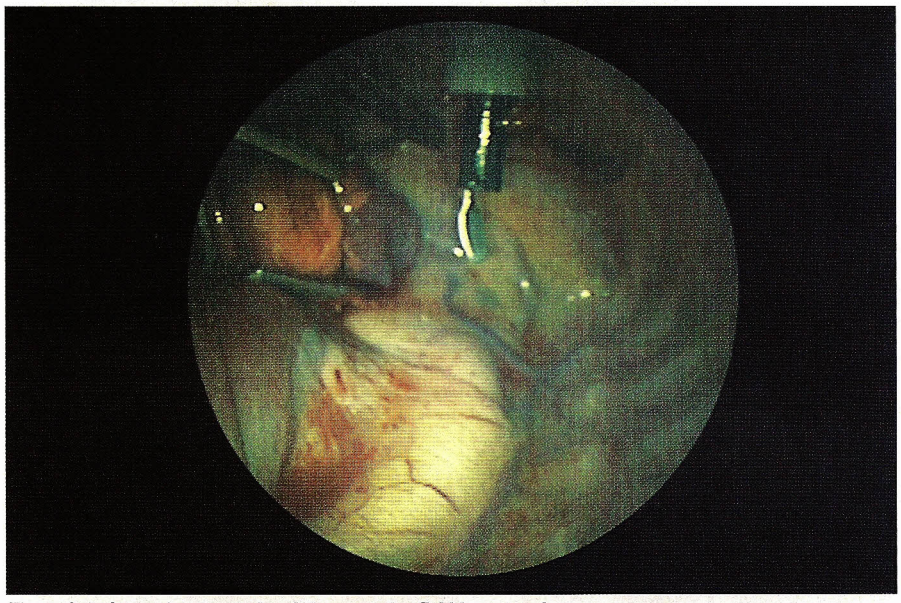

Figure 3. Left lung is retracted and the operative field is exposed.

Figure 4. The location of 5 trocars insertion.

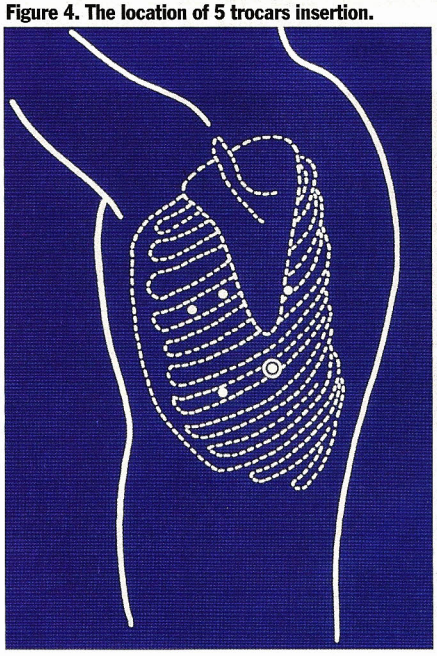

Figure 4a. Schema.

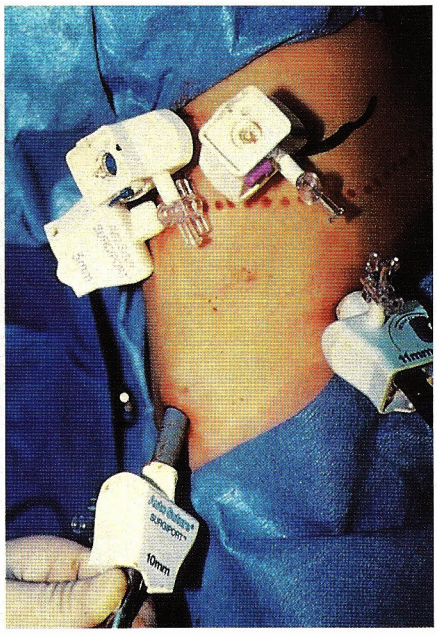

Figure 4b. Photo in operating room.

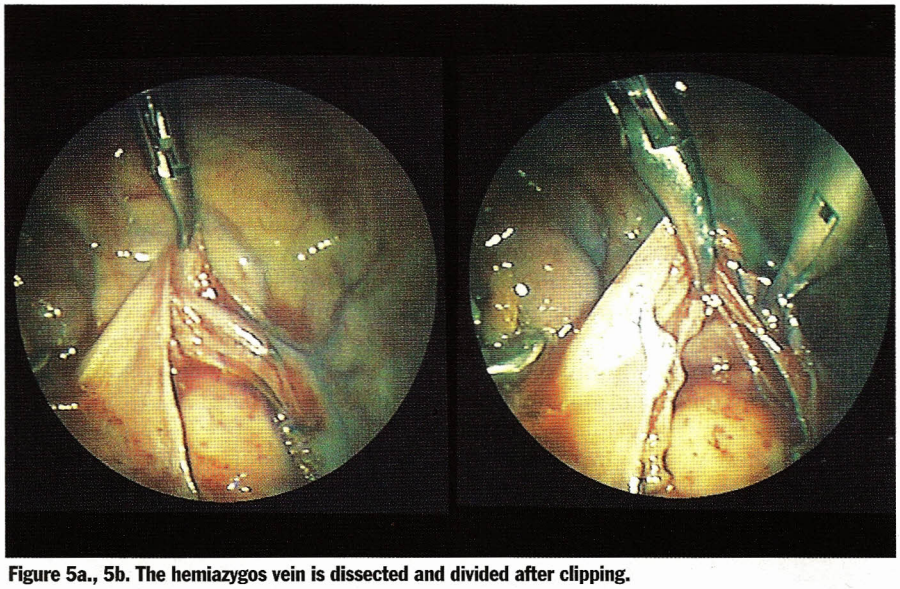

Figure 5a., 5b. The hemiazygos vein is dissected and divided after clipping.

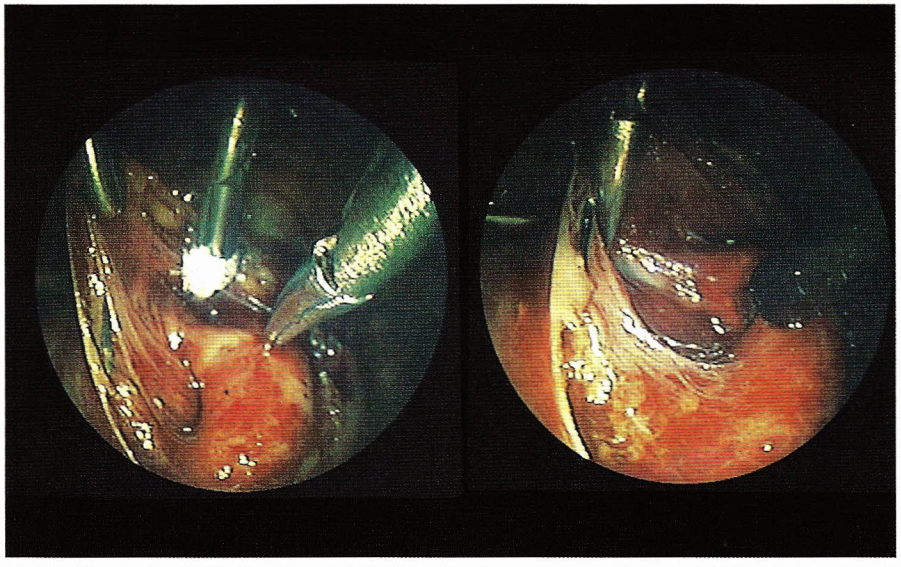

Fig 6a. The ductus is bluntly dissected by dissecting forceps or small gauze. 6b. The lower edge of ductus is carefully dissected by a spatula shaped elctrocautery.

Fig 7a. Titanium clip is applied onto the ductus. 7b. Two titanium clips are in place on the ductus.

the operative field on the screen is even more precise than that of the macroscopic operative field. Thus, with proper endoscopic surgical techniques, the injury of the left recurrent laryngeal nerve and other operative complications can be avoided. Also, the possibility of intraoperative bleeding, which may be the greatest risk associated with thoracoscopic dissection of the ductus, can also be ruled out since blunt dissection is performed very slowly while monitoring a high-power field. Therefore, this procedure is considered to be adequately safe. However, incomplete dissection, particularly in the upper edge of the arterial ductus, and not clipping the entire ductus (resulting in incomplete closure of the patent ductus) are associated with a very high risk. It is important, therefore, to confirm that both ends of the arterial ductus are completely dissected before clipping. With clipping of the arterial ductus, as used in the present technique, the ductus is blocked in a line, not at a point. Thus, the risk of hemorrhage after the blockade is smaller than with point blockade produced by the ligation method. Although the arterial ductus tissues are somewhat fragile, the present technique is safe provided that the indication of the present technique is limited to infants and children, whose ductus is free of calcification and is not fragile.

Of course, it is also necessary to be prepared for an emergent thoracotomy and transfusion. Iatrogenic bleeding and the possibility of thoracotomy should, after all, also be explained to the patient's family members before obtaining consent for this technique.

Arterial ductus blockade using clipping has been performed at many institutions by thoracotomy for PDA in premature newborns and infants as well as during open-heart surgery for congenital heart disease accompanied by PDA. No problems associated with clipping have been reported even in long-term follow-up. However, the possibility of recanalization after clipping may have to be investigated further in the future by carefully monitoring long-term post-operative cases.

In adult patients with calcification of the arterial ductus, clipping should not be used both with thoracotomy and thoracoscopic surgery. More experiences with this technique are needed, as is the development of better instruments

before the present technique can be indicated for all patients with PDA. STI

CONCLUSIONS

Thoracoscopic closure of the arterial ductus was performed in a 5-year-old girl with PDA with a successful outcome. This was the first experience with thoracoscopic surgery for PDA in Japan. The present technique provides a useful therapeutic approach to the treatment of PDA since it is less invasive than the conventional open-chest surgery. Improvement of operative instruments is necessary in order to expand the indications for thoracoscopic surgery to allow clipping for all patients with PDA.

After the submission of the present case report for publication, we also successfully performed thoracoscopic surgery in 7 additional patients with PDA (20 months to 6 years in age).

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