One-Lung Ventilation for Video-Assisted Thoracoscopic Interruption of Patent Ductus Arteriosus

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Abstract

Purpose. Video-assisted endoscopic techniques have recently been employed in congenital heart surgery for patent ductus arteriosus (PDA) interruption. We report our preliminary experience of using a new technique of single-lung ventilation to perform video-assisted thoracoscopic PDA interruption (VATS-PDA) in small infants and children.

Methods. Sixteen infants with a mean body weight of 6.5 ± 2.4 kg (range 2.6–12.8 kg) underwent VATS-PDA under selective right-lung ventilation using a 2-F balloon catheter for arterial embolectomy.

Results. We did not need to reposition the retractor or reinflate the atelectatic lung, as there was no transient hypoxia or hypercarbia. The mean procedure time was 81 ± 27 min (range 45–145 min) and all patients, with the exception of one with a total anomalous pulmonary venous connection, were extubated in the operating room.

Conclusion. This technique using single-lung ventilation for infants and small children was safe and effective in providing pediatric thoracic access and exposure within confined and delicate anatomic spaces.

Key words Video-assisted thoracoscopy · Patent ductus arteriosus · One-lung ventilation

Introduction

Video-assisted thoracoscopic surgical techniques are now commonly used to improve anatomic visualization and reduce surgical trauma in general thoracic and cardiovascular surgery.1 In the field of congenital heart surgery, video-assisted endoscopic techniques have been described for patent ductus arteriosus (PDA) interruption3,4 and vascular ring division.5 The success of these procedures demonstrates the efficacy of video-assisted thoracoscopy in providing pediatric thoracic access and exposure within confined and delicate anatomic spaces.

Single-lung ventilation with a double-lumen endotracheal tube has been widely used in video-assisted thoracoscopic surgery (VATS) for adult patients because it provides enough space to allow the surgeon to perform fine and precise procedures in a limited thoracic area. This technique is not applicable for pediatric VATS procedures because the double-lumen endotracheal tube is unsuitable for a small trachea; however, a single-lung ventilation technique using a single-lumen endotracheal tube for pediatric VATS has been described.6-8 We report our preliminary experience of using this new technique of single-lung ventilation to perform video-assisted thoracoscopic PDA interruption (VATS-PDA) in small infants and children.

Patients and Methods

Patient Demographics (Table 1)

Between April 2001 and September 2003, we placed 16 infants under selective one-lung (right lung) ventilation using a balloon catheter for arterial embolectomy (2F, Vasutech, Burlington, MA, USA), to perform VATS-PDA. The mean body weight of these infants was 6.5 ± 2.4 kg (range 2.6–12.8 kg) and their mean age was 11.8 months (range 1.1–33.3 months). The size of the PDA was 5.7 ± 1.1 mm (range 4–7 mm), and the preoperative pulmonary blood flow/systemic blood flow ratio was 3.4 ± 2.8 (range 1.4–11.2). Patient 7 was a 1-month-old baby boy diagnosed with a large PDA and a total anomalous pulmonary venous connection (TAPVC,
supracardiac type). He had no pulmonary venous obstruction and the PDA was about 6 mm in diameter. For this infant, we planned to perform a palliative VATS-PDA to control the pulmonary blood flow before complete repair.

Technique of Selective Right-Lung Ventilation

The airway size and anatomy of each patient were carefully assessed before surgery. Patients were intubated with the appropriate-size single-lumen endotracheal tube. A balloon catheter for arterial embolectomy was inserted through the endotracheal tube and advanced into the left main-stem bronchus with fiberoptic guidance. The balloon was inflated with air to occlude the left main stem bronchus, establishing selective right-lung ventilation. Routine monitoring included transcutaneous oximetry, electrocardiography, and blood pressure via an arterial line in the lower extremities.

Surgical Technique

After the induction of general anesthesia, the patient was placed on the right side, then prepped and draped in the usual fashion. Four small incisions (12, 5, 5, and 4 mm, respectively) were made into the pleural space bluntly, and trocars were inserted. A 4 mm 30° angled videoscope was advanced into the pleural space, providing good visualization. After deflation of the left lung, the left upper lobe was mobilized medially with an expandable retractor, resulting in excellent exposure of the aortic arch (Fig. 1). The parietal pleura, overlying the duct, was elevated with grasping forceps, and a cautery dissector was used to incise the pleura and make a flap. The upper and lower duct angles were dissected without skeletonizing the duct, and the recurrent nerve was moved medially. When the upper and lower borders were free, the appropriate-sized vascular clip was advanced through the posterior incision, but not through a trocar, and placed around the duct, parallel to the aorta. Clip size was chosen to completely encircle the duct to avoid impaling the wall. Real-time transesophageal echocardiography (TEE) was used to confirm complete interruption of ductal flow as the clips were applied. The aorta and left pulmonary artery were also evaluated by TEE while the patient was still in the operating room. If TEE showed persistent ductal flow, a second clip was placed. The instruments were removed and a single chest tube was advanced to the apex. The occlusion balloon was deflated and the left lung was re-expanded. After re-expansion, the chest tube was removed. The patients were extubated in the operating room and transferred to the general ward.

Results

We successfully established selective one-lung ventilation, allowing us to complete the VATS procedure in all 16 patients, including a 1-month-old baby weighing 2.6 kg with TAPVC. The mean lowest arterial oxygen saturation (SaO₂) during the VATS procedure was 98.3% ± 1.3% (range 97%–100%) in the 15 patients other than the baby with TAPVC. The SaO₂ in this cyanotic baby remained at around 85% throughout one-lung ventilation. Repositioning of the retractor or