

Video-Assisted Thoracoscopic Division of Vascular Rings

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This study reports our early experience with thoracoscopic division of vascular rings. Three patients were reviewed; their ages at surgery were 25 months, 4 years, and 57 years. All patients were suffering from complete vascular rings involving combinations of the right aortic arch, left ligamentum arteriosum, Kommerell's diverticulum, and retroesophageal left subclavian artery. The median surgical time was 180.5 minutes, and the patients showed immediate recovery. Three complications, namely chylothorax, transient supraventricular tachycardia, and left vocal cord palsy, were observed. Our early experience indicates that thoracoscopic division of a vascular ring may provide early recovery and could be a promising operative choice.

Key words: 1. Vascular ring
2. Aorta, Thoracic/abnormalities
3. Thoracic surgery, Video-Assisted

CASE REPORT

Vascular rings have traditionally been managed surgically through an open thoracotomy approach. Thoracoscopic division of a vascular ring was first described in 1993, and since then, it has become a popular surgical approach in the western countries [1-4]. Here, we present our early experience of thoracoscopic division of a vascular ring over a 1-year period.

From December 2012 to July 2013, three patients underwent video-assisted thoracoscopic (VATS) division of their vascular ring. Their ages at operation were 25 months, 4 years, and 57 years, and their weights were 13.5 kg, 14.2 kg, and 76 kg, respectively (Table 1). All of them complained of compressive esophageal or respiratory symptoms relevant to their vascular rings. The 25-month-old boy had been suffering from recurrent respiratory tract infection since birth.

Bronchoscopy revealed external tracheal compression, and subsequent computed tomography found a complete vascular ring involving the right aortic arch and retroesophageal ligamentum arteriosum with Kommerell's diverticulum (type 2 right aortic arch) (Fig. 1A). The 4-year-old boy complained of dysphagia lasting three years. The vascular ring was discovered incidentally during the evaluation of Kawasaki disease by echocardiography when the patient was four years of age. Subsequent computed tomography revealed a complete vascular ring similar to that in the case of the 25-month-old boy (Fig. 1B). The 57-year-old woman also suffered from dysphagia, particularly when swallowing solid foods. Esophagogastroduodenoscopy performed at another institution revealed an external esophageal compression. Computed tomography revealed a complete vascular ring involving the right aortic arch, left ligamentum arteriosum, and retro-

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Table 1. Patients' demographic data

Characteristic	Patient 1	Patient 2	Patient 3
Sex/age	Male/25 mo	Male/4 yr	Female/57 yr
Weight (kg)	13.5	14.2	76
Symptom	Recurrent respiratory infection	Dysphagia	Dysphagia
Diagnosis	Right aortic arch, left ligamentum arteriosum, Kommerell's diverticulum	Right aortic arch, left ligamentum arteriosum, Kommerell's diverticulum	Right aortic arch, left ligamentum arteriosum, retroesophageal left subclavian artery
Operation time (min)	206	155	217
Extubation time (hr)	6.5	1	In the operating room
Intensive care unit stay (day)	1	3	0
Hospital stay (day)	4	6	3
Feeding (hr)	15	8	6
Postoperative complication	Left vocal cord palsy	Chylothorax	Transient supraventricular arrhythmia
Symptom improvement	Steady	Immediate	Immediate

Median operation time: 180.5 min, thoracotomy conversion: no, intraoperative complication: no.



Fig. 1. Preoperative computed tomograms of vascular rings. (A) 22-month-old boy with right aortic arch and left ligamentum arteriosum with Kommerell's diverticulum. (B) 4-year-old boy with right aortic arch and left ligamentum arteriosum. (C) 57-year-old woman with right aortic arch, left ligamentum arteriosum, and retroesophageal left subclavian artery.

esophageal left subclavian artery. The esophagus was stuck between the trachea and the left subclavian artery (Fig. 1C). In all three patients, neither intracardiac nor extracardiac anomalies were found to be associated with the cases based on echocardiography.

Operations were performed via VATS (Fig. 2). Patients were placed in the right lateral decubitus position. Standard two-lung ventilation was used, except for the 52-year-old woman, who was capable of single-lung ventilation alone. Four trocars were then placed; 5-mm trocars were placed through the 4th to 6th intercostal spaces, and a 5-mm 30° thoracoscope was used, or 10-mm trocars were placed through the 4th to 6th intercostal spaces, and a 10-mm 30° thoracoscope was used in the adult patient. The posterior mediastinal pleura was opened, and the anatomy of the ring was

confirmed. Once the dissection was completed, clips were placed across the ligamentum arteriosum, and the ligamentum arteriosum was divided. Any atretic arch or Kommerell's diverticulum was divided by the endoscopic vascular stapler or divided after double clipping. Any residual fibrous bands and ring elements along the esophagus and the surrounding structures were divided or lysed to open the ring completely.

The operation time ranged from 155 to 217 minutes (median time, 180.5 minutes). There were neither thoracotomy conversions nor intraoperative complications during the operation. The patients were extubated in the operating room or immediately after the operation in the intensive care unit (ICU) (at 1 hour and 6.5 hours) (Table 1). The length of the ICU stay ranged from 0 to 3 days and that of the total hospital stay from 3 to 6 days. Feeding was started on the

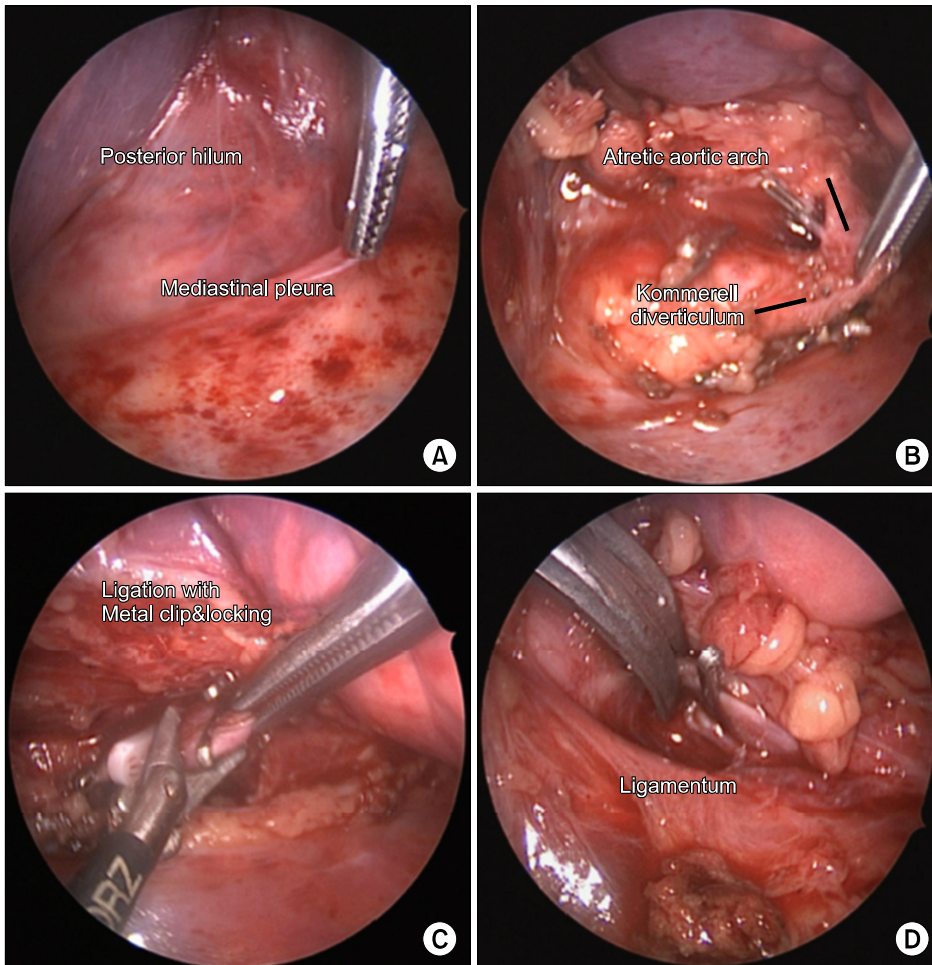


Fig. 2. Thoracoscopic surgical procedures. (A) The posterior hilum and mediastinal pleura are exposed. (B) The atretic aortic arch and Kommerell's diverticulum are identified. (C) Ligation of Kommerell's diverticulum with a metal clip and a locking clip into its proximal portion. (D) Ligamentum division after ligation with metal clips.

day of the operation, 6 to 15 hours postoperatively. The 4-year-old patient presented with a chylothorax complication after surgery but recovered after 2 days of a no-fat diet. His symptom improvement was immediate, and he is currently doing well without any residual symptoms identified at regular outpatient follow-ups. The 25-month-old boy expressed hoarseness when he cried after extubation. What was originally thought to be laryngeal edema was found to be left-sided vocal cord palsy by laryngoscopy performed 1 month later at the outpatient clinic. Follow-up laryngoscopy confirmed the improvement of his vocal cord function after 3 months. His respiratory symptoms showed steady resolution; the frequency of respiratory infection was markedly decreased. The 57-year-old woman showed transient supraventricular tachycardia (atrial fibrillation and atrial tachycardia) 2 days after the operation, but this condition resolved spontaneously. Otherwise,

in her case, the improvement of the swallowing symptom was immediate, with the patient reporting no complaints of the symptom during the regular outpatient follow-ups.

DISCUSSION

The first successful division of the double aortic arch was reported by Dr. Gross in 1945 [5]; since then, vascular ring surgery has been performed using a thoracotomy approach. The operative results have markedly improved, and most of the symptomatic patients undergoing the division of the vascular ring compartment have reported an improvement in their symptoms [6].

However, concerns about compromised respiratory mechanics, postoperative pain syndrome, and chest wall deformities after the open thoracotomy approach have been raised. In par-

ticular, post-thoracotomy scoliosis and shoulder muscle dysfunction may be more pronounced in the pediatric population, where rapid growth could exaggerate a post-thoracotomy-induced imbalance in the chest wall mechanics. These problems have led the founders to consider a less traumatic approach, namely the VATS division of a vascular ring [1].

Thoracoscopic surgery has recently gained popularity because of the relatively less intense early postoperative pain, early improvement of respiratory mechanics, and results similar to the postoperative outcomes of a thoracotomy approach. The thoracoscopic approach has been widely applied to pulmonary resection and mediastinal surgery. Avoiding muscle division and rib spreading, thoracoscopic surgery may also be beneficial in the pediatric population.

The principle of operation of the thoracoscopic approach is not different from that of an open thoracotomy approach for vascular ring division. The division of the ligamentum arteriosum or atretic arch segment, or both, and the release of the encircling fibrous bands are mandatory to completely relieve the patient of vascular ring-related tracheoesophageal constriction [5]. Patient selection based on computed tomography or magnetic resonance imaging is essential to identify the precise anatomy of a vascular ring [7]. Currently, thoracoscopic surgery is applicable to patients with non-patent ring segments (an atretic arch or a ligamentum arteriosum, or both), which comprise the majority of vascular rings as in our case series described above [5].

Whether the thoracoscopic approach offers a significant benefit over open thoracotomy in the case of this condition is still unclear. Previous reports are insufficient to demonstrate the benefits of the thoracoscopic approach. Recently, Kogon et al. [7] compared the thoracoscopic approach (n=14) with the open thoracotomy approach (n=15). They found that there were no differences in procedure time, length of ICU stay, or total length of hospital stay. This is the largest series ever reported in this field of study; however, they could not com-

pare the functional outcomes of respiratory mechanics, which was originally the cause of the adoption of the thoracoscopic approach. Nevertheless, we believe that thoracoscopic approach may offer an alternative for selected patients because of its simplicity and theoretical advantage. Complications could be minimized and rather long operation time could be shortened as our experience accumulates. Here we report the first experience of thoracoscopic division of vascular rings in Korea.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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