COMPANION OR PET ANIMALS

Thoracoscopic hilar lung lobectomy in two dogs

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BACKGROUND

This report aimed to describe the surgical procedure and outcome of thoracoscopic hilar lung lobectomy in two dogs with a solitary pulmonary emphysema. Both patients were positioned in left lateral semirecumbency, where the angle formed between the median plane and the operating table became approximately 45°. Three ports were placed in the third, fifth and seventh intercostal spaces at the level of the costochondral junction. The thoracoscope was inserted toward the base of lobe; the blood vessels and bronchi branching to the lung lobe were bluntly dissected from the lung lobe and surrounding connective tissues and were closed using intracorporal ligation, ligating loop and/or clipping. Hilar lung lobectomy was completed by dissection. Both patients had no postoperative complications. Thoracoscopic hilar lung lobectomy without staplers was feasible in small-sized dogs where the right medial lobe had congenital emphysema. The patient's position and portal formation were suggested to be important for this procedure.

CASE PRESENTATION

Case 1, a neutered male toy poodle, 18 months of age and weighing 4.6 kg, was presented with main complaints of cough, sudden onset of dyspnoea and sputum production after becoming listless 2 weeks previously.

Case 2, an intact male Pomeranian, 3 years of age and weighing 4.7 kg, was presented due to a decline in energy and dyspnoea.

INVESTIGATIONS

In case 1, serum alanine aminotransferase concentration was elevated (120 U/l); however, there were no other abnormalities found on the blood test. The X-ray and CT revealed a collapsed pneumothorax in the right lung and multiple emphysemas measuring approximately 15.1 x 7.1 x 5.6~59.3 x 46.3 x 32.7 mm throughout the right middle lobe (figure 1).

In case 2, the blood test showed no abnormalities. A pneumothorax and multiple emphysemas measuring approximately 9.5 x 13.0 x 6.2~10.0 x 25.4 x 8.6 mm were found throughout the right middle lobe on X-ray and CT (figure 2).

TREATMENT

In both patients, anaesthesia was induced with midazolam (0.15 mg/kg intravenous), butorphanol (0.02 mg/kg intravenous), meloxicam (0.2 mg/kg subcutaneous) and propofol (5.0 mg/kg intravenous), and anaesthesia was maintained with isoflurane. The entire chest was clipped and prepared for the aseptic surgery. Ketamine (5 µg/kg/minute continuous rate infusion (CRI)) and fentanyl (10 mg/kg/hour CRI) were administered intravenously for intraoperative pain management. A 7-Fr endobronchial blocker balloon catheter (Cook Medical, Indiana, USA) was used for one lung ventilation as needed.

Case 1 was positioned in left lateral semirecumbency, with which the angle formed between the median plane (dorsoventral plane) and the operating table became approximately 45° (figure 3A). One lung ventilation was started with the blockage of right-side pulmonary bronchi. The first trocar (12-mm Yelloport plus SwingTop System, Surgical Innovations, Leeds, UK) was inserted close to the right fifth intercostal pace at the level of the costochondral junction for the camera port. The second and third trocars (5-mm EZ Trocar, Hakko, Tokyo, Japan) were inserted close to the right third and seventh intercostal spaces at the level of costochondral junctions to form the operation ports, respectively (figure 3B).

A 30°, a 10-mm telescope (Karl Storz SE & Co. KG, Tuttlingen, Germany) was inserted via the right fifth intercostal port and approached the hilum of right middle lobe. The thoracoscopic procedure is shown in video 1. First, the pulmonary vein was isolated using a 5-mm Maryland curved forceps (Karl Storz SE & Co. KG) and a 5-mm right-angled forceps (Karl Storz SE & Co. KG) from the lung lobe and surrounding tissues and occluded at the four haemoclips (5-mm Hem-o-lok, ML, Teleflex, North Carolina, USA). The vein was cut using the endoscopic scissors with the two clips remaining in the body (figure 4). Using a 5-mm Maryland curved forceps (Karl Storz SE & Co. KG) and a 5-mm right angled forceps (Karl Storz SE & Co. KG), we isolated the bronchus and artery of the right middle lobe, and the intracorporal ligation using 2–0 monofilament nylon suture (Monosof; Medtronic, Minneapolis, Minnesota, USA) was performed at two sites for en bloc ligation of the bronchus and the artery. One transfixation ligation with a 2–0 absorbable suture (Prolene 2–0; Johnson & Johnson, New Brunswick, New Jersey, USA) was added between the two sutures using a 5-mm endoscopic needle holder (Karl Storz SE & Co. KG). The bronchus and artery were en bloc resected using the endoscopic scissors with the two suture ligations remaining in the body (figure 5). The fifth intercostal port was removed and enlarged to approximately 3 cm, so

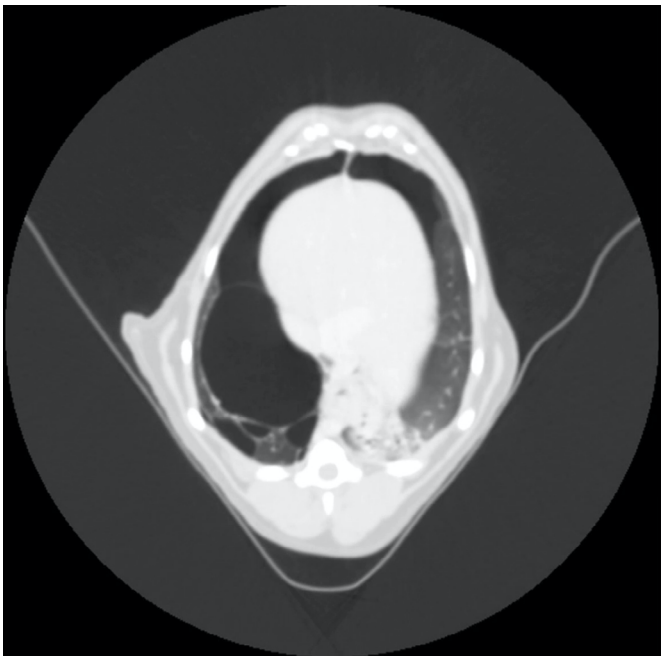


Figure 1 CT image of multiple bullas in the right middle lobe in case 1. A pneumothorax was found, and a large bulla and multiple small ones were detected in the right middle lobe.

the excised lung lobe put in a sterile collection bag was took out from the body via the enlarged fifth intercostal incision. In addition, an intact marginal part of the right cranial lobe was ligated with a ligating loop, and the excisional biopsy was performed for the histopathological examination of other lung lobes.

One lung ventilation was stopped, and the patient was repositioned to right lateral semirecumbency. Two trocars were inserted close to the left fifth and seventh costochondral junctions, and the entire left lobe was evaluated for the presence of

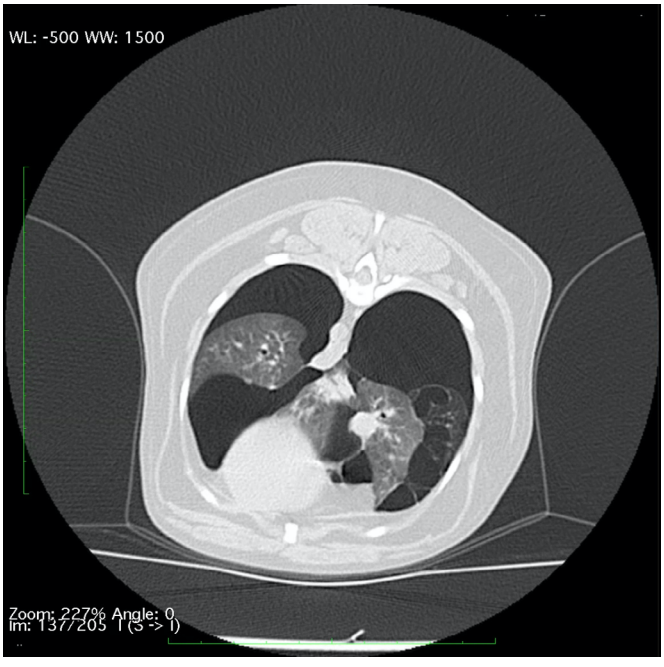


Figure 2 CT image of multiple bullas in the right middle lobe in case 2. A pneumothorax was found, and multiple small bullas were detected in the right middle lobe.

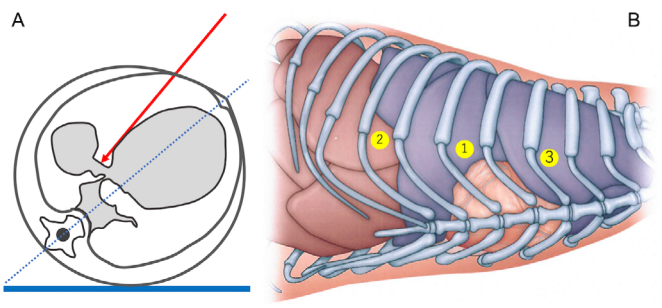
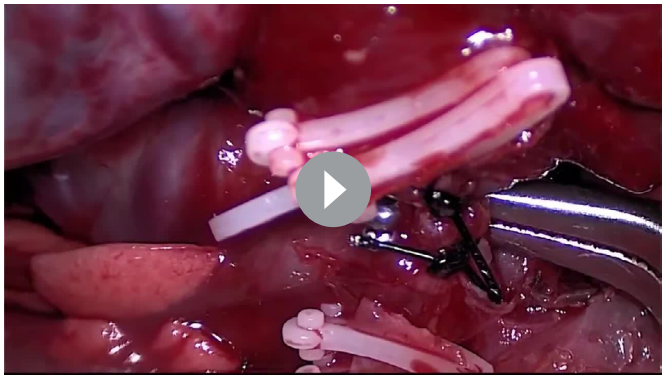


Figure 3 Illustration of portal formation in case 1. (A) The patient was positioned in left lateral semirecumbency, with which the angle formed between the median plane (dorsoventral plane) and operating table became approximately 45°. (B) Three ports were placed in the third, fifth and seventh intercostal spaces at the level of the costochondral junction for the hilar resection of the right middle lobe.

bulla lesions, causing the pneumothorax. After the checking, a chest drain tube was put in place, and the chest wall and skin were routinely closed.

Case 2 was positioned in left semirecumbency, with which the angle formed between the median plane (dorsoventral plane) and the operating table became approximately 45° (figure 6A). One lung ventilation was started with the blockage of right-side pulmonary bronchi. The first trocar (12-mm Yelloport plus SwingTop System, Surgical Innovations) was inserted close to the right fifth intercostal space at the level of costochondral junction to form the camera port. The second and third trocars (5-mm EZ Trocar, Hakko) were inserted close to the right third and seventh intercostal spaces at the level of costochondral junctions to form the operation ports, respectively (figure 6B). The insertion of trocars produced adequate collapse of the affected lobe caused by pneumothorax; one lung ventilation was withdrawn. The thoracoscope was inserted into the right fifth intercostal port and approached the hilum of the right middle lobe along the visceral surface. Thoracoscopic procedure is shown by the video 2. The pulmonary vein was first dissected from the lung lobe and surrounding tissues using a 5-mm Maryland curved forceps (Karl Storz SE & Co. KG) and a 5-mm right-angled forceps (Karl Storz SE & Co. KG) and occluded with five haemoclips (5-mm Hem-o-lok, ML), and was then resected with three haemoclips remaining in the body (figure 7). Using a 5-mm Maryland curved forceps (Karl Storz SE & Co. KG) and a 5-mm right-angled forceps (Karl Storz SE & Co. KG), the bronchus and artery of the right middle lobe were isolated. An additional 3-mm port was placed at the right third intercostal space for the introduction of 2–0 absorbable ligating loop (2–0 PDS



Video 1 Thoracoscopic procedure in case 1

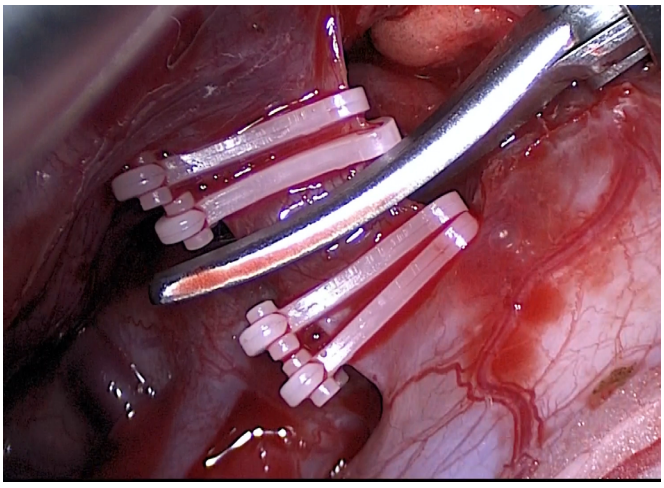


Figure 4 Clipping and cutting the vein from the right middle lobe in case 1.

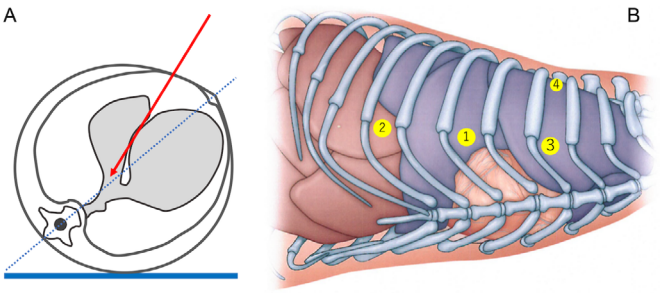


Figure 6 Illustration of portal formation in case 2. (A) The patient was positioned in left lateral semirecumbency, with which the angle formed between the median plane (dorsoventral plane) and the operating table became approximately 45°. (B)Three ports were placed in the third, fifth and seventh intercostal spaces at the level of the costochondral junction for the hilar resection of the right middle lobe. An additional port was placed at the right third intercostal space for introducing the ligating loop.

Endoloop Ligature, Johnson & Johnson). Three intracorporal ligations were performed at the hilum of the affected lobe with the ligating loops. The bronchus and the artery were resected with two suture ligations remaining in the body (figure 8). The fifth intercostal port was removed and enlarged to approximately 3 cm. The excised lung lobe was put in a sterile collection bag, which was taken out from the body via the enlarged fifth intercostal incision.

The patient was repositioned to right semirecumbency. Three trocars were inserted close to the left third, fifth and seventh intercostal spaces at the level of costochondral junctions, and the entire left lung lobe was evaluated for the presence of bulla lesions causing the pneumothorax. Finally, a chest drain tube was put in place, and the chest wall and skin were routinely closed.

OUTCOME AND FOLLOW-UP

In case 1, there were no intraoperative complications. The volume of intraoperative blood loss was ≤5 ml; therefore, no blood transfusion was required. The operating time from the skin incision to closure was approximately 150 minutes.

The histopathological diagnosis was congenital lobar emphysema. The patient's condition was good from the next day after the operation, and the chest tube was removed on the third day after the operation. The patient was discharged from our hospital on the third day after the operation. At the time of writing this article (960 days after the operation), the patient was generally in good condition without any respiratory abnormalities.

In case 2, there were no intraoperative complications. The volume of intraoperative blood loss was ≤5 ml; therefore, no blood transfusion was required. The operating time from the skin incision to closure was approximately 120 minutes.

The histopathological diagnosis was congenital lobar emphysema. The patient's condition was good on the next day after the operation, and the chest tube was removed on the third day after the operation. The patient was discharged from our hospital on the fourth day after the operation. At the time of writing this article (483 days after the operation), the patient was generally in good condition without any respiratory abnormalities.

DISCUSSION

In our case series, thoracoscopic hilar lung lobectomy was feasible for small-breed dogs with right medial lobar emphysema without any of staplers. EndoGIA stapler is generally used for humans with congenital lung lesions.[1–6] Previous studies have reported that EndoGIA or TA stapler is used for lung lobectomy with the thoracoscopic surgery or video-assisted thoracic surgery (VATS) in dogs.[7–23] However, those staplers are too large to be inserted and manipulated in the thorax of small-sized dogs. In addition, in case of the lesions close to the lung hilum, the use of the staplers has the potential risk for leaving the lesions. Especially, leaving malignant lesions in the surgical margin might cause the dissemination and regrowth in the thorax. Therefore, thoracoscopic lung lobectomy is limited to

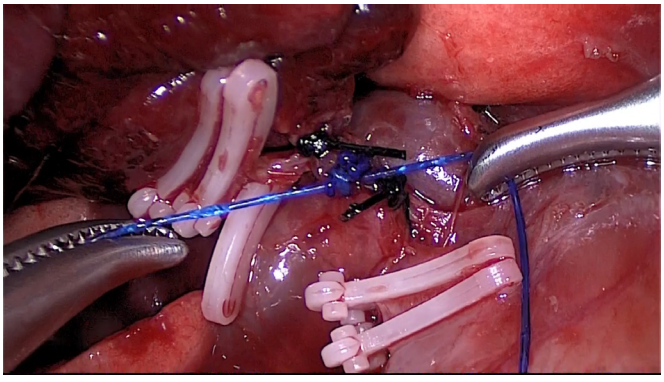
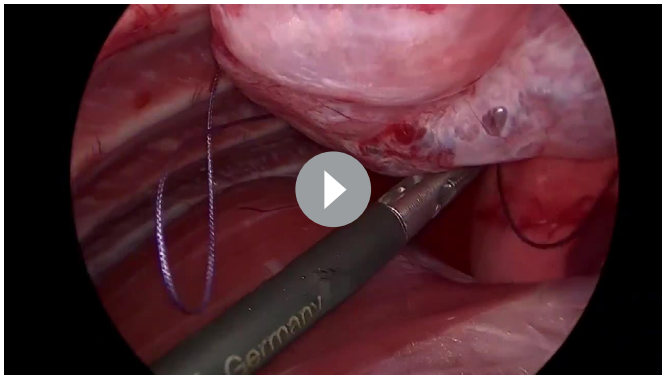


Figure 5 Intracorporal en bloc ligation of bronchus and artery from the right middle lobe in case 1.



Video 2 Thoracoscopic procedure in case 2

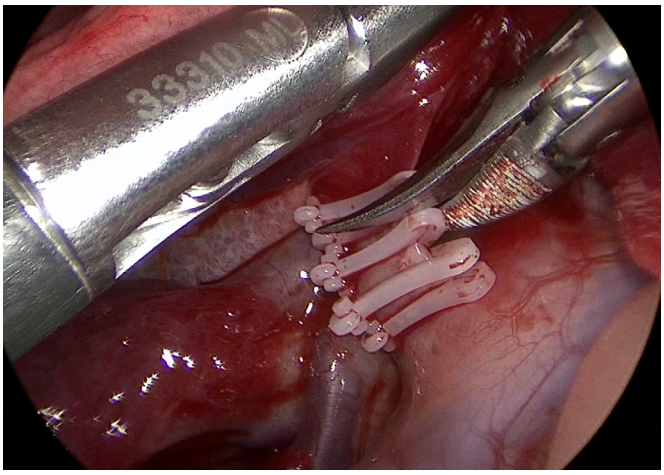


Figure 7 Clipping and cutting the vein from the right middle lobe in case 2.

be indicated for small animals.[7–21 23] Our study suggests that use of intracorporal ligation, haemoclips and endoloop achieves thoracoscopic hilar lung lobectomy in small-breed dogs.

For small-sized dogs, VATS might be available for lung lobectomy without the staplers. However, it requires a relatively large intercostal incision for retracting the affected lobes compared with the thoracoscopic hilar lung lobectomy. Considering the point of view of minimally invasiveness, VATS for lung lobectomy is thought to have little advantages in small-sized dogs compared with thoracotomy. In our cases, only three trocars with diameters of 2, 3, 5 and 12 mm were used for completing the resection of the affected lobe, and one trocar mark was enlarged to only approximately 3 cm for removing the lobe. Therefore, the invasiveness of our procedure is thought to be less than VATS.

The previous studies described that the patients were positioned in the lateral recumbency for the thoracoscopic lung lobectomy.[7–23] In our study, the patient's position was left semirecumbency for approaching the right medial lobe, and three portals were formed at the costochondral junction level in the third, fifth and seventh intercostal spaces. The patient's position and portal formation were facilitated to approach the hilum of the affected lobe along the visceral side and to keep the operation field for the isolation of vessels and the bronchus. In the lateral recumbency, it is challenging to individually dissect the vessels and the bronchus of the affected lobe, especially

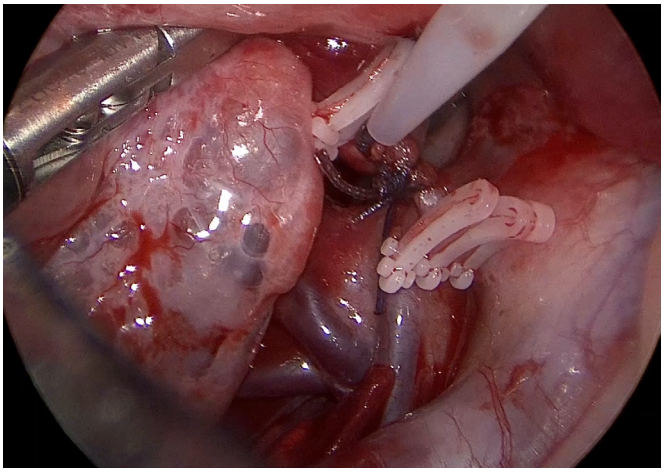


Figure 8 Ligating loops for the intracorporal en bloc ligation of the bronchus and artery from the right middle lobe in case 2.

Learning points

- Thoracoscopic hilar lung lobectomy without staplers was feasible for small-sized dogs with right medial lobe suffering from congenital emphysema.
- The patient's position and portal formation were suggested to be important for this procedure.
- Thoracoscopic hilar lung lobectomy is promising for the surgical removal of affected lobes in small-sized dogs.

pulmonary veins. In contrast, the dissection, ligation/clipping and resection of the vessels and bronchus at the hilum was possible in the semirecumbency applied in our study. Especially, the pulmonary veins were easily visible and isolated in this position. Anatomically, the length and width of pulmonary veins at the hilum are short and wide, respectively, for the hilar lung lobectomy. In addition, they are located in the medial side. The haemorrhage from the pulmonary veins at the hilum is difficult to be controlled under the thoracoscopic guidance. Therefore, the patient's position is suggested to be suitable for thoracoscopic hilar lung lobectomy in small-breed dogs because adequate operation field for the dissection, ligation/clipping and resection of pulmonary veins was required to achieve complete lung lobectomy without leaving the diseased pulmonary parenchyma.

A disadvantage of the patient's position and portal formation for thoracoscopic hilar lung lobectomy was identified. In this method, identification of the pulmonary artery to the affected lobe was interfered by the bronchus. Anatomically, the pulmonary artery runs along the bronchus at the hilum, especially behind the bronchus in this approach. Thus, the dissection of the bronchus needed to be carefully performed to prevent haemorrhage. For the prevention, preoperative evaluation of the location relationship of vessels and bronchus in the hilum of the affected lobe is thought to be important. In case of the difficult isolation of the artery from the bronchus at the hilum, their en bloc resection might be feasible like our cases. In addition, our procedure for thoracoscopic hilar lung lobectomy may not be applicable in case of adhesion of the affected lobe to the mediastinum.

One major study limitation of this case report is the small sample size. This study included only cases involving the right medial lobe. There are, of course, anatomical differences in the positions of each lobe and the branching blood vessels and bronchi. It is essential to determine the indications for thoracoscopic hilar lung lobectomy based on the type and size of the dog and the size and location of the lesion. In addition, the appropriate positioning, portal formation and lobe resection techniques should be considered. Therefore, further investigations on thoracoscopic hilar lung lobectomy involving the other lobes are required for the establishment of suitable methodology.

Contributors All authors contributed to the surgical plan in this study. IE, RO and KK performed the surgeries and were involved in the perioperative management of all cases. KA consulted and supervised concerning their operations and management. All authors participated in writing the manuscript and approved the final manuscript.

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