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Thoracoscopic Right Middle Lung Lobectomy in a Maltese Dog with Primary Pulmonary Bronchoalveolar Carcinoma

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Abstract : A 14-year-old, 3.9 kg, castrated male Maltese presented with an intermittent cough. A solitary mass (1.6 × 2 × 1.8 cm) was located in right middle lung lobe on CT examination and thoracoscopic right middle lung lobectomy was performed without lung separation. The patient recovered uneventfully and was discharged at POD3. With a histopathologic diagnosis of pulmonary bronchoalveolar carcinoma, Re-evaluation via CT scanning with contrast on POD 50 and 255 revealed no evidence of residual, metastatic or recurrent lesions. The patient has been doing well since surgery during a 9-month follow-up period.

Key words **:** primary lung tumor, thoracoscopy, lung lobectomy, small breed dog.

Introduction

Thoracoscopy in veterinary practice has been rapidly expanding since it was first clinically described in 1998 (12). Benefits of this procedure include greatly improved magnification and lighting, avoidance of rib retraction, low morbidity rates, and a rapid recovery (2,5,10,11). For lung lobectomies, thoracoscope-assisted and totally thoracoscopic surgery have been performed (5). According to the data that has been accumulated with more clinical trials and increases in surgeons' proficiency, canine studies on the thoracoscopic resection of primary lung tumors have reported that not only short-term but also long-term outcomes are not significantly different from those following open thoracotomies (1,4). These results would lighten the workload of surgeons about long-term complications of thoracoscopic lung lobectomy (TLL), therefore, the use of this procedure has been expanding.

Nevertheless, the thoracoscopy could not be performed in every case of thoracic diseases and also could not obviate the need for open approaches in some cases (12). Even though thoracoscopic surgeries have become the standard for treating lung tumors in human medicine (14), only 3-32% of cases were reported to have been performed via video assisted thoracic surgery (1). Generally speaking, dogs with small masses in the peripheral lung parenchyma are regarded as candidates for TLL because of the improved hilar visualization, lobar manipulation, and satisfactory placement of the stapler to guarantee a clean margin (1,6). TLL in canine patients has been performed mostly in medium- to large-breeds; studies have reported mffedian body weights of 31.4 kg (n=22), 30.4 kg (n=8, thoracoscope-assisted lung lobectomy), and 29 kg (n=10) (1,4,14). In small patients (< 10 kg), thoracoscopic procedures might be more technically challenging because of their smaller body size and consequent decreased working space due to the constraints of a small thoracic cavity, which may be why this procedure is less commonly reported in small toy-breed dogs and cats (11,14). However, there has been an increase in the desire for minimally invasive surgery (MIS) in small breed dogs and the concept has recently been expanded to feline patients. Thoracoscope-assisted lung lobectomy has been reported in 3 cats (median body weight = 6.79 kg, 6.1-8.2 kg), 1 Maltese dog (3 kg), and 1 Shihtzu dog (6.4 kg) (3.8.14). This report describes a case involving thoracoscopic right middle lung lobectomy (TRMLL) in a Maltese dog with a primary lung tumor.

Case Description

A 14-year-old, castrated male Maltese weighing 3.9 kg (BCS: 6/9) presented with recently developed intermittent non-productive cough. He had a history of mild mitral valve insufficiency (MVI) over the previous 2 years and life-long recurrent chronic pancreatitis. When screening tests (CBC, serum chemistry, electrolyte analysis, X-ray, echocardiography) were performed for the grade 5 holosystolic murmur, the MVI had further progressed but there was neither pleural effusion nor pulmonary edema associated with cardiomegaly. Meanwhile, a round radiopaque region in the right lung field was visible on a plain thoracic radiograph (Fig 1). In the following CT scan with contrast study, a solitary pulmonary mass (1.6 × 2 × 1.8 cm) was identified in the right middle lung lobe (RMLL) showing partial hyper-attenuation (Fig 2). The lesion was isolated from the thoracic wall and there was no intrathoracic sentinel lymph node involvement.

Three weeks later, a 3-portal TRMLL was performed under general anesthesia without lung isolation (Fig 3). The patient was pre-medicated with midazolam (0.1 mg/kg, IV, Midazolam®, Bukwang Pharm., Korea), hydromorphone

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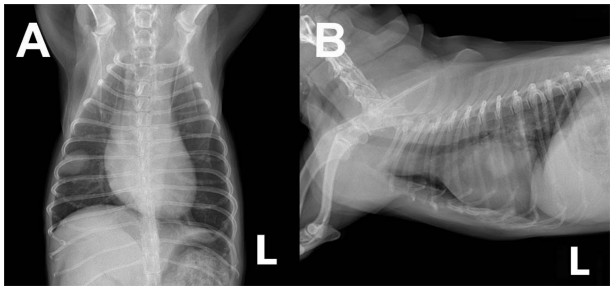

Fig 1. Plain thoracic radiographs of a pulmonary lesion in a Maltese dog. A solitary mass was identified in the right middle lung field in ventrodorsal (A) and lateral views (B).

(0.1 mg/kg, IV, Dilid®, Hana Pharma, Korea), and glycopyrrolate (0.011 mg/kg, SC, Mobinul™, Myungmoon, Korea); etomidate (1 mg/kg, IV, Etomidate®-Lipuro, B. Braun Melsungen, Germany) was used to induce anesthesia. The dog was intubated and isoflurane with 100% oxygen was inhaled (< 1.5%) along with remifentanil (6~11 μg/kg/hr, constant rate infusion, Remiva®, Hana Pharm., Korea). The patient was monitored vigilantly (HR, RR, $EtCO_2$, NIBP, SpO_2, BT) and intermittent PEEP (positive end expiratory pressure, 5 mmHg) was applied once the thoracic cavity was opened.

The patient was placed in a left lateral recumbency with his dorsal thoracic region elevated. The ventral third of 8th intercostal space (ICS) was selected for a 5-mm camera, and the right hemithorax was explored. At first, the lesional mass was not differentiated from the surrounding inflated, pale, pink lung parenchyma but it was then identified following parenchymal collapse due to the loss of intrathoracic negative pressure and manipulation (Fig 3, A-D). The mass was located in the dorsal parenchyma of the RMLL relatively close to the hilus. The dorsal third of 10th ICS and the ventral fifth of 6th ICS were selected for lobar retraction and for stapling or specimen retrieval. After the thoracic cavity was secured, the hilar region was exposed with the RMLL retracted cranio-ventrally (Fig 3, E-H). A self-cutting linear endoscopic stapler (ENDOPATH-ETS-FLEX®, 35 mm standard, Ethicon endo-surgery, USA) was introduced toward the hilus perpendicular to the thoracic vertebrae and fired at the hilus. The resected RMLL was retrieved in a specimen retrieval bag (Lap Bag™ (S), Sejong Medical, Korea) in a row. No hemorrhaging or inadvertent tearing were observed when the resected site was re-explored. The collapsed lung field was re-expanded with several ventilations of 5 mmHg PEEP, and the portal sites were routinely closed following placement of a closed-wound chest-tube drainage system (Barovac®, Sewoon Medical, Korea) (Fig 3, J). Throughout the procedure, anesthesia was maintained satisfactorily (SpO_2 > 95). On gross examination, the collapsed RMLL had a smooth surfaced round, prominent mass located proximally near the hilus, which was firm and had a cream-colored, densely textured cut surface (Fig 4, A/B).

The patient recovered uneventfully and showed a rapidly restored appetite and activity. The chest tube was removed at 48 hours after surgery, and the patient was discharged on post-operative day (POD) 3. A histopathological diagnosis of bronchoalveolar carcinoma was made with 3 mitotic figures per 10 HPFs (Fig 4, C/D). There was an infiltration into the adjacent alveolar spaces but no vascular or lymphatic invasion. When he was re-examined via CT scanning with contrast on POD 50 and 255, there was no evidence of residual, recurrent, or metastatic lesions. He has been doing well during the first 262 PODs.

Discussion

Although small peripheral lesions are optimal for TLL (6), larger masses located closer to the hilus can also be treated by TLL, as shown in this study and supported by a previous study (4). TRMLL was performed without 1LV and additional time was needed for right lung field to be collapsed spontaneously. Because the mass was located in the dorsal parenchyma near the hilus, there was a certain degree of difficulty in manipulation for hilar exposure and lobar retraction. It was not optimal for manipulation, but there was no need for conversion by spatial issue. The criteria that tumors less than 8 cm or less than 150 cm^3 (7 × 5 × 4.5 cm on CT scan) have been found to be reasonable guideline in canine TLLs (4). However, these were in dogs weighing over 30 kg and are not relevant for small-breed dogs. The lesion in present report was a round mass measuring 2.2 cm in its largest dimension. The patient weighed 3.9 kg (BCS 6/9) at the time of TLL but 2.45 kg (BCS 3/9) when suffering from pancreatitis; however, his rib cage remained the same size regard-

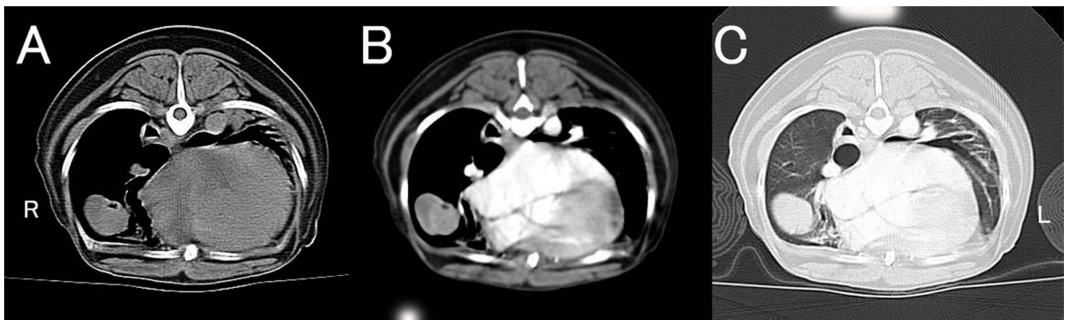

Fig 2. Transverse views of a thoracic CT scan in a Maltese dog. The lesion was identified in the right middle lung lobe in a pre-contrast soft tissue window (A), post-contrast soft tissue window (B), and pre-contrast lung window (C). The mass (1.6 × 2 × 1.8 cm) was close to the hilus, but separate from the bronchus to the RMLL.

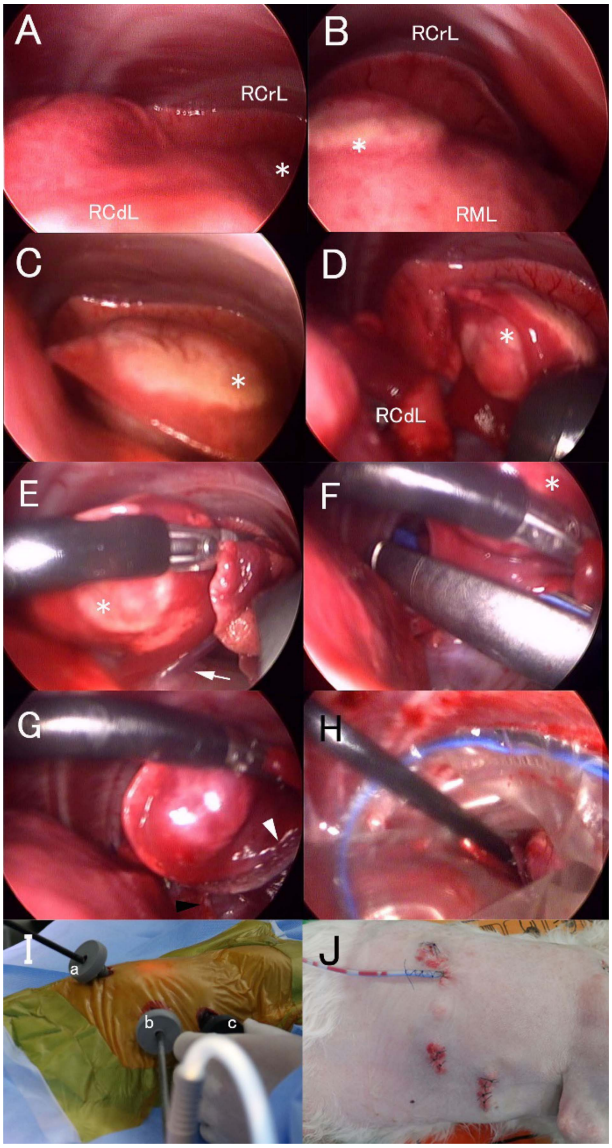

Fig 3. Thoracoscopic right middle lung lobectomy with an 8-6-10 ICS approach in a Maltese dog without lung separation. The mass gradually became visible as the lung collapsed (A-D), and the right middle lung lobe (RMLL) was retracted for hilar exposure (E). An endoscopic linear self-cutting stapler was applied (F, G), and the resected RMLL was retrieved using a specimen retrieval bag (H). External view (I) with portal sites for grasping forcep (a), camera (b), and stapling device/specimen retrieval bag (c) and postoperative thoracic wall (J).
ICS: intercostal space, RCrL; right cranial lobe, RCdL; right caudal lobe, *; mass, white arrow; hilus, white arrow head; stapled line on lung parenchymal side, black arrow head; stapled line on hilar side.

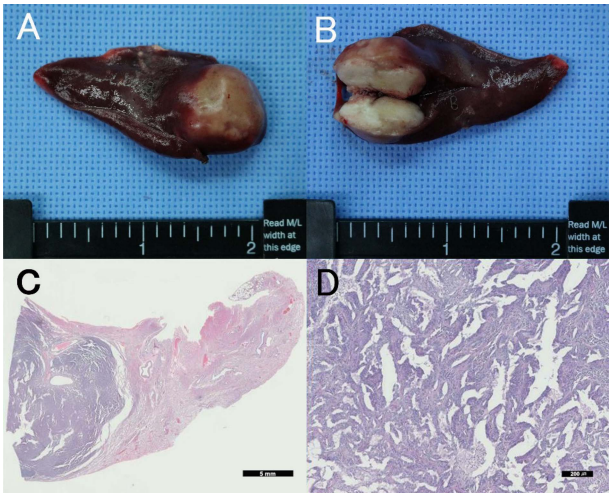

Fig 4. Gross and microscopic images of resected lung lobe. The mass was well circumscribed, cream-colored, and firm; Parietal view (A) and cut surface (B) (The units shown are inches). Histopathologic images of primary pulmonary bronchoalveolar carcinoma showed a non-encapsulated, infiltrative, poorly demarcated lesion consisted of tall columnar to pleomorphic neoplastic cells with moderate anisocytosis and anisokaryosis. H&E, ×2.5 (C), ×50 (D).

less of disease status or weight. Therefore, it is not reasonable to use only the numeric value of tumor size or body weight to assess the relationship between patient and lesion in case selection for TLL. Not only body weight but also the BCS, ratio of the size of the lesion (in both diameter and volume) relative to the body weight or the body surface area or thoracic cavity of the animal, or some other new parameter might be considered. A previous TLL study in medium- to large-breed dogs reported that the median volume of tumors and the ratio of their volume relative to body weight were 41.1 cm^3 (1.7-174.4 cm^3) and 1.2 cm^3/kg (0.06-6.7 cm^3/kg) (4). These values in the present case were 3.4 cm^3 and 0.87 cm^3/kg. In addition, the ratio in diameter of the tumor relative to the vertical height (highest distance from the thoracic vertebra to the sternum; 5.6 cm) and to the half horizontal width (1/2 x widest distance between bilateral costal arches; 5.5 cm) of the rib cage were 0.39 and 0.4. A ratio in volume of the tumor to the ipsilateral hemi-thoracic cavity also could deserve consideration; it was 0.022 in this case and right lung field was measured except heart. Further data are needed to investigate whether these ratios could serve as useful assessment parameters.

Canine TRMLL was first reported in 2012, and 5 cases have been reported in several retrospective studies (1,4,9). The 8-6-10 portal approach in this case was similar to the case reported by Pelaez except that the location for the stapler port in the 6th ICS was the ventral fifth versus the ventral third in previous report (9). The smaller thoracic cavity is, the longer the introduction pathway for the stapling device needs to be to guarantee that the jaw can open sufficiently. Insertion at the ventral fifth permits the direct introduction of the stapler to the hilus lateral to the heart; it provides the longest axis from the portal site to the hilus on the transverse plane. It also secures the aim of the tip of device abaxial to the main vessels (aorta, vena cava), which protects them from inadvertent damage. Even though 35 mm cartridge was used, it appeared to be slightly larger than would be optimal relative to the patient's thoracic cavity. The hilus had to be placed between the blades as soon as the hinge exited the portal opening and the jaw was opened, with the stapler aimed right toward the hilus during introduction. This proce-

dure was slightly tricky but was performed successfully. If available, more compact instruments (1.7, 2.0, 2.7, or 3.0 mm sets) and shorter cartridge (30 mm) are expected to be helpful in treating very small patients (11), although we still used 5 mm instruments. The length of commercial cartridges could occasionally be a drawback in smaller patients.

Histopathological evaluation of a sentinel lymph node has been established for tumor staging, and a biopsy of the tracheobronchial lymph node (TBLN) is usually recommended during surgery (1,2,4,6,7,13). However, this is not carried out in every case, even in open surgery, and was not attempted in present case because there was no specific finding in the preoperative CT with contrast. A previous study compared CT and histopathologic findings for TBLN involvement in 14 dogs with primary lung tumors and reported a 93% diagnostic accuracy of CT examination with positive characteristics of nodal enlargement or contrast enhancement (7). In that study, the sensitivity, specificity, positive predictive value, and negative predictive value were 83%, 100%, 100%, and 89%, respectively. Only 6 biopsies were performed under TLL in 32 dogs with a primary lung tumor (1,4), and it could be more difficult in small patients by spatial issue or poor visualization. All patients in which TBLN biopsies are not obtained should be monitored closely in a long-term manner. Our patient has shown no distant metastasis or recurrence at surgical margin in regular check-ups until 262 PODs. A near-infrared field fluorescence technology with indocyanin green has been investigated to assess sentinel lymph nodes and surgical margins intraoperatively. This fluorescence imaging allows for the activation of tumor cells and the following visible tumor-to-background ratio (2,6).

The patient in this case had a solitary primary pulmonary bronchoalveolar carcinoma without lymph node involvement or distant metastasis. A TLL was selected with concerns related to MVI and chronic pancreatitis, and was performed uneventfully. This report has clinical relevance in that it provides data on TLL in a small-breed dog that might also support the feasibility of TLL in other small patients. There is no doubt that appropriate case selection is paramount even in large-breed dogs and it would obviously be unpractical to insist on MIS in all small-breed dogs based only on this one case. However, it would be reasonable to make an effort to consider small dogs and cats for TLL. These smaller patients, which have often not been considered in the past, may also be good candidates. Further clinical studies of MIS might be attempted with thorough preoperative patient evaluation and surgical planning, as well as prompt decision making regarding conversion.

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