The Thai Journal of Veterinary Medicine

Volume 36
Issue 4 *December, 2006*

Article 2

12-1-2006

Thoracoscopic-guided Lung Biopsy in Dogs

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Original Article

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Abstract

The study developed a thoracoscopic-guided lung biopsy technique that was able to be performed on the right or left lung lobes of dogs. Ten experimental dogs weighing 6-20 kilograms were anesthetized, ventilated and positioned in a lateral recumbency. Either the left or right hemithorax was approached. Two instrumental ports were utilized, the first port for a telescope was located at the fifth or sixth intercostal space at a half way distance between the vertebral column and sternum. The second port for the grasping forceps, 12-mm in diameter, was located at either the fourth or sixth or seventh intercostal space at the costochondral junction. When performing the thoracoscopy, the distal part of the lung lobe was grasped and retracted externally through the second port. A pulmonary parenchyma was twice ligated close to the border with endoloops and cut. The pulmonary stump was examined for hemorrhage before being released back into the chest. The sample size was about 0.8 x 1 x 0.4 cm. which was adequate for histopathology and no complications were encountered. The second thoracoscopy was performed in order to observe the lungs two weeks after the biopsies of four dogs. The biopsied lobes were covered with a fibrinous-like tissue. In conclusion, the thoracoscopic-guided lung biopsy technique was a simple, safe, fast, less invasive procedure and is potentially applicable for clinical diagnosis.

Keywords : Thoracoscopic-guided lung biopsy, interstitial diffuse lung diseases, dogs, endoloop.

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Presented as a poster in 2003 WSAVA, Bangkok, Thailand.
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บทคัดย่อ

การส่องกล้องช่วยในการเก็บตัวอย่างเนื้อปอดของสุนัข

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การศึกษาได้พัฒนาเทคนิคการเก็บตัวอย่างเนื้อปอดจากพูขวาและซ้ายโดยใช้การส่องกล้องผ่านช่องอกสุนัขทดลองจำนวน 10 ตัว น้ำหนัก 6-20 กก. ได้รับการวางยาสลบ ควบคุมการหายใจ แบบไม่อัดอากาศภายในช่องอกในท่านอนตะแคงข้าง ช่องอกด้านซ้ายหรือขวาได้รับการส่องตรวจ และได้เก็บตัวอย่างเนื้อปอดจากพูต่างๆของสุนัข โดยมีการเจาะผนังช่องอกเป็นช่องสำหรับใส่เครื่องมือ 2 ตำแหน่ง ตำแหน่งแรกอยู่ระหว่างซี่โครงที่ 5 หรือ 6 และประมาณ 1/2 ระยะระหว่างแนวกระดูกสันหลังและแนวกระดูกอก สำหรับสอดกล้องเทเลสโคป ตำแหน่งที่ 2 ซึ่งมีขนาดเส้นผ่านศูนย์กลาง 12 มม. สำหรับสอดเครื่องมือหนีบจับ ตำแหน่งนี้อยู่ระหว่างกระดูกซี่โครงที่ 4 หรือ 6 หรือ 7 ระดับคอสโตคอนดรอลจังชั่น ภายใต้การส่องกล้อง ทำการจับส่วนปลายพูของปอดพูต่างๆและดึงออกมาภายนอกผ่านช่องเปิดผนังอกตำแหน่งที่ 2 ผูกเนื้อปอดเหนือส่วนปลายพูของปอด โดยใช้เอ็นโดลูป และทำการตัดให้ปม 2 เปลาะอยู่ติดกับสุนัข ตรวจดูการมีเลือดออกก่อนปล่อยกลับเข้าสู่ตำแหน่งปกติ ขนาดชิ้นเนื้อมีขนาดใหญ่เพียงพอต่อการตรวจทางจุลพยาธิวิทยา ไม่พบมีอาการแทรกซ้อนสุนัข 4 ตัวได้รับการส่องกล้องสำรวจช่องอกครั้งที่สอง 2 สัปดาห์หลังการตัดเก็บชิ้นเนื้อ ลักษณะที่เห็นผ่านกล้องเอ็นโดสโคปพบว่าบริเวณที่ได้ทำการตัดเนื้อปอดมีเยื่อบางๆลักษณะคล้ายแผ่นไฟบรินคลุมอยู่ โดยสรุปการศึกษานี้แสดงให้เห็นว่า เทคนิคการเก็บตัวอย่างชิ้นเนื้อโดยการส่องกล้องช่วยเป็นเทคนิคที่ทำได้ง่าย ปลอดภัย รวดเร็ว และบาดเจ็บน้อย และ สามารถนำมาใช้ในการวินิจฉัยโรคปอดที่มีรอยโรคชนิดแทรกกระจายทั่วไปในเนื้อปอด

คำสำคัญ: การส่องกล้อง การเก็บตัวอย่างเนื้อปอด สุนัข เอ็นโดลูป

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ได้เสนอเป็นแผ่นภาพ ในงานประชุมวิชาการ WSAVA 2003 กรุงเทพ ประเทศไทย
*** ผู้รับผิดชอบบทความ**

Introduction

The diagnosis of pulmonary disease in dogs is very challenging. Cytologic or histologic evaluation of diseased tissue usually reveals a definite diagnosis. Lung biopsy often helps differentiate neoplasms from fungal or inflammatory lesions. In addition, determining the type of neoplasm often leads to therapeutic and prognostic assessment. Routine diagnostic approaches include transtracheal washes, bronchial brushing, bronchoalveolar lavage, transthoracic lung aspiration, transthoracic needle-core biopsy and thoracotomy. Each technique has its own advantages and limitations. Misinterpretation and nondiagnosis are the major concern with the cytologic evaluation of samples obtained by transtracheal wash, bronchial brushing, bronchoalveolar lavage, transthoracic lung aspiration and transthoracic needle-aspiration biopsy. Pulmonary biopsy specimens for histologic evaluation may be obtained via either a

transbronchiolar approach or lateral thoracotomy. For the transbronchiolar biopsy, the lesion must be in close proximity to the bronchi where a bronchoscope can be located. Thoracotomy is not routinely performed on dogs because it is associated with morbidity and expense (Faunt et al., 1998).

Thoracoscopy is a less invasive technique by which the pleural cavity and thoracic structures are visualized. Thoracoscopic lung biopsies are used to aid the diagnosis and treatment of adults and children with interstitial lung disease. Generally the procedure is performed with about the same morbidity as that of transbronchial biopsy, and the information gained is usually much more extensive (Rothenberg, 1994). Thoracoscopic lung biopsy is becoming the procedure of first choice for the diagnosis of many localized and diffuse lung diseases. (Ayed and Raghunathan, 2000; Takamori et al., 2000; Tiitto et al., 2005).

In Veterinary Medicine, interest in performing thoracoscopic procedures for diagnosis includes staging neoplastic disease, the preoperative evaluation of lesion resectibility, the direct visualization of pathologic conditions, visually direct biopsy, the evaluation and treatment of spontaneous and persistent traumatic pneumothorax, the treatment of pericardial and pleural effusion and the evaluation and repair of intrathoracic trauma (Faunt et al., 1998; Jackson et al., 1999; Walsh, 1999; Dupre et al., 2001; Walton, 2001, Atiptamvaree and Pramatwinai, 2006). The objective of the study is to report on thoracoscopic-guided lung biopsy and to determine the port positions for the biopsy of all lung lobes in dogs.

Materials and Methods

Animals

This study was carried out on 10 mature and healthy mongrel dogs, weighing between 6-20 kg. The right or left lung lobes were separately biopsied in groups of five dogs.

Anesthesia

Each dog was premedicated with atropine sulphate (0.04 mg/kg, IM) and buphrenorphine (10 mcg/kg, IM). General anesthesia was induced with thiopental sodium (10-20 mg/kg, IV). The animals were intubated and anesthesia was maintained with 1-2 % halothane in oxygen. Ventilation was controlled with a volumetric ventilator (Penlon Nuffield Anesthetic Ventilator Series 200). The right or left pleural cavity was opened to the outside environment through a hole between an intercostal space. No gas was insufflatted into the pleural cavity.

Surgical Technique

A 10-mm zero-degree thoracoscope (Olympus A5254A) was connected to a camera head and digital signal processor (Olympus OTV-S4) and to a xenon light source (Olympus CLV-U20). Images were viewed on a monitor and recorded. The endoscopic instruments used included grasping forceps (Olympus), Babcock forceps (Endopath Ethicon) and 5-mm and 12-mm trocar-cannulae (Endopath Ethicon). The endoloop (Ethicon) was a manually pre-tied Roeder knot with 3/0 polydioxanone.

The dogs were positioned in either a left or right lateral recumbency and an area of chest was widely clipped and prepared for aseptic surgery. Two ports were utilized for each dog. A small skin incision was made at the 5th or 6th intercostal space, half way distant between the vertebral column and sternum through which a 5-mm trocar-cannula was initially introduced into the thoracic cavity. The 5-mm trocar-cannula was removed and a 12-mm trocar-cannula was reinserted into the same position to make a thoracoscope port. The thoracic structures were visualized and a lung biopsy was performed. For the biopsy, a 12-mm trocar-cannula was inserted at either the 4th, 6th or 7th intercostal space with a prior incision at the costochondral junction under thoracoscopic visualization. The 12-mm trocar-cannula at the second

port was removed and a pair of grasping forceps or a Babcock forceps was introduced through the second port to grasp and retract the distal lobe of each lung lobe through the port externally. The lung parenchyma was ligated twice with the Endoloop, then cut and the lung lobe was checked for hemorrhage. Then, the pulmonary stump was released back into the thoracic cavity. All the lung lobes were biopsied. The biopsied sites were thoracoscopically examined for their intregrity before closing the wounds. The muscular and subcutaneous layers of the wounds were sutured. The intrathoracic pressure was returned to negative pressure and the dogs allowed to breathe spontaneously.

Thoracoscopy was repeated on four of the dogs two weeks after the lung biopsy. The anesthesia and the procedure were the same as for the first operation and the port was created at the former site.

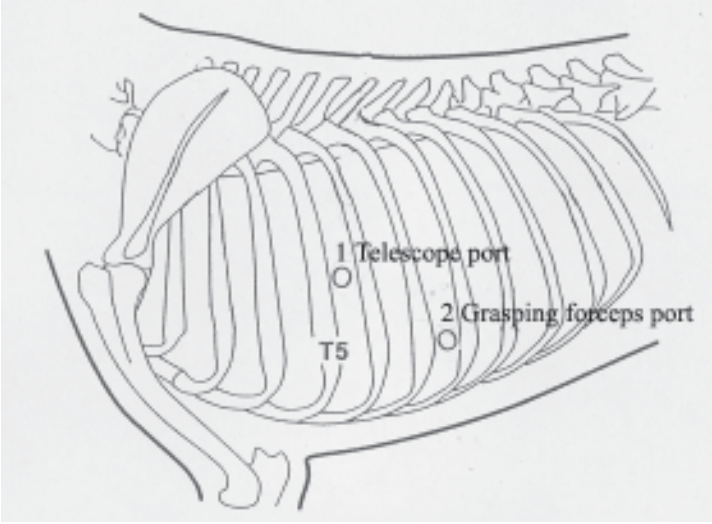

Figure 1 Two ports were utilized for the thoracoscopic-guided lung biopsy. The first port for the telescope was located at 5th or 6th intercostal space and half way between the vertebral column and sternum. The second port for the grasping forceps was located at 4th or 6th or 7th intercostal space at the level of the costochondral junction.

Results

Thoracoscopy at the 5th or 6th intercostal space and half way between the vertebral column and sternum allowed an adequate examination of the cranial, dorsal and caudal surfaces of the pleura, the lung lobes of each hemithorax and the mediastinum. The intercostal spaces covered by the parietal pleura of the chest wall were clearly seen. The diaphragm covered by the caudal lung lobe was visualized when the caudal cavity was examined.

The thoracoscope port positioned at the 5th or 6th intercostal space and half way between the vertebrae and sternum is located at about the center of each hemithorax and gives adequate visualization of all the lung lobes. The instrumental port, created by a 12-mm trocar-cannula at the 4th, 6th or 7th intercostal space at the costochondral junction and the trocar-cannula was removed after insertion and was adequate in diameter to allow the border of lung parenchyma from various lobes of lungs to be pulled externally and directly biopsied. There was not much tension on the pulmonary tissue which was retracted and biopsied. There were no complications observed in any of the dogs over two postoperative weeks.

The cranial and caudal parts of the cranial lobe of the left lung and the cranial and middle lobes of the right lung were biopsied via instrumental ports located at the 4th intercostal space of the left and right thorax walls respectively. The caudal part of cranial lobe and caudal lobe of the left lung and the middle and caudal lobes of the right lungs were biopsied via instrumental ports located at the left 6th or 7th intercostal space of the left and right thoracic walls respectively (Table 1). The size of the tissue samples was about 0.8 x 1 x 0.4 cm. This was large enough and adequate for histopathological evaluation.

Table 1 Lobes of left and right lungs were biopsied through the grasping forceps port located on the intercostal spaces.

ICS[a]	Lobes of left lungs	Lobes of right lungs
4th	- cranial and caudal parts of cranial lobe	- cranial and middle lobes
6th / 7th	- caudal part of cranial lobe and caudal lobe	- middle and caudal lobes

ICS[a] intercostal space

Two weeks after the operation, the four dogs that underwent a repeated thoracoscopy showed that the pulmonary parenchyma around the biopsied site was covered with thin fibrinous-like tissue but it had not adhere to the thoracic wall. Suture materials at the biopsied sites were intact and no complications were observed in any of the dogs.

Discussion

The technique of thoracoscopic-guided lung biopsy developed in this study is the first report. It utilized two ports of 12 mm in diameter: a thoracoscope and a grasper. The lung tissue was endoscopically grapsed and retracted from the pleural cavity through the grasping port and tied with a pre-tied Endoloop. Previous studies of lung biopsy have been endoscopically performed in the pleural cavities (Boutin et al., 1982; Faunt et al., 1998; Potter and Hendrickson, 1999; Fossum, 2002). A thoracoscopic lung biopsy was performed on 14 experimental dogs and then on 75 human patients via two ports: a thoracoscope and a 5-mm in diameter biopsy forceps connecting to a diathermocoagulating device. Minor complications in some patients included blood-streaked sputum, fever and peumothorax (Boutin et al., 1982). In addition, in a lung biopsy technique performed in six experimental dogs, an Endoloop was thoracoscopically snared and the distal cardiac lobes of the left cranial lung lobe were ligated with some minor complications. Four ports were utilized in the study including a thoracoscope and three instrumental ports (Faunt et al., 1998). Furthermore, a similar biopsy technique with an Endoloop has been presented using only three ports (Potter and Hendrickson, 1999; Fossum, 2002). Lung biopsy has also been performed by using a linear stapler in dogs (Potter and Hendrickson, 1999). Recently, in human patients, the biopsy site has been selected on the basis of a preoperative chest roentgenogram and Computer tomography (CT). One or two stapled wedge excisions of the lung parenchyma have been taken in each patient (Takamori et al., 2000; Tiitto et al., 2005).

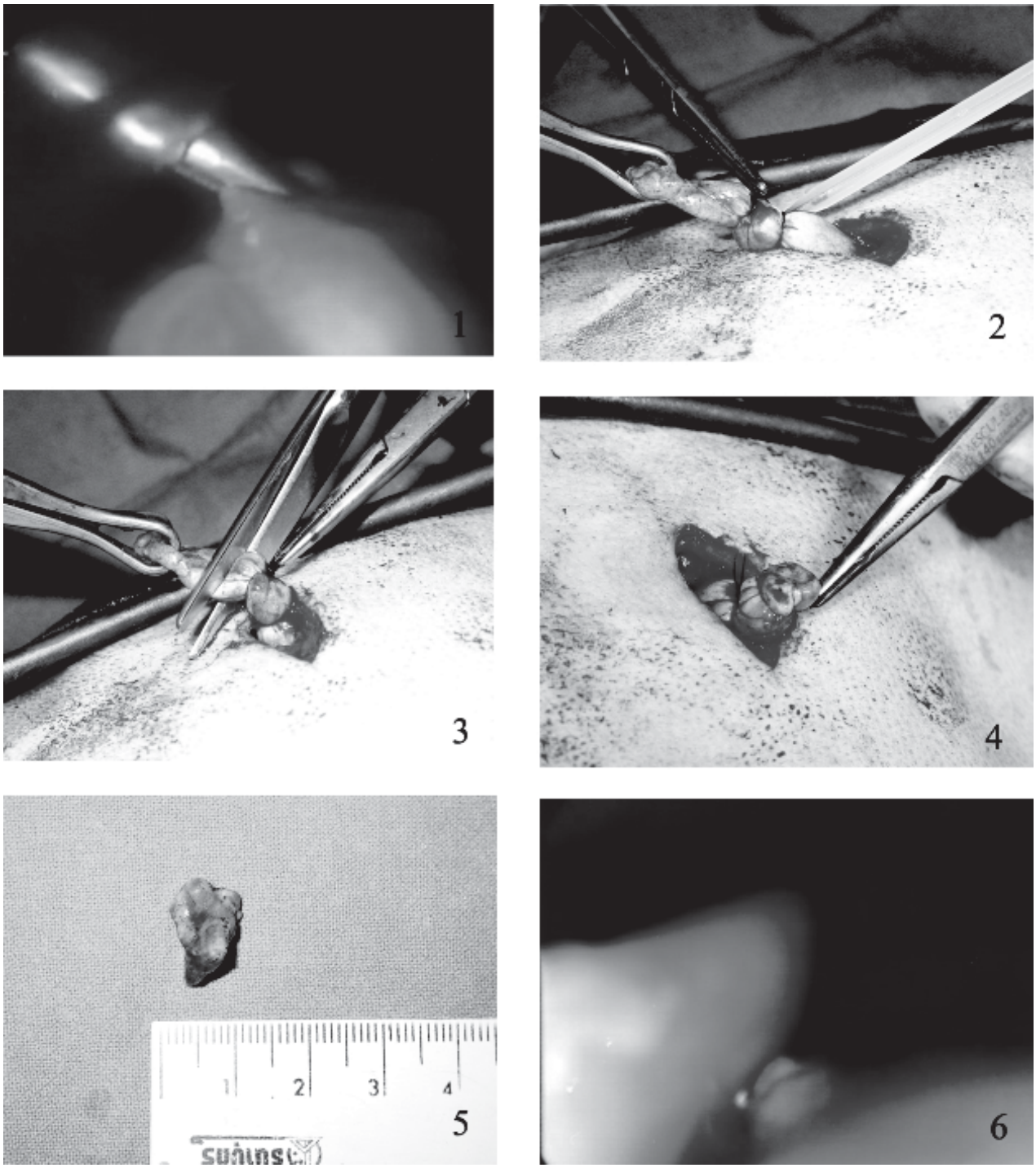

Figure 2 The left caudal lung lobe was thoracoscopically grasped and pulled through the instrumental port (1). The distal border of the lung lobe was ligated twice with endoloops (2), excised (3) and checked for hemorrhage (4). The size of the biopsied specimen was adequate for histological examination (5). Repeat thoracoscopy performed two weeks after the biopsy showed intact suture materials at the biopsied site (6).

In our study, the pleural space was not filled with air to create a moderate tension peumothorax condition. The capacity of the lung was controlled using a small tidal volume. The thoracoscopic view was adequate for performing a lung biopsy. However, gas insufflation to create tension pneumothorax allowed better thoracoscopic visualization and a thoracoscopic-guided lung biopsy could be performed. In human patients, video-assisted thoracic surgery (VATS) lung biopsy has always been performed with double-lumen endotracheal intubation and single-lung ventilation (Takamori et al., 2000; Tiitto et al., 2005).

Due to the elastic recoil property of the lungs and the close proximity of the caudal parts of most lung lobes to the instrumental ports on the thoracic wall, the lung biopsy was performed without much tension on the lung lobes. The knot tying around the lung parenchyma was performed under a three-dimensional circumstance which allowed fast and convenient manipulation. The technique does not need skillful operators. In contrast, endoscopic placement of an endoloop around lungs with a two-dimensional view requires more skillful or trained operators. In addition, it may cause more technique difficulty in small to medium-size dogs.

In this study the pre-tied endoloop was prepared using 3/0 polydioxanone with a hand-tied Roeder knot which worked well. The lung parenchyma was tied with a loop of suture material and the pre-tied knot was tightened by a pusher rod. The monofilament suture did not cause damage to the lung parenchyma and made for a secure knot. The knots prevented haemorrhage and air leakage from all the excised lobes and no complications were detected during the study. The lung parenchyma can also be tied with a conventional knot such as a surgeon's knot. It should be carefully tied. With either an instrument or hand-tie technique, the suture material may be moved to some degree during tying process and this can affect the knot tightening. Complications may be encountered in the case of using a smaller gauge of both braided and non-braided suture materials. Lung tissue may be compressed and crushed during ligation. In addition, the position of the knot ligation should not be too far from the caudal border of lung lobes because the knot may not adequately compress the closest proximity of the lung lobes. The knot may fail to function and pneumothorax may result.

In this study the first thoracic approach with a trocar-cannula was probably safe because of the insertion of a 5-mm trocar-cannula prior to a 12-mm trocar-cannula. The 5-mm trocar-cannula was more easily passed through the intercostal spaces than a 12-mm especially by novices.

The thoracoscopic-guided lung biopsy provided an adequate amount of lung tissue for histopathological evaluation. There were no complications observed in any of the dogs for two postoperative weeks. In conclusion, it is considered to be a less invasive, simpler, safer and faster technique for interstitial diffuse lung diseases in dogs. We believe that this procedure deserves additional evaluation in clinically diseased dogs.

Acknowledgement

This work was funded by a grant from the Faculty of Veterinary Science, Chulalongkorn University in the year 2000.

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