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Case Report
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Thoracic duct lymphography by subcutaneous contrast agent injection in a dog with chylothorax

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Abstract
A 4-year-old male Japanese Shiba Inu presented with recurrent chylothorax. The thoracic duct was successfully imaged using computed tomography after the injection of an iodine contrast agent into the subcutaneous tissue surrounding the anus. The thoracic duct was successfully ligated and pericardectomy performed via an open thoracotomy. Pleural effusion improved but relapsed a week after the surgery. A second lymphography revealed a collateral thoracic duct that was not detected during the first lymphography. The collateral duct was ligated and chylothorax was resolved after the second surgery. The lymphography applied in this study was minimally-invasive and easily provided images of the thoracic duct in a dog with chylothorax.
Keywords: Chylothorax, Computed tomography, Lymphography, Thoracic duct.

Introduction

Chylothorax in dogs can be caused by thoracic damage such as that from traumatic injury or inflammation. Accumulation of chylous pleural effusion often causes dyspnoea and requires periodic removal or a curative approach. Thoracic duct ligation and pericardectomy has been reported as a treatment for chylothorax in dogs (Carobbi *et al*., 2008; da Silva and Monnet, 2011; Mayhew *et al*., 2012). Pre-operative thoracic duct imaging may reveal the cause of disruption of the thoracic duct (Naganobu *et al*., 2006; Johnson *et al*., 2009) or aid in surgical planning.

Recently, minimally invasive imaging methods have been reported in experimental settings. These methods involved imaging the thoracic duct using computed tomography (CT) after the injection of an iodine contrast agent into the superficial lymph nodes (i.e., popliteal lymph nodes) or subcutaneous tissue (Enwiller *et al*., 2003; Naganobu *et al*., 2006; Johnson *et al*., 2009; Millward *et al*., 2011; Singh *et al*., 2011; Ando *et al*., 2012).

In this report, we applied this method to a dog with chylothorax and found it helpful for imaging the thoracic duct in cases with primary and relapsed chylothorax.

Case Details

A 4-year-old male Japanese Shiba Inu weighing 4.08 kg was referred to Kagoshima University Veterinary Teaching Hospital. The dog had been injured in a traffic accident 2 years previously and presented with repeated dyspnoea caused by pleural effusion. Based on the diagnosis of chylothorax, the dog had been treated with low-fat diet therapy and rutin administration, as well as repeated thoracocentesis at another veterinary hospital. On initial examination, the dog exhibited mild respiratory distress (respiration rate of 52 breaths per min) and auscultation revealed a heart rate of 100 beats per min with sinus arrest observed at a frequency of one arrest per 30 beats. The dog had a body condition score of 2/5, although appetite and activity levels were normal.

The results of a complete blood cell count were within the normal ranges, but serum biochemistry showed elevation of C-reactive protein (61.0 mg/L: reference range 0–10 mg/L) and alkaline phosphatase activity (537 IU/L: reference range 104–239 IU/L). Thoracic radiography showed pleural effusion and a mass-like lesion with soft tissue opacity around the middle lobe. No abnormal findings were observed during echocardiography. Ultrasound-guided thoracocentesis was performed. Pleural fluid was chylous and hypertriglyceridemic (500 mg/dL), typical findings of chylothorax. Computed tomography revealed pleural effusion and collapse of the middle right lung lobe. Based on these findings and the patient's history, chylothorax secondary to a traffic accident was

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suspected. Thoracic duct imaging with CT was performed according to a previous publication (Ando *et al*., 2012), with minor modifications. A water-soluble contrast medium (iopamidol, OIPALOMIN 370 Inj., Konica Minolta, Tokyo, Japan), warmed to body temperature, was injected subcutaneously into four sites surrounding the dog's anus at a total dosage of 0.6 m*l*/kg using a 25-G 5/8 inch needle.

The sites was massaged for 2 min. The time was shortened from 5 min in the original report (Ando *et al*., 2012) to obtain earlier CT images. Images were obtained with a multi-detector helical CT scanner (Aquilion™ LB, TOSHIBA MEDICAL SYSTEMS, Tochigi, Ootawara, Japan) at 2, 8, 10 and 15 min after the injection. The timing of the scanning was also changed from the original study (Ando *et al*., 2012). The contrast medium reached the mediastinal lymph nodes at 10 min after injection and leakage of the contrast agent was detected at the anterior mediastinal lesion (Fig. 1).

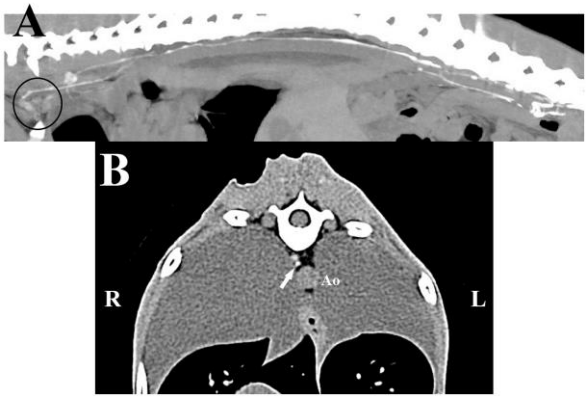

Fig. 1. Computed tomograph (CT)-generated lymphography of the thoracic duct prior to surgery. Imaging was performed using a multi-detector helical CT scanner 10 min after iopamidol injection into the subcutaneous tissue around the anus. (A) The lymphatic duct was identifiable in both the thoracic and abdominal cavities in the sagittal plane. The contrast agent blurred around the mediastinal lymph nodes (ellipse), indicating a leak into the thoracic cavity. (B) In the transverse plane at the eighth thoracic vertebra, a lymphatic duct (arrow) passing between the aorta (Ao) and azygos vein (asterisk) could be identified.

Thoracic duct ligation was planned at the eighth-ninth vertebrae, as the collateral of the thoracic duct was not observed in this lesion. The thoracic duct was approached via a right intercostal thoracotomy performed at the eighth intercostal space. Indocyanine green was injected into the subcutaneous tissue around the anus to allow visualization of the thoracic duct in the surgical field. The thoracic duct was ligated using vascular clips.

A pericardectomy was performed because the increased systemic venous pressure caused by a thickened pericardium may impede the drainage of chyle via the lymphatic venous communications (Fossum *et al*., 2004). A thoracostomy tube was inserted to allow the drainage of pleural fluid. Although the volume of chylous fluid initially decreased to 10 mL per day by 3 days after surgery, it subsequently increased. On day 7 post-surgery, 78 mL of pleural fluid was removed from the thoracostomy tube. A second lymphography was scheduled to clarify the cause of the relapse. During the second lymphography, the thoracic duct was completely ligated with vascular clips at the eighth thoracic vertebra. However, a collateral thoracic duct running along the left-hand side of the ligated duct was found (Fig. 2).

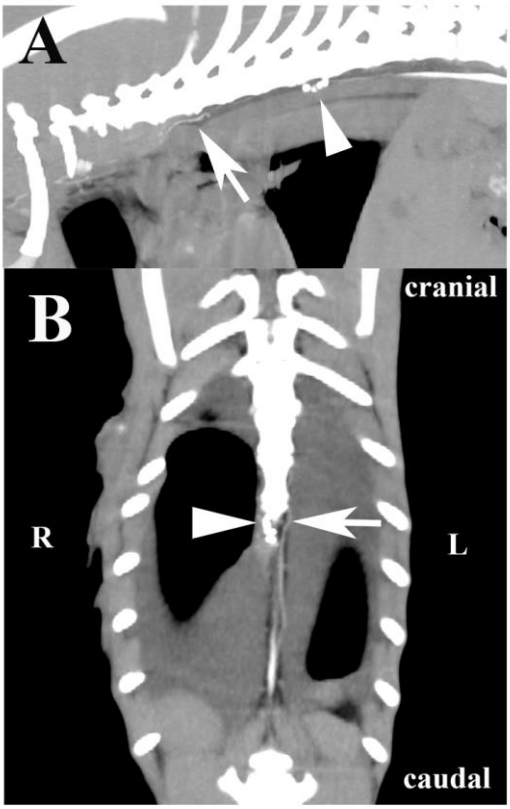

Fig. 2. Lymphography 7 days after thoracic duct ligation. Computed tomography imaging was performed 15 min after iopamidol injection into the subcutaneous tissue around the anus. (A) In the sagittal plane, the vascular clips used to ligate the thoracic duct during the first surgery can be seen (arrowheads). Thoracic tracts cranial to the vascular clips were also observed, indicating the incomplete blockade of lymph flow (arrows). (B) In the coronal plane, the collateral lymphatic duct (arrows) passing through the left side of the vascular clips (arrowheads) could be identified near the eighth vertebra.

This collateral thoracic duct was not detected at the first lymphography. A second surgery was performed via a

left intercostal thoracotomy and the collateral thoracic duct was ligated using vascular clips. Small volumes of pleural effusion were drained after the second surgery, but the fluid was not chylous nor hypertriglyceridemic. The thoracostomy tube was removed on day 5 after the second surgery. At 17 months after the surgery (at the time of writing), the dog was living without detectable pleural effusion.

Discussion

In this case report, a method of lymphography described by Ando *et al*. (2012) was successfully applied to a clinical case to aid planning of the surgical procedure. The injection of indocyanine green during the thoracotomy was helpful to visualize the thoracic duct in the surgical field. The indocyanine green is usually injected into the popliteal or mesenteric lymph nodes or cisterna chyli (Radlinsky *et al.*, 2002; Enwiller *et al*., 2003; Hayashi *et al*., 2005; Sicard and Mcanulty, 2005; Macdonald, 2008; Leasure *et al*., 2011; McAnulty, 2011; Mayhew *et al*., 2012).

The injection into perianal tissue is easier than into the popliteal nodes and less invasive than into the mesenteric lymph nodes, as there is no need for laparotomy. Adverse events caused by the injection were not observed in this case, other than local swelling and redness at the injection sites. The reaction was mild and relieved within 72 hrs (3 days). We applied this method to another case with chylothorax and delineated the thoracic duct successfully (data not shown). Because this method is easy to perform, it can be a technique of choice for thoracic duct imaging in chylothorax cases. The chylothorax relapsed after the first surgery and a second lymphography revealed the presence of a collateral lymphatic duct.

The recurrence of chylothorax has been reported in 0%–30 % of cases receiving thoracic duct ligation and pericardectomy (Fossum *et al*., 2004; Carobbi *et al*., 2008; Allman *et al*., 2010; da Silva and Monnet, 2011). Recurrence often occurs several months to a year after surgery and the development of a collateral lymphatic duct is thus thought to be a cause of recurrence (Kerpsack *et al*., 1995; Hayashi *et al*., 2005; Carobbi *et al*., 2008; da Silva and Monnet, 2011; McAnulty, 2011; Staiger *et al*., 2011; Mayhew *et al*., 2012).

In one case report, multiple collateral lymphatic ducts were detected by lymphography 50 days after thoracic duct ligation (Kerpsack *et al*., 1995). As there was only a single collateral duct (not multiple) and recurrence occurred soon after the first surgery, the hidden collateral lymphatic duct may have already existed at the time of the first surgery in this case. It may be worthwhile to try lymphography during surgery after thoracic duct ligation to detect hidden collateral lymphatic ducts to reduce the recurrence rate, if intraoperative CT is available.

In conclusion, CT-based lymphography involving the injection of a contrast agent into the perianal subcutaneous tissue is a minimally invasive and easy method of imaging the thoracic duct. It enabled the necessary imaging to be obtained for surgical treatment of a case of chylothorax. The method was also useful in the identification of the cause of recurrence after surgery with minimal invasion.

Conflict of interest

The authors declare that there is no conflict of interest.

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