

The accessory thoracic duct in a dog

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ABSTRACT

An unusual lymph vessel was found in a male dog of estimated age 5-6 years, probably a German shepherd and Rottweiler cross bred. At the level of the 11th right dorsal intercostal artery a common trunk arising from the cranial cisterna chyli divided into a very thin thoracic duct (ductus thoracicus) with a diameter of 1-2 mm and a much bigger lymphatic vessel with a diameter of 6 mm. The thoracic duct, very thin in its postcardiac segment, was situated in its normal anatomical position while the big lymphatic vessel extended cranially through the right mediastinum covered with the right mediastinal pleura (pleura mediastinalis dextra). It ran laterally to the origins of the right dorsal intercostal arteries, situated at the ventral border of the right azygos vein, the right surface of the oesophagus and the dorsal wall of the Sussdorff's cavity (cavum mediastini serosum). At the root of the right lung (radix pulmonis dextra) it crossed the ventral surface of the oesophagus, inclined to the left cranial mediastinum and drained into the thoracic duct. We recognized this large lymphatic vessel and its unusual course as the accessory thoracic duct - an anatomical variation with its origin in the embryonic development of the thoracic duct.

Key words: dog, *Canis familiaris*, accessory thoracic duct, ductus thoracicus accessorius, anatomical variation

Introduction

Exact anatomical knowledge of the lymphatic system is of great importance in the collection of lymph samples and the proper diagnosis and treatment of pathologic disorders related to the lymphatic system (EKEN et al., 2002). The thoracic duct is the chief collecting vessel of the lymphatic system (SISSON and GROSSMAN, 1956). It conveys lymph from

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the cisterna chyli to the venous angle and also receives efferent vessels from neighbouring lymphocentres (VOLLMERHAUS, 1981). Since the thoracic duct develops from a plexus of ducts in the embryo, considerable variation from its more usual course occurs (SISSON and GROSSMAN, 1956). The knowledge on the exact position of the thoracic duct and its lymph circulation is of great importance in thoracic surgery especially treatment of chylothorax. Namely, chylothorax is usually caused by leakage from the thoracic duct or one of the main lymphatic vessels that drain to it.

Variations in the course of the thoracic duct have been well documented in humans (review in SKANDALAKIS et al., 2007). CHEN et al. (2006) described a rare case of bilateral thoracic ducts with a coexistent persistent left cranial cardinal vein (vena cava superior) in a 77-year-old Japanese female. INOUE and MAKITA (1994) studied variations in the thoracic duct of Japanese monkeys and compared them with variations of the human (Japanese) thoracic duct. In domestic animals the topography of the thoracic duct has been well described in the cat (EKEN et al., 2002) and the dog (DE FREITAS et al., 1981). Despite the published research in thoracic lymph circulation in the dog (KUBIK and TÖMBÖL, 1958; ENWILLER et al., 2003; SHIBATA et al., 2006) reports on anatomic variations of the thoracic duct in the dog are rare. SISSON and GROSSMAN (1956) state that the thoracic duct may be single throughout, but often divides anteriorly into two branches, which may then unite and form a dilatation. He noted that other variations occur and the primitive plexiform arrangement persists in varying degrees. VOLLMERHAUS (1981) points out that a second vessel of the thoracic duct is not uncommon in the dog. The second, left vessel is situated dorsally and to the left of the aorta and is linked to the right vessel of the thoracic duct by cross anastomoses. GOMERČIĆ and ŠKRTIĆ (1981) described a case of an inverse position of the thoracic duct in a dog; e. g. the thoracic duct was situated in the right mediastinum and terminated in the right external jugular vein. RADLINSKY et al. (2002) determined thoracic duct anatomy by lymphangiography in five dogs and ESTERLINE et al. (2005) examined the thoracic duct and its branches by radiographic and computed tomography lymphangiography in 10 healthy female dogs, but none of these studies mentioned thoracic duct variations. Case reports on chylothorax in dogs (GELZER et al., 1997; KUMAR and RAMESH, 2007) and its treatment (VIEHOFF and STOKHOF, 2003) show that better knowledge of thoracic duct variations in dogs is urgently needed. The described accessory thoracic duct in a dog presented in our study should contribute to the knowledge on thoracic duct variations and should be considered in thoracic surgery and chylothorax treatment.

Materials and methods

The study was performed on two dog carcasses used for dissection in a gross anatomy course at the Department of Anatomy, Histology and Embryology Faculty of Veterinary Medicine University of Zagreb, Croatia. The accessory thoracic duct was studied in a

male castrated dog, probably a German shepherd and Rottweiler cross bred. The estimated body mass of the dog was 40 kg and the age was about 5-6 years. The control dog was a cross bred of similar body mass and age. Both animals were fixed with 10% formalin. The right wall of the thoracic cavity and the right lung were removed for the study of the right mediastinum in both animals. The origin, course and termination of the large thoracic lymphatic vessels were revealed by fine dissection, and the observations were recorded and photographed.

Results

The cisterna chyli, well filled with coagulated reddish-brown muddy lymph, was situated on the right dorsal border of the abdominal aorta at the level of the first lumbar vertebrae. The cranial part of the cisterna chyli divided into two trunks. These two trunks united at the level of the last dorsal intercostal arteries to a common trunk running cranially medial to the right 13th, 12th and 11th dorsal intercostal arteries. At the level of the right 11th dorsal intercostal artery the common trunk divided into two vessels with different diameters.

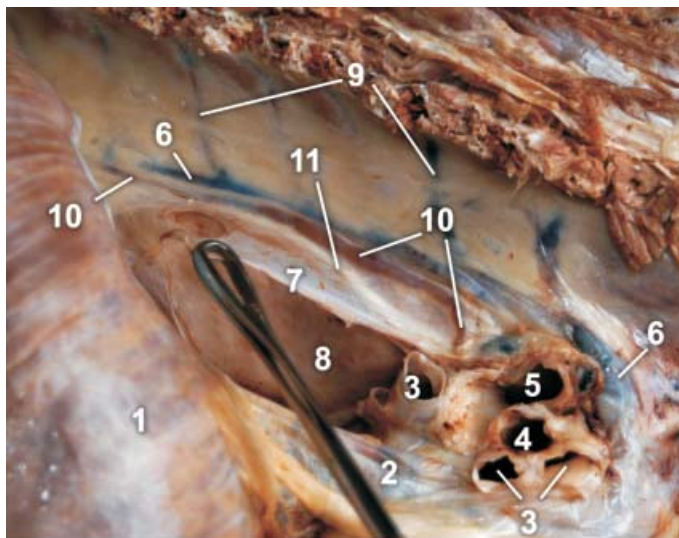


Fig. 1. The course of the accessory thoracic duct in the dorsal mediastinum - right lateral view.
1 - diaphragm, 2 - vena cava caudalis, 3 - venae pulmonales, 4 - arteria pulmonalis dextra, 5 - bronchus principalis dexter, 6 - vena azygos dextra, 7 - dorsal wall of the Sussdorff's cavity (open), 8 - oesophagus, 9 - venae intercostales dorsales, 10 - ductus thoracicus accessorius, 11 - truncus vagalis dorsalis dexter or ramus oesophagicus dorsalis nervi vagi dexter

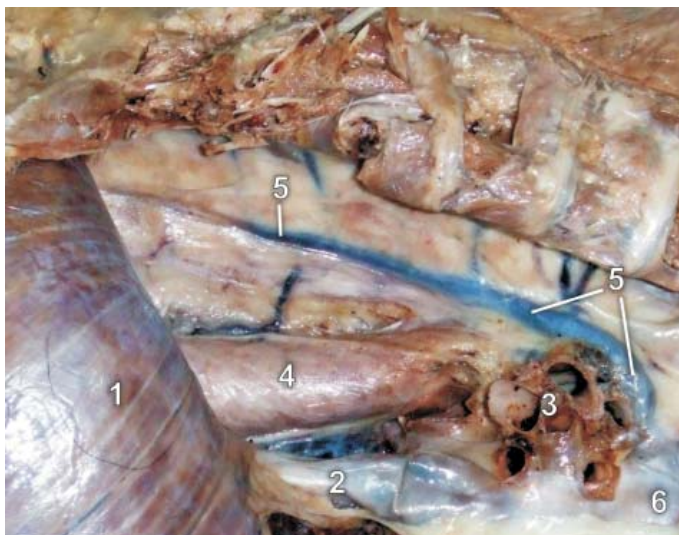


Fig. 2. Mediastinum of the control dog - right lateral view: 1 - diaphragm, 2 - vena cava caudalis, 3 - radix pulmonis, 4 - oesophagus, 5 - vena azygos dextra, 6 - vena cava cranialis

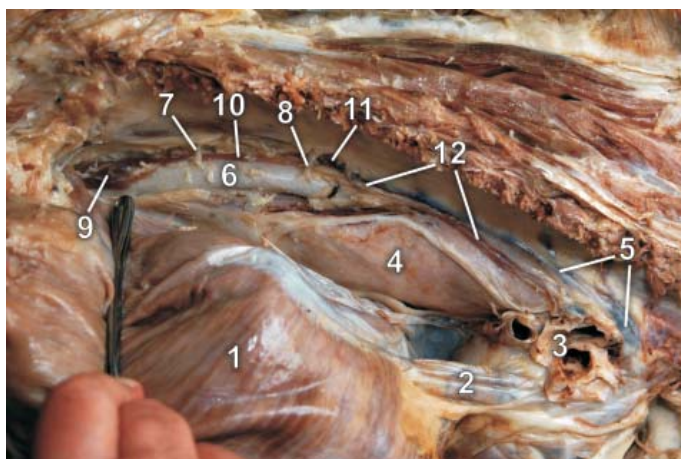


Fig. 3. The accessory thoracic duct and cisterna chyli - right lateral view: 1 - diaphragm, 2 - vena cava caudalis, 3 - radix pulmonis, 4 - oesophagus, 5 - vena azygos dextra, 6 - aorta, 7 - last (13th) right dorsal intercostal artery, 8 - right 11th dorsal intercostal artery, 9 - cisterna chyli, 10 - common trunk of two united cranial trunks of cisterna chyli, 11 - very thin postcardial thoracic duct, 12 - accessory thoracic duct

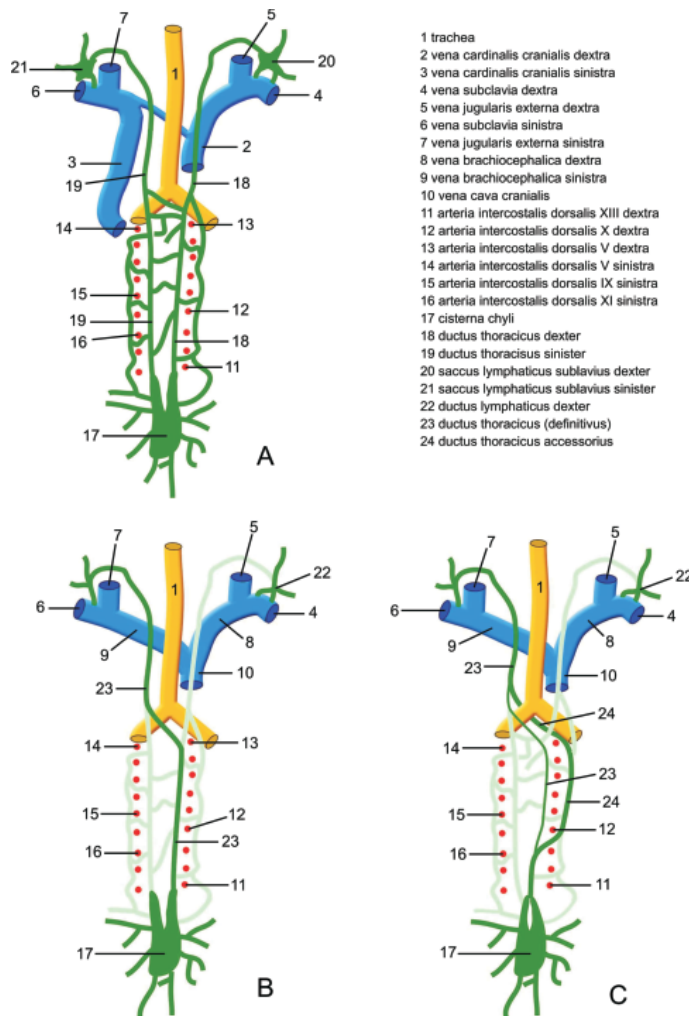


Fig. 4. Diagram showing the development of the thoracic duct and the presumed development of the accessory thoracic duct in the dog - dorsal view. The obliterated components are indicated by light green colour; A - early embryonic lymphatic vessels; B - normal thoracic duct; C - accessory thoracic duct.

The thinner vessel was identified as the thoracic duct. It was only 1-2 mm in diameter, fully developed and well filled with lymph. It was situated medial to the origins of the dorsal intercostal arteries, emerging directly from the aorta, ran cranially dorsal to the thoracic aorta and ventral to the right azygos vein. In the cranial mediastinum the thoracic duct reached the left and ventral surface of the oesophagus. At this level a large lymphatic vessel, identified as the accessory thoracic duct, drained into the thoracic duct. The thoracic duct continued its course cranioventrally through the left cranial mediastinum, covered with left mediastinal pleura, but now as a much larger vessel, with a diameter of about 9 mm. Immediately before its termination in the left venous angle (the junction of the left subclavian and the left external jugular veins), the thoracic duct received the left tracheal duct (truncus trachealis sinister).

The bigger lymphatic vessel, originating from the common trunk, had a diameter of about 6 mm. It left the course dorsal to the aorta by crossing the origin of the 11th intercostal arteries. Cranially it ran laterally to the origins of the right 10th, 9th and 8th dorsal intercostal arteries, surrounded by fat and covered with the right mediastinal pleura. This lymphatic vessel was identified as the accessory thoracic duct (ductus thoracicus accessorius). In its caudal mediastinal course the accessory thoracic duct ran on the dorsal border of the cavum mediastini serosum (Sussdorff's cavity), the right-hand surface of the oesophagus and directly on the ventral border of the right azygos vein, up to the level of the right fifth dorsal intercostal vein, e.g. 3.5 cm caudally of the right azygos vein opening into the right atrium (Figs. 1 and 3). Here the accessory thoracic duct reached the root of the lung and extended to the concave surface of the tracheal bifurcation. At this level, vessels from middle mediastinal lymph nodes, situated directly on the caudal side of the tracheal bifurcation, opened into the accessory thoracic duct. Cranially, the accessory thoracic duct ran on the right surface of the oesophagus directly on the concave side of the tracheal bifurcation. It ran ventrally, crossed the ventral surface of the oesophagus and inclined to the left cranial mediastinum, where it terminated in the thin thoracic duct.

In the control dog the origin, course and termination of the thoracic duct were in concordance with the normal anatomical position described in literature. There was no macroscopically visible accessory thoracic duct (Fig. 2).

Discussion

As already described in literature (GRAU, 1943; VOLLMERHAUS, 1981) the thoracic duct of the studied dog arose as a double trunk from the cisterna chyli. Its postcardiac segment was situated dorsal to the thoracic aorta and ventral to the right azygos vein. The thoracic duct may subsequently divide (GRAU, 1943; VOLLMERHAUS, 1981), which was the case in the studied dog, but the position of the second vessel described in the literature (GRAU, 1943; VOLLMERHAUS, 1981) does not correspond to the position of the accessory

thoracic duct described in our study. Namely, the second vessel passes dorsally and to the left of the aorta (GRAU, 1943; VOLLMERHAUS, 1981) while in the studied dog the second vessel, much bigger than the thoracic duct, ran from the dorsal border of the aorta to its right surface, situated laterally to the right dorsal intercostal arteries, directly under the right mediastinal pleura.

The case described in our study is most similar to the inverse thoracic duct found in a German shepherd crossbred bitch about 6-8 years old (GOMERČIĆ and ŠKRTIĆ, 1981), although there is a significant difference in the precardiac segment. Namely, the inverse thoracic duct (GOMERČIĆ and ŠKRTIĆ, 1981) ran through the right cranial mediastinum and drained about 3 to 4 cm cranial to the first right rib into the right external jugular vein. In contrast, the accessory thoracic duct described in our study inclined to the left side in the middle mediastinum, crossing the oesophagus ventrally, and drained into the thoracic duct, which terminated in the left venous angle.

In their study of a fatal chylothorax in a ten year old male spitz, KUMAR and RAMESH (2007) did not mention if the left or right pleural cavity, or both, were involved, nor where the chylus originated from. They stated that the chylothorax was caused by the torsion of the left cranial lung lobe, so one can presume that the torsion caused ruptures of the lymphatic vessels in the root of the left lung or even lesions of the thoracic duct itself, as it is normally situated in that region. This presumption would also prove the normal anatomical course of the thoracic duct in the described spitz. In contrast, the chylothorax associated with torsion of the accessory lung lobe in an Afgan hound (GELZER et al., 1997) could be connected to an accessory thoracic duct, as described in this study, or an inverse thoracic duct, as described by GOMERČIĆ and ŠKRTIĆ (1981).

Variations in the course of the thoracic duct are recognised as failure of the normal developmental pattern to progress in the usual manner (CHEN et al., 2006). We presume that the accessory thoracic duct described in our study developed from embryonic lymphatic vessels situated laterally to the right dorsal intercostal arteries which formed a large lymphatic vessel recognized as the accessory thoracic duct (Fig. 4). We conclude, as already stated by AKCALI et al. (2006), that anatomic variations of the thoracic duct are numerous and must be considered to avoid complications during surgery.

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SAŽETAK

U psa mase 40 kg u dobi oko 5 do 6 godina, vjerojatno križanca između njemačkoga ovčara i rotvajlera, nađena je i opisana neuobičajena limfna žila. Ova velika limfna žila izlazi iz zajedničkoga debla čiji početak čini cisterna chyli. U visini 11. desne dorzalne međurebrene arterije ovo zajedničko deblo dijeli se na vrlo tanak glavni limfni vod (ductus thoracicus) promjera 1-2 mm i znatno veću limfnu žilu promjera 6 mm. Glavni limfni vod, koji je izrazito tanak u svom postkardijalnom dijelu nalazi se u normalnom anatomskom položaju dok se druga velika limfna žila usmjeruje kranijalno kroz desni dio sredoprsta (mediastinum) ležeći neposredno pod desnom sredoprskom pleurom (pleura mediastinalis dextra). Ova velika limfna žila leži lateralno od korijena desnih dorzalnih međurebrenih arterija, prati ventralnu površinu desne neparne vene (vena azygos dextra), leži uz desnu površinu jednjaka i uz dorzalnu stijenku Sussdorffove šupljine (cavum mediastini serosum), sve do desnoga plućnoga korijena (radix pulmonis dextra). Tu skreće na lijevu stranu prolazeći s lijeve i ventralne strane jednjaka i ulijeva se u glavni limfni vod. Ovu veliku limfnu žilu neuobičajenog položaja označili smo kao dodatni vod glavnog limfnog voda (ductus thoracicus accessorius). Smatramo da je dodatni vod glavnoga limfnoga voda anatomska varijacija koja je nastala tijekom embrionalnoga razvoja glavnoga limfnoga voda.

Cljučne riječi: pas, *Canis familiaris*, dodatni glavni limfovod, ductus thoracicus accessorius, anatomska varijacija
