Latissimus Dorsi Muscle Flap-Augmented Closure for Esophageal Perforation in a Dog

Mikyung Kim[1]

Junbeom Kim[1]

Soonwuk Jeong[1]

Hun-Young Yoon[1]

Jung-Hyun Kim[2]

[1]Department of Veterinary Surgery, College of Veterinary Medicine, Konkuk University, Seoul, Republic of Korea

[2]Department of Veterinary Internal Medicine, College of Veterinary Medicine, Konkuk University, Seoul, Republic of Korea

Corresponding author: Dr. Hun-young Yoon,

Department of Veterinary Surgery, College of Veterinary Medicine, Konkuk University, Seoul 05029, Republic of Korea, Email: yoonh@konkuk.ac.kr

KEY WORDS: canine esophageal perforation; foreign body ingestion; latissimus dorsi muscle flap

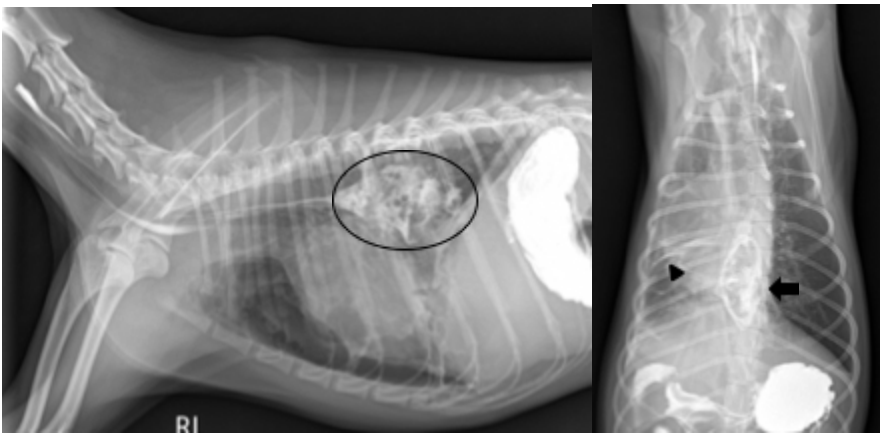
ABSTRACT

A 2-year-old castrated male Maltese dog weighing 3.48 kg was referred for evaluation of lethargy, dyspnea, and anorexia that had persisted for 5 days. On physical examination, drooling, labored breathing, and depression were identified. Laboratory examination findings included marked leukocytosis and elevated C-reactive protein levels. Survey radiographs revealed pleural effusion and pneumothorax. Contrast esophagograms showed leakage caudal to the base of the heart. Based on these findings, a diagnosis of esophageal perforation was made. Endoscopy was then performed and revealed ingested bone. After a muscle-sparing thoracotomy through the right fifth intercostal space, the esophageal perforation was identified caudal to the base of the heart. After removal of the foreign body, a 4- × 4.5-cm beef bone fragment, necrotic tissues were minimally removed by surgical debridement. Closure of the esophagus was performed using a double-layer suture pattern and was supported with a latissimus dorsi muscle flap through the fourth intercostal space. An esophagostomy tube was placed for 3 weeks post-operatively. A liquid diet was fed orally for 1 week after esophagostomy tube removal. Clinical signs were resolved, and the dog was discharged 4 weeks post-operatively. There was no evidence of drooling, labored breathing, and regurgitation by 4 months postoperatively. Hence, the latissimus dorsi muscle flap could be considered a useful approach for veterinarians when performing esophagus surgery.

INTRODUCTION

Esophageal foreign body ingestion often presents as an emergency in veterinary

Figure 1. *Positive contrast esophagogram. On the right lateral view, it shows leakage of contrast medium (circle) at the caudal part of the thoracic esophagus (A). On the ventrodorsal view, there is a fissure line (arrow head) composed of contrast medium between the right middle and caudal lung lobe region (B). There is a filling defect at the caudal part of the thoracic esophagus (arrow).*



medicine.[1,2] Dogs are predisposed to esophageal foreign bodies due to their tendency to eat indiscriminately and swallow without chewing.[3] The most common types of foreign bodies ingested are bones, followed by rawhides, balls, toys, dog treats, fish hooks, carpets, and pieces of wood.[2] Esophageal foreign bodies may be identified in all sites in the esophagus, but the most frequently reported sites are the thoracic inlet, heart base, and distal portion of the esophagus between the heart base and diaphragm.[2,4] Clinical symptoms include lethargy, anorexia, retching, regurgitation, ptyalism, dysphagia, and distress.[2,5] Radiography is used for the initial diagnostic evaluation of dogs presenting with foreign body ingestion.[4] As soon as the diagnosis is made, the esophageal foreign body should be removed to prevent pressure necrosis and esophageal perforation.[1,6]

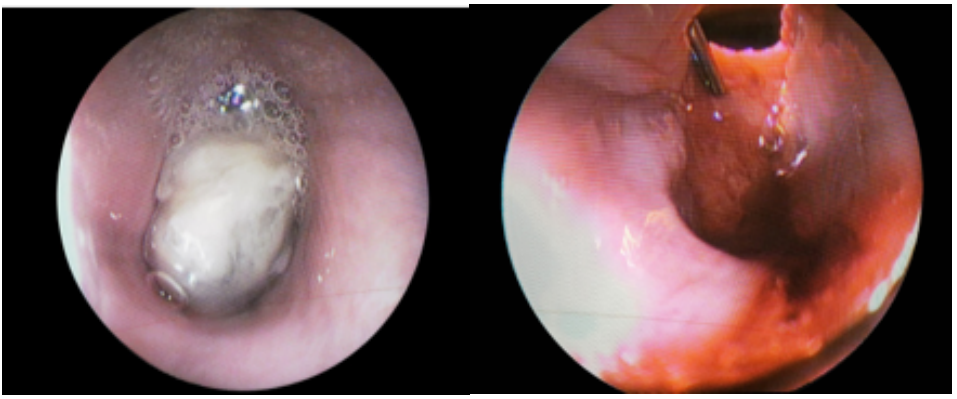
Foreign bodies in the thoracic esophagus can be removed by several methods, including esophagoscopy, gastrotomy, and transthoracic esophagotomy.[5] Endoscopy can first be attempted to retrieve the foreign body per os, or to dislodge it into the stomach.[7] If removal by esophagoscopy fails, a surgical intervention should be performed immediately.[2]

Esophageal surgery can be associated with life-threatening complications, including esophageal stricture, aspiration pneumonia, esophageal perforation, mediastinitis, and pneumothorax, since a number of factors, such as poor blood supply and continuous peristaltic activity at the surgical site, may contribute to incomplete healing of the esophagus.[5,8] Reinforcing esophageal suture with the latissimus dorsi muscle in a dog has not been described previously. The purpose of this case report was to describe the successful surgical management of esophageal perforation caused by a foreign body using latissimus dorsi muscle flap-augmented closure in a dog.

CASE PRESENTATION

A 2-year-old castrated male Maltese dog weighing 3.48 kg was presented with lethargy, dyspnea, and anorexia that had been persistent for 5 days. The owner reported that the dog had ingested a beef leg bone 5 days prior to presentation, and that depression, diarrhea, and dyspnea had been observed. On the following day, the referring veterinarian had detected a foreign body in the thoracic esophagus on radiographic examination. Removal of the foreign body was attempted using endoscopy, but this approach failed. After 3 days, the foreign body

Figure 2. *Endoscopic findings. Appearance of the esophageal foreign body within the esophagus, preoperatively (A). The esophageal lumen was inspected intraoperatively, and there was mucosal ulceration and necrotic tissue around the perforation site (B).*



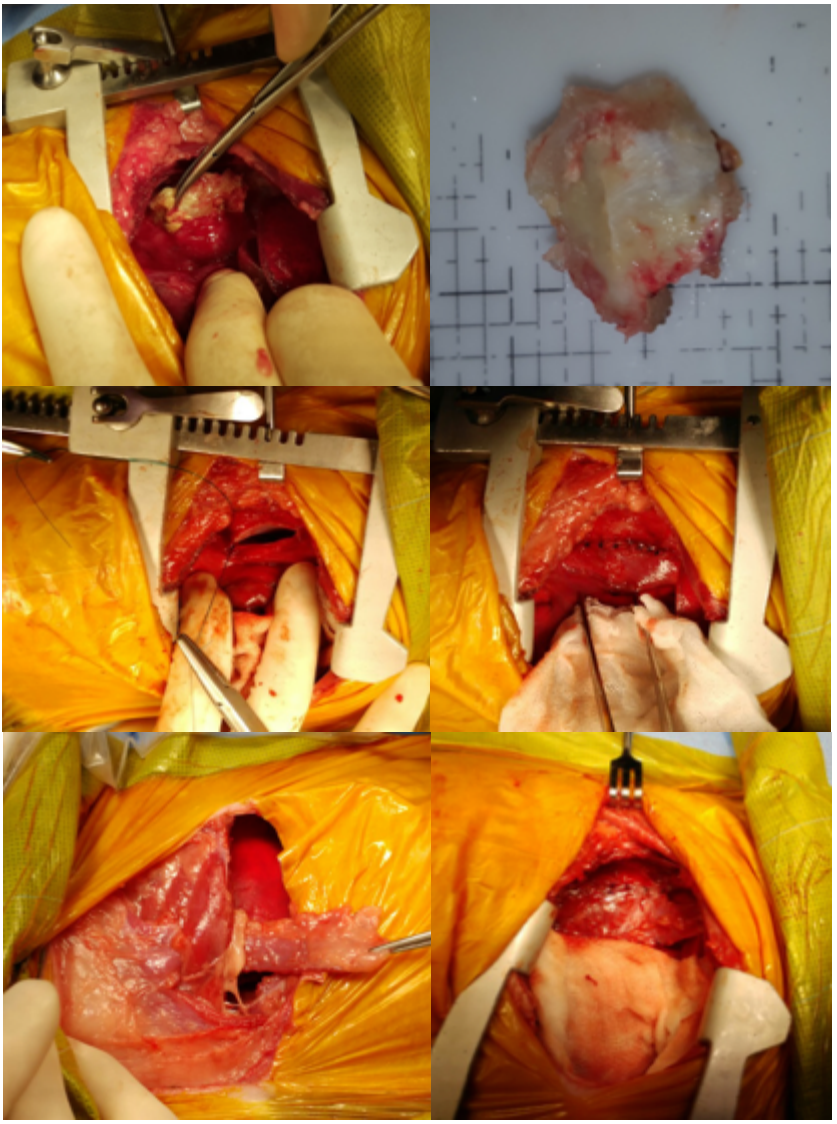
had still not moved, so the dog was referred to our hospital. On initial presentation, drooling, labored breathing, and depression were noted. Survey radiographs revealed a foreign body, pleural effusion, and pneumothorax. A contrast esophagogram showed leakage of contrast medium (OmnipaqueTM 300 mg; GE Healthcare Co., U.S.A.) caudal to the base of the heart (Figure 1). Endoscopic examination revealed the ingested bone caudal to the base of the heart (Figure 2). Surgical removal of the foreign body was indicated since retrieval or advancement of the foreign body had failed.

Complete blood cell count revealed that the white blood cell count (22.72 × 109/l; reference range, 5.05–16.76 × 109/l) was elevated, and there was no evidence of anemia. On serum biochemical analysis, increased aspartate aminotransferase (75 U/l; reference range, 0–50 U/l), alkaline phosphatase (221 U/l; reference range, 23–212 U/l), creatine kinase (375 U/l; reference range, 10–200 U/l), and lactate dehydrogenase (835 U/l; reference range, 40–400 U/l) levels were noted. Additionally, decreased calcium (7.6 mg/dl; reference range, 7.9–12 mg/dl), total protein (5 g/dl; reference range, 5.2–8.2 g/dl), and albumin (2.2 g/dl; reference range, 2.3–4 g/dl) levels were observed.

To remove the esophageal foreign body, transthoracic esophagotomy was chosen. The dog was premedicated with cefazolin 30 mg/kg intravenously (IV) (Cefozol inj. ®; Koruspharm. Co., Ltd., Seoul, Korea), atropine 0.01 mg/kg subcutaneously (SC) (Atropine sulfate inj. ®; Jeil Pharm. Co., Ltd., Seoul, Korea), and butorphanol 0.1 mg/kg IV (Butophan Inj. ®; Myungmoon Pharm. Co., Ltd., Seoul, Korea) followed by anesthetic induction with propofol 4 mg/kg IV (Provive Inj. ®; Myungmoon Pharm. Co., Ltd., Seoul, Korea). The dog was intubated, and the anesthesia was maintained with isoflurane (Isoflurane®; Choongwae Co., Ltd., Seoul, Korea) and oxygen. The dog was placed in left lateral recumbency. Esophageal foreign body removal was performed via a right fifth intercostal thoracotomy. After a muscle-sparing thoracotomy, serosanguinous pleural effusion was observed, and suction was performed. The esophageal perforation site at the base of the heart was exposed. A foreign body was observed in the perforated area and was removed through the perforation site.

The foreign body was grasped using curved mosquito forceps and removed by gentle manipulation and traction (Figure 3A). The foreign body was a 4.0 × 4.5 cm beef bone fragment (Figure 3B). The esophageal perforation site, which was 2.4 cm in length longitudinally, was identified after removal of the foreign body (Figure

Figure 3. *Intraoperative photographs of the foreign body removal and latissimus dorsi muscle flap-augmented closure. The esophageal wall perforation and foreign body can be seen (A). The foreign body is a 4.0 × 4.5 cm beef bone fragment (B). Closure of the esophagus is performed using a double-layer suture pattern (C, D). The designed latissimus dorsi muscle flap (asterisk) is introduced into the thoracic cavity through the fourth intercostal space (E). The flap is placed over the esophageal suture site (F).*



3C). The esophageal lumen was inspected by endoscopy to assess whether secondary damage had been caused by the foreign body (Figure 2). In the region of the esophageal perforation, mucosal ulceration and necrotic tissue were observed around the perforation site; these were removed by surgical debridement.

Closure of the esophagus was performed with a double-layer suture pattern using 4-0 polyglyconate (Maxon®; Covidien Animal Health and Dental Division, Fridley, MN, USA). The first layer incorporated the submucosa and the mucosa, and the knots were placed in the esophageal lumen. The second layer consisted of the muscularis and

adventitia, which were closed with a simple interrupted suture and the knots were placed extraluminally (Figure 3D).

To augment esophageal perforation closure, a latissimus dorsi muscle flap was used to support wound healing. Dorsally retracted latissimus dorsi muscle was incised from the second rib to the seventh rib and was designed to have a rectangular shape. Thus, a latissimus dorsi muscle flap 10 cm in length and 2 cm in width, was created. The flap was introduced into the thoracic cavity through the fourth intercostal space (Figure 3E). The root of the latissimus dorsi muscle flap was sutured to the periosteum of the fifth rib, to relieve tension. The muscle flap was placed over the perforation closure site, and was sutured to the esophageal wall using a simple interrupted suture pattern (Figure 3F). The thoracic cavity was lavaged three times with warm normal saline solution (0.9 %), and a chest tube (12-French gauge) was placed before thoracic closure. Initial recovery from the anesthesia was uneventful.

In the postoperative period, oral intake of food and water was avoided, and an esophagostomy tube was placed caudal to the esophageal suture region to facilitate early nutritional support. The esophagostomy tube was removed 3 weeks post-operatively. The chest tube was aspirated three times daily, and removed 3 days postoperatively when serosanguineous fluid production was below 1 ml/kg/day. Metronidazole 15 mg/kg IV (Metrinal inj.®, Daehan Newpharm. Co., Ltd, Korea), enrofloxacine 5 mg/kg SC (Baytril®, Bayer Korea Co., Ltd, Seoul, Korea), cefazoline 30 mg/kg IV (Cefozol inj.®; Koruspharm. Co., Ltd., Soul, Korea), and famotidine 0.5 mg/kg IV (Gaster®, Dong-A ST. Co., Ltd, Seoul, Korea) were prescribed for 7 days post-operatively.

After esophagostomy tube removal, a liquid diet was fed orally for 1 week. Clinical signs were resolved, and the dog was discharged 4 weeks postoperatively. There was no evidence of drooling, labored breathing, depression, and regurgitation 4 months post-operatively. The patient follow-up was completed by telephone 1 year post-operatively, and the owner reported that there was no evidence of complications related to surgery.

DISCUSSION

Esophageal perforation by a foreign body generally has a poor prognosis. Moreover, if treatment is delayed for more than 24 hours after perforation, the ingesta, saliva, retained gastric contents, and air leak into the thoracic cavity, resulting in life-threatening complications including mediastinitis, pneumomediastinum, pneumothorax, hemothorax, pyothorax, and pleuritic.[2] Delay in the diagnosis and initial treatment of the esophageal perforation may cause development of necrotic mediastinitis and preclude the possibility of primary repair.[3] Therefore, early diagnosis and treatment of esophageal perforation are essential for preventing the aforementioned life-threatening conditions.[6,9] In the case reported here, the time between injury and surgical intervention exceeded 3 days. While the local veterinarian was waiting for spontaneous movement of the foreign body to the stomach, leakage through the esophageal perforation site persisted and pleural effusion and pleuritis occurred.

Esophageal perforation is described in the literature as being manageable both by conservative means and by surgical repair.[3] Although successful medical management of esophageal perforation has been reported in several cases, experimental esophageal perforation has demonstrated that a perforation site up to only 12 mm in diameter can contract and heal.[10] However, the negative intrathoracic pressure can cause rapid infection of the mediastinum and the pleura after esophageal perforation, and fatal complications might arise while waiting for the perforation to heal. Therefore, prompt aggressive treatment, including surgical intervention, is necessary to manage esophageal perforation.[11]

Nevertheless, surgeons are reluctant to perform esophageal surgery due to the risk factors for esophageal healing and lack of

information about a surgical technique for management of esophageal perforation in the literature. Esophageal surgery is generally considered laborious and the difficulties inherent to the esophageal surgery result in a high incidence of complications, such as anastomotic leakage, dehiscence, and stenosis resulting from the surgery.[2] Matt et al. described the proper suture pattern for esophagotomy closure in healthy dogs. The double-layer appositional technique was reported to provide excellent immediate wound strength and good tissue apposition and healing.[12] However, even if the proper suture pattern has been used, additional support of esophageal suture sites may be necessary if necrosis at the repair site is suspected.[13] The esophagus is difficult to heal because of its segmental blood supply, lack of serosal layer, constant motion, extensive tension, and continuous stimulation by food and saliva.[12,14] The absence of a serosal layer also makes healing of the esophagus a time-consuming process, unlike healing in the rest of the alimentary tract.[2] Owing to these characteristics, additional tissue or material may be required to provide structural continuity, tissue integration, and anastomosis of the surgical sites, as well as a safe suture pattern.

In the case reported here, the necrotic tissue was identified at the time of surgery, and surgical debridement and decortication were performed. Although a double-layer suture pattern was used, it could not guarantee perfect healing of the esophageal suture site. Delayed esophageal perforation and presence of friable esophageal tissues makes more difficult to induce primary repair.[15] Richardson et al. reported successful primary closure of esophageal perforations by use of muscle flap in extensive esophageal defect in feline model.[16] Additional reinforcement at the esophageal surgical site is required to prevent complications, including dehiscence and leakage.[13]

For decades, intrathoracic muscle transposition has been used to reinforce the anastomosis site at the trachea, esophagus, and great vessels in human medicine.[17] A muscle flap promotes healing of wound injuries by enhancing neovascularization and increasing oxygen supply.[18] Furthermore, a muscle flap provides an extra layer of protection, reducing the risk of leakage and dehiscence.[19] A muscle flap is commonly used in esophageal surgery for reinforcing anastomosis and site closure.[20]

Most commonly, a longus colli muscle flap, diaphragmatic flap, intercostal muscle flap, and pectoralis major muscle flap have been used for esophageal reinforcement.[14,20] The intercostal muscle flap has been used in esophageal surgery due to its blood supply, wide range of rotation, and accessibility.[20] The longus colli muscle flap and pectoralis muscle flap have also been used in human medicine, because of their anatomical location and its ease of transfer to the esophagus.[14] However, in the extensive region of the esophageal perforation in this case, the intercostal muscle has insufficient muscle volume and the pectoralis muscle has limited length and mobility applied on the lesion. Longus colli muscles have the disadvantage of possibility to injure the sympathetic trunk, and diaphragmatic flap has limitation that it can be applied only caudal portion of esophagus.[14] In veterinary medicine, long-term follow-up of a tubed latissimus dorsi musculocutaneous flap, used experimentally in six puppies to replace a circumferential thoracic esophageal defect, revealed that the graft tolerated a long period of feeding with a normal diet without any complications.[21] Appropriate selection of the types of muscle flaps is essential to providing healing and sufficient coverage of the esophageal repair site.[14]

The latissimus dorsi muscle flap is currently one of the most frequently used flaps in reconstructive surgery in veterinary medicine.[22] The latissimus dorsi muscle is flat, covers the dorsal half of the lateral thoracic wall, and has been used extensively to repair defects of the trachea and diaphragm,

and for reconstruction of the head and neck, the chest, and the upper arm.[19] Using a latissimus dorsi muscle flap is less invasive than using the omentum, pericardium, small intestine, or stomach.[23] A thoracodorsal vascular pedicle is dominant and provides an extremely stable blood supply to the latissimus dorsi muscle. This allows a vascular attachment of the suture site to be maintained, improving healing by abundant blood flow.[10] The well-vascularized latissimus dorsi muscle provides the oxygen, nutrients, and neutrophils necessary to promote healing.[19] The flexibility of the muscle allows the flap to be mobilized easily to anywhere on the esophagus without causing tension to the esophageal defect.[21] A previous experimental report has described the successful use of the latissimus dorsi muscle flap for repairing tracheal defects.[19] In the present case report, the latissimus dorsi muscle flap-augmented closure for esophageal perforation resulted in no complications, such as fistula, leakage, stricture formation, and dehiscence.

Some surgical considerations may increase the likelihood of a successful surgery. In this case, the latissimus dorsi muscle flap was introduced through the fourth intercostal space and sutures were applied to the periosteum of the fifth rib and base of the latissimus dorsi muscle flap. The sutures help to ensure that the flap is positioned reliably, without tension at the suture site. A tension-relieving suture is effective for reducing tension at the esophageal suture site during peristalsis of the esophagus. The flap was designed to be wide enough for sufficient coverage and augmentation of the esophageal repair site.

To our knowledge, latissimus dorsi muscle flap-augmented closure for esophageal perforation has not been described previously. This technique is safe, and no complications were identified in this case after one year. The latissimus dorsi muscle flap could be considered a useful approach for veterinarians when performing esophagus surgery. Further studies of a large case series with clinical long-term follow up are necessary to evaluate the reliability of latissimus dorsi muscle flap-augmented closure for esophageal perforation.

REFERENCES

1. Luthi C, Neiger R. Esophageal foreign bodies in dogs: 51 cases (1992–1997). *European Journal of Comparative Gastroenterology*. 1998; 3:7–11.
2. Thompson HC, Cortes Y, Gannon K, Bailey D, Freer S. Esophageal foreign bodies in dogs: 34 cases (2004–2009). *Journal of Veterinary Emergency and Critical Care*. 2012; 22(2):253–261.
3. Pearson H. Symposium on conditions of the canine oesophagus*—I foreign bodies in the oesophagus. *Journal of Small Animal Practice*. 1966; 7(2):107–116.
4. Leib MS, Sartor LL. Esophageal foreign body obstruction caused by a dental chew treat in 31 dogs (2000–2006). *Journal of the American Veterinary Medical Association*. 2008; 232(7):1021–1025.
5. Sale CS, Williams JM. Results of transthoracic esophagotomy retrieval of esophageal foreign body obstructions in dogs: 14 cases (2000–2004). *Journal of the American Animal Hospital Association*. 2006; 42(6):450–456.
6. Spielman B, Shaker E, Garvey M. Esophageal foreign body in dogs: A retrospective study of 23 cases. *Journal of the American Animal Hospital Association*. 1992; 28:570–574.
7. Yoon H, Kang M, Jeong S. Gastrotomy approach retrieval of esophageal foreign body using long forceps technique in five dogs. *Journal of Veterinary Clinics*. 2009; 26(6):628–631.
8. Deroy C, Corcuff JB, Billen F, Hamaide A. Removal of oesophageal foreign bodies: Comparison between oesophagoscopy and oesophagotomy in 39 dogs. *Journal of Small Animal Practice*. 2015; 56(10):613–617.
9. Ryan W, Greene R. Conservative management of esophageal foreign bodies and their complications: A review of 66 cases in dogs and cats. *Journal of the American Animal Hospital Association*. 1975; 11(3):243–249.
10. Killen DA, Pridgen WR. Tolerance of the dog to esophageal perforation. *Journal of Surgical Research*. 1961; 1(4):315–317.
11. Petrone P, Kassimi K, Jiménez-Gómez M, Betancourt A, Axelrad A, Marini CP. Management of esophageal injuries secondary to trauma. *Injury.* 2017; 48(8):1735–1742.
12. Oakes MG, Hosgood G, Snider TG, Hedlund CS, Crawford MP. Esophagotomy closure in the dog: A comparison of a double-layer appositional and two single-layer appositional techniques. *Veterinary Surgery*. 1993; 22(6):451–456.
13. Bouayad H, Caywood D, Alyakine H, Lipowitz A, Liepold H. Surgical reconstruction of partial circumferential esophageal defect in the dog. *Journal of Investigative Surgery*. 1992; 5(4):327–342.
14. Haku T, Okuda S, Kanematsu F, Oda T, Miyauchi A, Yamamoto T, Iwasaki M. Repair of cervical esophageal perforation using longus colli muscle

flap: A case report of a patient with cervical spinal cord injury. *The Spine Journal*. 2008; 8(5): 831–835.

15. Kotzampassakis N, Christodoulou M, Krueger T, Demartines N, Vuillemier H, Cheng C, Dorta G, Ris H. Esophageal leaks repaired by a muscle onlay approach in the presence of mediastinal sepsis. *The Annals of Thoracic Surgery*. 2009; 88(3):966–972.
16. Richardson JD, Martin LF, Borzotta AP, Polk HC. Unifying concepts in treatment of esophageal leaks. *The American Journal of Surgery*. 1985; 149(1):157–162.
17. Fujita H, Kawahara H, Kakegawa T, Yamana H, Machi J, Yoshimatsu H. Intrathoracic application of the latissimus dorsi muscle for esophageal cancer operation. *The Japanese Journal of Surgery*. 1987; 17(3):217–219.
18. Nicoll SA, Fowler JD, Remedios AM, Clapson JB, George D. Development of a free latissimus dorsi muscle flap in cats. *Veterinary Surgery*. 1996; 25(1):40–48.
19. Fujita H, Kawahara H, Hidaka M, Yoshimatsu H. The latissimus dorsi muscle flap is useful for the repair of tracheal defects—an experimental study. *The Japanese Journal of Surgery*. 1987; 17(2):91–98.
20. Kwek BH, Wain JC, Aquino SL. The radiologic appearance of intercostal muscle flap. *The Annals of Thoracic Surgery*. 2004; 78(2):432–435.
21. Yamataka A, Wang K, Kobayashi H, Segawa O, Miyahara K, Sueyoshi N, Miyano T. Tubed latissimus dorsi musculocutaneous flaps for esophageal replacement in puppies: Long-term follow-up. *Journal of Pediatric Surgery*. 2000; 35(11):1623–1625.
22. Watanabe K, Kiyokawa K, Rikimaru H, Koga N, Yamaki K, Saga T. Anatomical study of latissimus dorsi musculocutaneous flap vascular distribution. Journal of Plastic, *Reconstructive & Aesthetic Surgery.* 2010; 63(7):1091–1098.
23. Yamataka A, Miyano T. Tubed latissimus dorsi musculocutaneous flaps for thoracic esophageal replacement in dogs: Possible clinical application. *Surgery Today*. 1994; 24(9):852–853.