

## Reconstruction of the oesophagus using pedicle diaphragm and omentum flaps in a dog: a case report

H.B. LEE<sup>1</sup>, M.R. ALAM<sup>2</sup>, N.S. KIM<sup>1</sup>

<sup>1</sup>College of Veterinary Medicine, Chonbuk National University, Jeonju, Republic of Korea

<sup>2</sup>Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh, Bangladesh

**ABSTRACT:** A two-years-old, intact female, Shih-Tzu dog weighing 5 kg was presented to the Chonbuk Animal Medical Centre, College of Veterinary Medicine, Chonbuk National University, with the history of bone ingestion before two days. The survey radiographs of the thorax revealed a bone at the caudal thoracic oesophagus. An oesophagram was performed which did not reveal any oesophageal leakage or perforation. The left caudolateral thoracotomy was performed and the caudal oesophagus was found partially necrosed, friable and inflamed. The necrosed, friable part was removed and the oesophageal defect was reconstructed using a full-thickness muscle flap collected from the diaphragm. A part of the omentum was mobilized from the abdomen and sutured over the reconstructed site of the oesophagus to aid healing. Oesophagoscopy after nine days postoperatively showed a good adhesion of the diaphragm flap. The patient showed normal activity after 12 days and no complications were observed during a one-year follow up period. The pedicle flap collected from the left hemidiaphragm in addition to the omentum flap can be successfully used to reconstruct the circumferential oesophageal defect.

**Keywords:** oesophageal reconstruction; diaphragm flap; omentum flap; dog

Stricture and fibrosis of the thoracic oesophagus may occur after segmental resection and anastomosis which result at least in part from the localized disruption of blood supply (Hayari et al., 2004). The ideal protocol would be a resection of oesophageal injury followed by anastomosis of the remaining segments with no tension. However, in cases of extensive damage in the oesophageal wall, approaching the borders after the dissection may not be possible (Delikaris et al., 1999). Such situations require the use of substitutes in order to reestablish the continuity of the organ. Several materials have been used for substitutive oesophagoplasty procedures, amongst which are: the rhomboid muscle (Lucas et al., 1982), autogenous pericardium and jejunal segment (Smith et al., 1999). Diaphragmatic pedicles have been used in substitutive oesophagoplasty in men since 1948 (Mineo and Ambrogi, 1995). The diaphragm is a strong, elastic, and well vascularized muscle, also resistant to necrosis, and bearer of a good regen-

eration capability. Its vascularization derives from the lower phrenic arteries, pericardium phrenic arteries, intermammary and intercostal arteries. Its enervation has a peripheral distribution originating from branches of the phrenic nerve, allowing the section of the muscle without the denervation of the remaining diaphragm. It is possible to remove wide bands of the diaphragm and still close the defect without tension.

An extensive oesophageal injury may require reconstruction following a massive resection, which is associated with a high risk of postsurgical complications as a consequence of tension and less vascularity. The segmental blood supply is one of the most important features of the anatomy of the oesophagus from a surgical aspect (Fujiwara et al., 1997; Wu et al., 1998). During the operative preparation, small supply vessels are injured, and the operation is therefore carried out on an organ with a poor blood supply. Accordingly, the complication rate is high (Young et al., 2000a,b; Kim et al., 2001).

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The omentum has been used some times in the most varied general surgical operations in order to improve the blood supply of a given organ in the abdominal cavity (Adams et al., 1992). However, its use outside the abdominal cavity is not routine. In previous studies, the omentum was found to be an adequate host organ for angiogenesis in different tissues (Goldsmith et al., 1975; Zhang and Yang, 1987). The omentum is a highly vascularized tissue and was shown to enhance anastomotic healing when added as an adjuvant to reconstruction procedures (Fekete et al., 1981; Zhang and Yang, 1987). The purpose of this study is to evaluate the surgical technique, complications and final functional outcomes of oesophagoplasty using a pedicle diaphragm and omentum flaps in a dog.

### Case presentation

A two-years-old, 5 kg, intact female, Shih-Tzu dog was presented with dysphagia, regurgitation and a history of bone ingestion before two days. The physical examination revealed the patient to have 7% dehydration. The complete blood count and serum biochemistry were performed, which revealed leukocytosis ( $20.4 \times 10^3/\mu\text{l}$ ; normal range  $6-15 \times 10^3/\mu\text{l}$ ), a high BUN level (30 mg/dl; normal range 10–25 mg/dl) and hyperproteinaemia (8 g/dl; normal range 5.5–7.8 g/dl). The blood gas analysis and urinalysis findings were within the normal range. The survey radiographs of the thorax revealed a bone at the caudal thoracic oesophagus. An oesophagram was performed to evaluate the oesophageal leakage and revealed no perforation.

The dog was sedated with acepromazine (Sedazect Inj<sup>®</sup>, Samwoo Pharm. Co. Ltd., Korea) 0.2 mg/kg, *i.v.*, ketamine (Ketamine Inj<sup>®</sup>, Yhan Pharm. Co. Ltd., Korea) and it was attempted to push the foreign body into the stomach using a balloon catheter but it failed. The patient was given intravenous crystalloid fluids (10 ml/kg/h) for correction of dehydration. The surgical area was shaved and prophylactic antibiotic, cephalexin (Methilexin Inj<sup>®</sup>, Union Korea Pharm. Co. Ltd., Korea) 25 mg/kg, *i.v.*, was administered one hour before surgery. The patient was premedicated with atropine sulphate (Atropin Sulfate Inj<sup>®</sup>, Dai Han Pharm. Co. Ltd., Korea) 0.05 mg/kg, *s.c.*, the anaesthesia was induced using propofol (Anepol Inj<sup>®</sup>, Hana Pharm. Co. Ltd., Korea) 6 mg/kg, *i.v.*, and was maintained with enflurane and oxygen. Supportive fluid therapy was

maintained throughout the procedure. The patient was positioned on the right lateral recumbency and draped. The left caudo-lateral thoracotomy was performed. The visceral pleura were transected, and the dorsal and ventral branches of the vagus nerve were carefully retracted. The location of the oesophageal foreign body was identified and the oesophagus was isolated from the thorax with wet gauze. Stay sutures were placed proximally and distally to the foreign body to facilitate the manipulation of the oesophagus and prevent leakage of the intraluminal contents. A perforation (5 mm/3 mm) on left side of the oesophagus was observed at the point of lodgment of the foreign body and the area was thickened, friable and inflamed. The right side of the oesophagus was also friable and inflamed. After removing the foreign body, the friable and inflamed part of the left side of oesophagus was removed (Figure 1), which created a longitudinal defect measuring 3.3 cm  $\times$  1.8 cm. The oesophageal defect was reconstructed using a pedicle diaphragm flap. A full-thickness of flap (10 cm  $\times$  3 cm) was collected from the left side of the diaphragm. The diaphragm flap was approximated over the oesophageal defect and sutured using 4-0 polydioxanone double layer simple continuous sutures. The first suture connected the mucosa to the submucosa and a knot was tied on the intraluminal oesophagus. The second suture was placed from the submucosa to the serosa and was tied on the

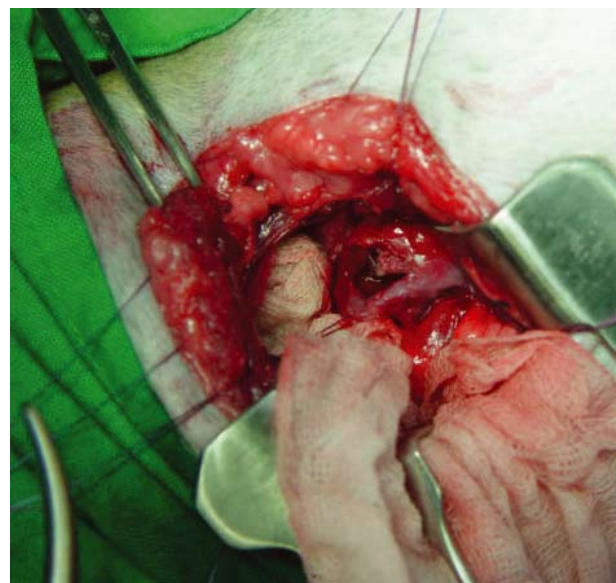


Figure 1. Photograph showing the lodged foreign body, thickened, inflamed and friable wall on the left side of the oesophagus

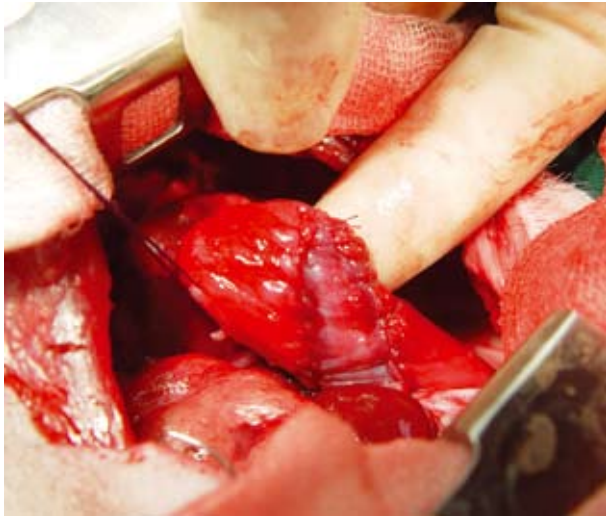


Figure 2. Photograph showing reconstruction of the oesophageal defect using a flap collected from the diaphragm

outer aspect of the oesophagus wall (Figure 2). A gastrostomy tube was placed into the stomach and part of the omentum was mobilized in the thorax through the diaphragmatic defect created from flap after the left paracostal incision. The omentum was sutured over the surgical wound and the inflamed area of the oesophagus. The diaphragmatic defect was closed with simple continuous sutures. The thoracic cavity was lavaged thoroughly with a warm saline solution three times, and a chest tube was inserted before closure. The wound was closed in a usual manner.

Postoperative treatment was given with butophanol (Butopan Inj<sup>®</sup>, Hana Pharm. Co. Ltd., Korea) 0.4 mg/kg, *i.m.*, every 12 h for three days, cephalixin (Methilexin Inj<sup>®</sup>, Union Korea Pharm. Co. Ltd., Korea) 25 mg/kg, *i.v.*, every 12 h for seven days, prednisolone (Prednisolon Inj<sup>®</sup>, Samwoo Pharm. Co. Ltd., Korea) 1 mg/kg, *i.m.*, every 12 h for three days and cimetidine (Cimetidin Inj<sup>®</sup>, Dae woo Pharm. Co. Ltd., Korea) 10 mg/kg, *i.v.*, every 12 h for three days. The intravenous fluid therapy was given for three days. The thorax was aspirated by a chest tube every hour after surgery until only a minimal volume (2 ml/kg/day) of air or fluid was obtained. The chest tube was removed after three days. Water and food were withheld for 48 hours. Small amounts of soft food were fed through the gastrostomy tube for nine days.

Nine days later, oesophagoscopy revealed good adhesion between the diaphragm flap and the oesophagus (Figure 3). The dog showed a normal

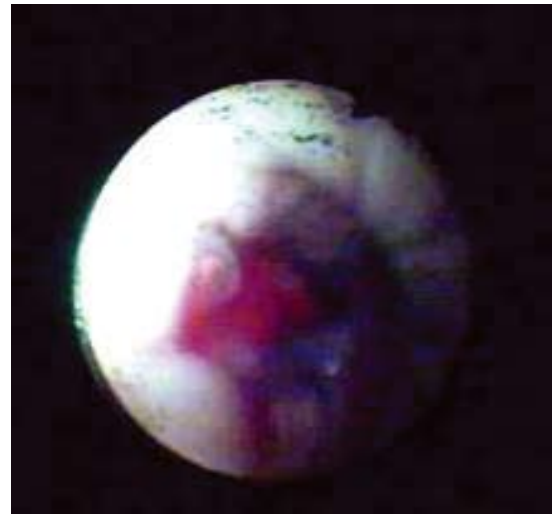


Figure 3. Oesophagoscopy nine days postoperatively revealed adhesion of the diaphragm flap and healing of the oesophagus

activity after 12 days. The dog did not show any vomiting or regurgitation during a one-year follow up period.

## DISCUSSION

Successful reconstruction of the oesophagus can be a challenge in small animal practice. The goal of oesophageal reconstruction is to restore both swallowing and a barrier to the gastroesophageal reflux with minimal mortality and morbidity (Young et al., 2000a,b). In oesophageal surgery, there is a higher risk of complications than in any other portion of the alimentary tract (Flanders, 1989; Lerut et al., 2002). This is believed to be a result of the absence of a serosa, segmental blood supply, constant motion and poor suture holding as compared to other parts of the alimentary tract (Lerut et al., 2002; Ranen et al., 2004). Less vascularity and excessive tension at the suture site appear to be the major reasons for the healing problems. It is important to choose the appropriate surgical techniques in order to reduce the excessive tension and to facilitate vascularization. In our case, the oesophagus was inflamed and friable, and had a 3.3 cm × 1.8 cm defect on the left side after debridement of necrosis and inflamed part of the left side of the oesophagus. A resection of more 3 to 5 cm of the oesophagus increased the risk of dehiscence (Hedlund, 2002). Anastomosis after the oesophagectomy was not indicated in this case because of the greater anastomotic tension. Therefore,

it was necessary to reconstruct the oesophageal defect without causing excessive wound tension, which is considered to be an important etiologic factor for wound dehiscence. For oesophageal reconstruction, various muscle flaps such as diaphragm, pleural, and intercostal muscle flap have been studied as a means of repairing an oesophageal defect and perforation depending on the location of the injury (Bouayad et al., 1992; Jones and Ginsberg, 1992; Richardson, 2005). The diaphragm muscle flap has been used to repair caudal oesophageal perforation in humans (Richardson, 2005) and animals (Paulo et al., 2007). The diaphragm is a strong, elastic and well vascularized muscle, also resistant to necrosis, and bearer of a good regeneration capability. In repairing an oesophageal defect, the diaphragm is thick, pliable and easy to handle. The diaphragmatic flap was used in this case to fill up the oesophageal defect and reduce the excessive tension, and it showed a good result. This result is in agreement with previous reports (Richardson, 2005; Paulo et al., 2007).

An omentum flap has been advocated in oesophageal injuries with severe inflamed infection (Fekete et al., 1981; Zhang and Yang, 1987). The omentum has a rich vascular, lymphatic tissue and has been shown to enhance anastomotic healing when added as an adjuvant for reconstruction procedures (Dicks et al., 1998; Nishimaki et al., 2001; Hayari et al., 2004). In our case, the omentum was placed at the friable, inflamed area and on the suture line to facilitate healing. In addition, it was used to reinforce the surgical site and good healing was observed. This result is in agreement with the previous reports (Dicks et al., 1998; Nishimaki et al., 2001; Hayari et al., 2004). Stricture is one of the most common complications after oesophagus surgery (Dicks et al., 1998; Nishimaki et al., 2001; Hayari et al., 2004). However, there was no stricture formation in our case, which was confirmed by oesophagram performed six months after surgery. The incidence of oesophageal stricture formation after reconstruction with muscle and omentum flap is lower than that in the primary closure of the oesophagus (Zhang and Yang, 1987; Bouayad et al., 1992). This might be related to the abundant elastic fibres of the diaphragm and rich vascular omentum.

The two-layer simple interrupted closure results in greater wound strength, good tissue apposition, and improved healing compared with the single-layer simple interrupted closure (Oakes et al., 1993;

Bardini et al., 1994). The operation time of the continuous suture pattern is faster than the interrupted suture pattern. In our case, the diaphragm flap was sutured at the oesophagus using a double-layer continuous closure pattern and sufficient holding strength was obtained to prevent the oesophagus motion. This suture pattern seemed to give greater wound strength.

Oesophagram and oesophagoscopy are useful for identifying the oesophagus. However, oesophageal perforation may not be observed on an oesophagram because the foreign body may prevent the leakage of the contrast agent (Kyles, 2002). In our case, the same thing happened; we did not know there was an oesophagus perforation until it was found during surgery.

In this case, an oesophageal defect, which occurred during oesophagotomy to remove a firmly lodged foreign body, was reconstructed using the full-thickness diaphragm flap and omentum flap resulted in a good prognosis. The patient showed normal activity after 12 days. The important reason for the good prognosis is believed to be due to revascularization and reduced wound tension. The pedicle diaphragm flap in addition to the omentum flap can be considered for the reconstruction of the circumferential oesophageal defect.

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## Corresponding Author:

Dr. Nam-Soo Kim, Associate Professor, Department of Surgery, and Director, Animal Medical Centre, College of Veterinary Medicine, Chonbuk National University, Jeonju 561-756, Republic of Korea  
Tel. +82 63 270 2800, fax +82 63 270 3778, e-mail: namsoo@chonbuk.ac.kr