Surgical Correction of a Persistent Right Aortic Arch in a Foal

VALORIE S. MACKEY, DVM, S. M. LARGE, VMD, E. M. BREZNOCK, DVM, PhD, Diplomate ACVS, and J. S. ARNOLD, DVM, Diplomate ACVS

A persistent right fourth aortic arch causing esophageal stenosis was diagnosed in a foal. Presenting signs included cervical swelling that developed following introduction to solid feed at weaning, and symptoms of chronic aspiration pneumonia. The esophagus was distended at the thoracic inlet; neither an endoscope nor a small nasogastric tube could be passed through the strictured esophagus at the heart base. The esophagus was seen to be dilated to the level of the heart base on plain and contrast radiographs. A left lateral thoracotomy through the fifth intercostal space was used to gain access for surgical correction of the defect. Radiographic and clinical evaluation of the foal 2 and 6 months following surgery showed a gradual decrease in size of the esophageal dilatation and an enlargement in the functional diameter of the esophagus at the previously strictured area at the heart base. Ten months following surgery the colt was eating normally and was of normal height and weight.

Perspective of the right fourth aortic arch, causing dysphagia, megaesophagus, and constriction of the trachea, has been reported in foals. Surgical correction of persistent right aortic arch has been described; however, complications have led to the early death of these foals. This article describes the successful surgical correction of a persistent right fourth aortic arch in an Arabian foal.

Case Report

A 5-month-old Arabian colt (184 kg) was referred with a 3 week history of a firm swelling in the midcervical region. The persistent enlargement had been noted several days after the foal was weaned. The foal had a history of respiratory disease commencing at birth and had been treated for recurring pneumonia. The foal was alert and in good condition and had a nonpainful firm swelling evident in the right midcervical area. The right jugular vein was more prominent than the left jugular vein. The foal’s temperature (39°C), pulse (40 beats/min), and respiratory rates (28 breaths/min) were slightly elevated. There was slight enlargement of the submandibular lymph nodes, and although no nasal discharge was present, auscultation revealed wheezes over the right hemithorax and normal breath sounds on the left side.

Endoscopic examination revealed that despite fasting, food remained in the dilated portion of the esophagus. Hyperemia and thickening of the esophageal wall were not observed. Attempts to pass the endoscope beyond the stricture at the base of the heart were unsuccessful.

Radiographs of the thorax and the cervical area were taken; marked esophageal dilatation was seen in the caudal cervical area, extending toward the thoracic inlet; bronchopneumonia was suspected in the ventral lung. On contrast esophagram, the esophagus was located to the right of the midline and narrowed from the third to the fifth intercostal spaces (Fig. 1).

A complete blood count was normal except for an increased fibrinogen level (600 mg/dl).

The foal was treated for bronchopneumonia with procaine penicillin (20,000 IU/kg IM) twice daily for 2 days before surgery. The diet was changed to a gruel
Fig. 1. Lateral radiograph of cranial thorax after barium esophagram showing esophageal stricture (arrow) with megaesophagus rostrally (1). The trachea (2) and aorta (3) are labeled for orientation.

of alfalfa pellets and grain, and with the special diet no further dilation or obstruction of the esophagus occurred.

Surgical Procedure

Feed was withheld for 12 hours before surgery. After sedation with xylazine (0.8 mg/kg IV), a nasogastric tube was passed into the esophagus to the level of the thoracic inlet. Anesthesia was induced with ketamine (1.6 mg/kg IV), and the foal was intubated in a standing position, to prevent reflux of feed material from the dilated esophagus. Anesthesia was maintained with halothane and oxygen, and controlled positive pressure ventilation. Pancuronium bromide* (0.1 mg/kg IV) was used to control muscle and respiratory movement.

A left lateral thoracotomy§ through the fifth intercostal space was used to gain access to the base of the heart. Finochietto self-retaining retractors were used to separate the fifth and sixth ribs. The left lung was retracted caudodorsally and isolated with moistened laparotomy sponges. The nasogastric tube was advanced to the esophageal obstruction and palpated to ascertain the position of the stricture. The aorta and pulmonary artery were identified, and the mediastinal pleura and pericardium surrounding these vessels were dissected to allow identification of the ligamentum arteriosum. The ligamentum arteriosum, a thick, white fibrous band 2 cm in width, was located dorsally below rather than lateral to the vertebral bodies as observed in dogs and cats. The ligamentum was isolated by blunt and sharp dissection.

Two transfixation ligatures of number 2 nylon 6-polyamide† were placed on the aortic side of the ligamentum arteriosum, and a single ligature was placed around the ligament at the level of the pulmonary trunk. The ligamentum arteriosum was incised between the ligatures. A very small lumen was identified in the transected ends. Transection of the ligamentum arteriosum permitted passage of the nasogastric tube beyond the heart. Further dissection of surrounding soft tissue cranial to the ligamentum arteriosum allowed the tube to be passed more freely. No other abnormalities were detected. The thoracic cavity was lavaged with warmed lactated Ringer's solution. The laparotomy sponges were removed, and the left lung was inflated.

The ribs were reapplied using 2 polyglactin 910.‡ An oblique, nondisplaced fracture of the fifth rib that occurred during rib retraction did not cause problems during closure. Before the last ventral suture was placed, a number 28 Fr chest tube§ with a one-way valve¶ was inserted in the thoracic cavity and tunneled subcutaneously to exit through the skin at the ninth intercostal space. The intercostal muscles were apposed with 2 polyglactin 910 using a simple continuous pattern, and the remaining muscle layers were individually apposed using 2 polyglactin 910 sutures. The subcutaneous layer was closed with a 0 polyglactin 910, and the skin edges were apposed with stainless-steel staple sutures.§

During closure, the effects of pancuronium bromide were reversed with edrophonium chloride**, (0.5 mg/kg IV), and the foal was removed from the ventilator. Oxygen was administered until the foal's respiratory efforts were regular and his muscle twitch responses had returned to normal. Oxygen insufflation via a demand valve was continued during recovery. The foal struggled violently during recovery and resisted assistance to stand. Butorphanol†† (0.02 mg/kg IV) was given for pain relief but had no effect. After additional butorphanol (0.02 mg/kg IV), the foal began to relax. Twenty milliliters of 2% mepivacaine hydrochloride¶¶ was infiltrated around the fourth, fifth, and sixth intercostal nerves. This appeared to reduce pain further, and the foal stood without assistance. The chest drain, which was damaged during recovery, was removed.

* Pavulon, Organon Inc., West Orange, NY.
† Vicryl, Ethicon Inc., Somerville, NJ.
‡ Argyle trocar catheter, Sherwood Medical, St. Louis, MO.
¶ Heimlich chest drain valve, Bard-Parker, Rutherford, NJ.
§ Elite disposable skin stapler, Elite Surgical Products Corp., Norwalk, CT.
** Tensilon, Roche Laboratories, Nutley, NJ.
†† Stadol, Bristol Laboratories, Syracuse, NY.
¶¶ Carbocaine, Winthrop Veterinary, New York, NY.
Postoperative Course

The foal remained intermittently painful for 6 hours after surgery. Xylozine (0.4 mg/kg IV) and butorphanol (0.02 mg/kg IV) did not appear to relieve the pain, and the intercostal nerves (4, 5, 6) were injected with 10 ml 0.5% of bupivacaine hydrochloride. Chloral hydrate (6.5 mg/kg IV) was given 6 hours after surgery, and respiratory movement became less guarded. The foal became quiet and nonpainful.

The foal was given trimethoprim/sulfadiazine (5.5 mg/kg IV) twice daily. Because a strongly positive fecal occult blood test result was found the second day following surgery, and stress-induced gastric ulceration was suspected, cimetidine (1.6 mg/kg IV) and sucralfate*** (10.9 mg/kg PO) were given IV four times daily.

Two days after surgery there was a moderate amount of pleural fluid but no significant pneumothorax visible on thoracic radiographs. The nondisplaced oblique fracture of the fifth rib was also noted.

The presurgical gruel diet was continued after surgery, and to avoid ingestion of straw, the stall was not bedded for 72 hours. The foal’s appetite continued to improve, and there was no postoperative dysphagia or esophageal filling. Although fecal consistency remained normal, Salmonella Group E grew on culture of feces 6 days following surgery, and the foal was moved to an isolation stall. Antibiotics were discontinued at 6 days; cimetidine and sucralfate were discontinued at 14 days.

During the next 2 weeks the pleural fluid was slowly resorbed, and airway sounds became audible over the entire thorax. Inspiratory wheezes could still be detected over the right ventral lung field. Thoracic radiographs could not be repeated because of isolation protocol.

Ten days after surgery a small amount of purulent discharge was noticed at the ventral aspect of the incision, and the foal was febrile (39°C). An incisional abscess was opened and flushed, and the fever abated. The remaining skin staples were removed at 14 days, and the incision healed without further complication. The foal was released from the hospital after six consecutive daily fecal cultures were negative for Salmonella sp. He was confined to a small paddock and was continued on moist alfalfa mashes.

Two months after surgery the foal was in good flesh and gaining weight. There was no history of coughing and no episodes of dysphagia, or esophageal distention or obstruction. Left laryngeal hemiplegia and an obvious esophageal enlargement in the caudal cervical region extending to the thoracic inlet were seen on endoscopic examination. The esophageal wall appeared thickened, but there was no hyperemia, and the endoscope passed freely through the esophagus.

Plain and contrast esophagography were repeated. Although the tortuosity of the esophagus was no longer noticeable, there was narrowing of the esophagus above the heart base. Tracheal compression was not present, but a mild interstitial pulmonary pattern remained. The colt was castrated and released with instructions to continue feeding soaked alfalfa cubes and provide access to pasture.

Six months after surgery, the foal was a normal height for his age and breed but thinner than a normal yearling. No abnormalities were detected during physical examination and thoracic auscultation. A large nasogastric tube was passed into the stomach without difficulty or discomfort to the foal. Left laryngeal hemiplegia and a small dilatation of the esophagus at the level of the thoracic inlet were seen on endoscopic examination. Feed material was not present at the dilatation, and there were no other visible abnormalities.

Radiographs and a barium esophagram revealed a narrowed esophageal lumen at the previous area of entrapment with some dilatation cranial to this site (Fig. 2). The foal was wormed, and the owners were instructed to feed the horse more. Ten months following the surgery, the colt was in good condition and was being fed hay and grass pasture. No problems with esophageal obstruction have occurred. No exercise in-

---

**Notes:**
- Marcaine, Breon Laboratories, New York.
- Tribrsin 48%, Wellcome Animal Health Division, Kansas City, MO.
- Tagamet, Smith Kline and French Laboratories, Carolina.
- Carafate, Marion Laboratories, Inc., Kansas City, MO.

---

Fig. 2. Lateral radiograph of thorax 6 months after surgical correction of persistent right aortic arch. Barium esophagram shows esophageal dilatation (1) and reduced luminal diameter (arrow) at site of previous constriction by ligamentum arteriosum. The reduced luminal diameter was not apparent on endoscopy, and no clinical problems occurred during feeding. The trachea (2) and aorta (3) are labeled for orientation.
tolerance or inspiratory noise was noticeable as the horse exercised freely.

Discussion

Surgical correction of a persistent right aortic arch has been reported\textsuperscript{1,2} in two foals, but complications led to their early deaths during the perioperative period.

Several features of the management of this case are worth noting. Aspiration pneumonia secondary to esophageal obstruction and dysphagia should be recognized and treated before surgery. Fasting before surgery will help empty the esophageal dilatation. Because reflux of feed from the esophageal dilatation may lead to aspiration during induction, tracheal intubation should be done with the foal in a standing position. Additionally, placement of a nasogastric tube adjacent to the esophageal stricture will facilitate stricture identification during surgery and allow assessment of the change in lumen diameter after the ligamentum arteriosum has been transected. Once the foal has been anesthetized, a muscle relaxant, such as pancuronium bromide, will allow control of respiratory movement and muscle contraction during the surgical procedure.

Rib removal was not necessary in this foal because the bony thorax was elastic and rib retraction provided adequate surgical exposure. However, care must be taken to avoid overretraction, leading to rib fracture. The pain associated with this foal's fractured rib may have contributed to the difficult, painful recovery, and it may be advantageous to desensitize adjacent intercostal nerves with local anesthesia before recovery following thoracotomy.

The postoperative discomfort may have been a combination of painful respiratory movements and colic-like symptoms due to ileus. The foal was bloated, kicked at his abdomen, and did not have normal gut sounds for 6 hours after surgery. Surgical trauma to the left vagus nerve may have caused ileus. Although the left recurrent laryngeal nerve was not visible at surgery, it may have been damaged during manipulation of the aorta during isolation and ligation of the ligamentum arteriosum.

The stress of surgery, the brief colic episode, and the change in feeding before surgery may have contributed to postoperative shedding of \textit{Salmonella}, which was found only as a result of a hospitalwide surveillance program of all horses treated in the intensive care unit. The foal also may have ingested \textit{Salmonella} at the clinic and was passing the same organism.

Complications experienced during recovery and in the postoperative period should become avoidable with additional experience with procedures of this type in the horse.

References