

Table of Contents

SECTION 1 • TRIAGE AND INITIAL STABILIZATION OF THE PATIENT

Chapter 1

TRIAGE OF THE EMERGENCY PATIENT

Tommaso Rosati, Roberta Troia

Principles of triage	1
Targeted clinical history collection	1
Clinical assessment	1
Supporting point-of-care diagnostics	3
Categorization	3
Initial stabilization	4

Chapter 2

ANALGESIA AND ANESTHESIA FOR CRITICALLY ILL PATIENTS

Thaleia Stathopoulou, Dario A. Floriano

Analgesia	9
Pain recognition and assessment	9
Pain management	10
Sedation/anxiolysis	12
General anesthesia	13
Premedication	13
Induction	14
Maintenance	15
Cardiovascular support	15
Recovery	16

SECTION 2 • SURGICAL APPROACHES

Chapter 3

ABDOMINAL APPROACHES

Simona Vincenti, Matteo Rossanese

Midline celiotomy	19
Parareputial caudal celiotomy	20
Paracostal/lateral abdominal approach	20

Table of Contents

Chapter 4

THORACIC APPROACHES

Matteo Rossanese, Simona Vincenti

Median sternotomy	23
Intercostal thoracotomy	25
Transdiaphragmatic thoracotomy	28

SECTION 3 • TUBE PLACEMENT AND STAPLING/SEALING DEVICES

Chapter 5

TUBE PLACEMENT

Anna Frykfors von Hekkel, Rhiannon Strickland

FEEDING TUBES	31
Nasoesophageal/nasogastric tubes	31
Esophagostomy tubes	32
Gastrostomy tubes	34
Enterostomy tubes	37
Tube feeding guideline	37
Tube feeding procedure	37
THORACOSTOMY TUBES/DRAINS	38
ABDOMINAL DRAINS	41
CYSTOSTOMY TUBES	43

Chapter 6

STAPLERS AND VESSEL-SEALING DEVICES

Rhiannon Strickland, Anna Frykfors von Hekkel

STAPLING DEVICES	47
Thoracoabdominal staplers	47
Gastrointestinal anastomosis staplers	49
Endoscopic gastrointestinal anastomosis staplers	50
VESSEL-SEALING DEVICES	51

SECTION 4 • SURGICAL WOUND MANAGEMENT

Chapter 7

BITE WOUNDS

Alison Moores

General overview	53
Cervical wounds	53
Thoracic wounds	54
Wounds to other areas	55
Wound contamination	55

Chapter 8**BURN INJURIES***Rachel Williams*

Clinical presentation and diagnosis.....	65
Treatment.....	66
Postoperative management.....	68
Outcome	69

Chapter 9**PENETRATING INJURIES***Marie Burneko, David E. Holt*

Gunshot wounds	71
Impalement injuries	72
Porcupine quills.....	73
Grass awns.....	75
Penetrating wounds: Treatment, Postoperative management, Outcome.....	75

Chapter 10**DEGLOVING AND SHEARING INJURIES***Ricardo De Sousa, Filippo Cinti*

Clinical presentation and diagnosis.....	79
Treatment.....	79
Postoperative management.....	82
Outcome	83

SECTION 5 • GASTROINTESTINAL SURGICAL EMERGENCIES**Chapter 11****GASTROINTESTINAL EMERGENCIES***Filippo Cinti, Benito de la Puerta, Sarah van Rijn*

Obstructive pharyngeal sialoceles	85
Penetrating injuries to the pharynx	88
Esophageal foreign body or trauma	92
Gastrointestinal foreign body	96
Intussusception	110
Gastric dilatation-volvulus.....	112
Rectal prolapse.....	118

Chapter 12**SPLENIC AND PANCREATIC EMERGENCIES***Adrien Aertsens, Stephen Martin*

Splenic torsion	125
Pancreatic abscess	129

Table of Contents

Chapter 13

BILIARY DISEASE

Karla Lee

Gallbladder mucocele.....	135
Colelithiathis	138
Neoplasia	139
Pancreatitis	139
Trauma.....	140
Surgical techniques for treatment of biliary disease.....	140

Chapter 14

HEPATIC SURGICAL EMERGENCIES

Sara D. S. Janssens, Anne Kummeling

Liver lobe torsion.....	147
Liver abscess.....	149
Liver trauma.....	151
Liver tumors.....	151

SECTION 6 • ABDOMINAL CAVITY SURGICAL EMERGENCIES

Chapter 15

ABDOMINAL HERNIAS

Filippo Cinti, Paolo Buracco

TRUE ABDOMINAL HERNIAS	159
Umbilical hernias.....	159
Inguinal and scrotal hernias	161
Femoral hernias	166
TRAUMATIC AND INCISIONAL ABDOMINAL HERNIAS.....	168
Traumatic hernias	170
Incisional hernias and evisceration	174
PERINEAL HERNIAS.....	177

Chapter 16

PERITONITIS

Rosario Vallefucio, Mark Longley

Septic peritonitis	193
Bile peritonitis	198
Hemoperitoneum.....	201
Pneumoperitoneum.....	205

SECTION 7 • URINARY SURGICAL EMERGENCIES

Chapter 17

UROABDOMEN

Natalie Kovak, Christiana Fischer

Clinical presentation	211
Initial patient stabilization.....	211
Diagnosis.....	212
Treatment.....	214
Complications and outcomes.....	215

Chapter 18

TRAUMA OR PROLAPSE OF THE URINARY TRACT

Marie Burneko, Lillian R. Aronson

RENAL AND URETERAL TRAUMA.....	219
Renal injury.....	219
Ureteral injury	220
BLADDER TRAUMA.....	223
URETHRAL TRAUMA	225
URETHRAL PROLAPSE.....	227

Chapter 19

URINARY TRACT OBSTRUCTION

Lillian R. Aronson, Marie Burneko

Ureteral obstruction.....	233
Urethral obstruction.....	241

SECTION 8 • REPRODUCTIVE SURGICAL EMERGENCIES

Chapter 20

GENITAL EMERGENCIES

Erin Gibson, Rachel Williams

FEMALE GENITAL EMERGENCIES	253
Dystocia.....	253
Uterine torsion.....	256
Uterine prolapse	257
Vaginal prolapse.....	258
Pyometra	259
MALE GENITAL EMERGENCIES	261
Prostatic cysts and abscesses.....	261

SECTION 9 • RESPIRATORY SURGICAL EMERGENCIES

Chapter 21

UPPER AIRWAY EMERGENCIES

Lynda Rutherford

EMERGENCY STABILIZATION OF PATIENTS WITH UPPER AIRWAY DISEASE.....	267
BRACHYCEPHALIC OBSTRUCTIVE AIRWAY SYNDROME.....	267
LARYNGEAL DISEASE	274
Laryngeal paralysis	275
TRACHEAL DISEASE.....	278
Temporary tracheostomy	278
Permanent tracheostomy.....	281
Tracheal and laryngeal trauma.....	283
Tracheal resection and anastomosis	284
Tracheal collapse	286

Chapter 22

THORACIC EMERGENCIES

Ben Mielke, Matteo Rossanese

EMERGENCY STABILIZATION OF PATIENTS WITH LOWER AIRWAY AND PLEURAL DISEASE.....	291
GENERAL TECHNIQUES	292
Pyothorax.....	296
Pneumothorax.....	299
Hemothorax.....	305
Lung lobe torsion.....	307
Diaphragmatic rupture/hernia	309

Chapter 23

CHEST WALL EMERGENCIES

Ben Kaye

Thoracic trauma	317
Rib fractures.....	319
Flail chest.....	322
Penetrating thoracic injury	325

SECTION 10 • CARDIAC AND VASCULAR SURGICAL EMERGENCIES

Chapter 24

PERICARDIAL DISEASE

Matteo Rossanese, Daniel J. Brockman

Clinical presentation and diagnosis.....	331
Treatment.....	332
Postoperative management.....	334
Outcome	335

Chapter 25**PATENT DUCTUS ARTERIOSUS***Matteo Rossanese, Daniel J. Brockman*

Clinical presentation and diagnosis.....	337
Treatment.....	339
Postoperative management.....	341
Outcome.....	342

SECTION 11 • ORAL AND MAXILLOFACIAL SURGICAL EMERGENCIES**Chapter 26****DENTOALVEOLAR EMERGENCIES***Ingrid Tundo, Boaz Arzi*

Dental trauma.....	343
Periodontal trauma.....	345

Chapter 27**MAXILLOFACIAL TRAUMA AND TEMPOROMANDIBULAR JOINT EMERGENCIES***Ingrid Tundo, Boaz Arzi*

Maxillofacial trauma.....	351
Temporomandibular joint emergencies.....	359

SECTION 12 • ORTHOPEDIC EMERGENCIES**Chapter 28****SEPTIC ARTHRITIS***Marie Burneko*

Clinical presentation and diagnosis.....	365
Treatment.....	366
Outcome.....	367

Chapter 29**OPEN FRACTURE MANAGEMENT***Anna Massie*

Clinical presentation and diagnosis.....	371
Treatment.....	373
Postoperative management.....	375
Outcome.....	375

Chapter 30**ELBOW AND HIP LUXATION***Anna M. Massie*

Elbow luxation.....	377
Coxofemoral luxation.....	378

SECTION 13 • OPHTHALMIC SURGICAL EMERGENCIES

Chapter 31

EYELID LACERATIONS

Maria-Christine Fischer

Simple eyelid lacerations.....	383
Complicated eyelid lacerations.....	384

Chapter 32

GLOBE PROPTOSIS

Maria-Christine Fischer

Clinical presentation and diagnosis.....	387
Treatment.....	387
Postoperative management.....	388
Outcome	389

Chapter 33

ENUCLEATION

Maria-Christine Fischer

Clinical presentation and diagnosis.....	391
Treatment.....	392
Postoperative management.....	394
Outcome	394

Chapter 11

Gastrointestinal emergencies

Filippo Cinti, Benito de la Puerta, Sarah van Rijn

Obstructive pharyngeal sialoceles

Salivary mucocele (or sialoceles) is the most common disease affecting the salivary glands in dogs, whereas it is rarely reported in cats.^{1–4} It refers to a collection of saliva that has leaked from a damaged salivary gland or duct into the subcutaneous tissue. Sialoceles can be cervical, sublingual (ranula), or zygomatic depending on the salivary gland involved.^{1,2} Pharyngeal sialoceles are uncommon but could result in a severe clinical presentation due to a swelling formed in the caudal dorsal or lateral pharynx just rostral to the level of the epiglottis, with a high risk of airway obstruction.^{1,5} It has been described that most affected animals do not have concurrent ranulas and cervical sialoceles;⁶ however, a recent study reported ipsilateral cervical sialoceles in 43% of dogs with ranulas.⁵ Pharyngeal sialoceles most commonly originate from the sublingual and mandibular salivary gland–duct complex.^{5,6} After the animal has been stabilized, marsupialization and/or sublingual and mandibular sialoadenectomy are necessary for treatment of pharyngeal sialoceles.^{5,6}

Clinical presentation and diagnosis

Miniature Poodles and male dogs appear to be overrepresented in cases of sialoceles. Common clinical signs include labored breathing, stridor, cough, and exercise intolerance.^{5,6} Concurrent ranulas or ipsilateral cervical

sialoceles are possible in affected animals.⁵ The diagnosis of sialoceles is typically based on clinical signs, such as a mass containing viscous, honey-colored, clear or blood-tinged fluid. Cytology often reveals inflammatory cells, and a periodic acid–Schiff (PAS) examination of the fluid can help confirm the presence of saliva. Additional diagnostic tests such as radiography, ultrasonography, computed tomography, and bacteriology can assist in confirming the presence of a sialocel and in ruling out other local diseases (Fig. 11.1).¹

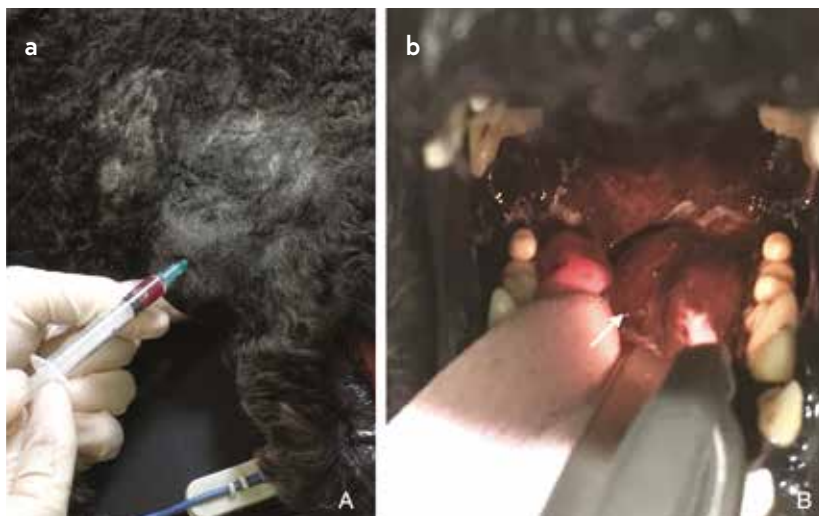
Treatment

Since pharyngeal sialoceles can result in acute airway obstruction, patients presenting with respiratory distress require immediate drainage, endotracheal intubation, or emergency temporary tracheostomy. After initial stabilization, marsupialization or sialoadenectomy must be performed.

Surgical technique

Emergency treatment with the patient under general anesthesia:

1. Intubation, oral examination, and rapid sialocel decompression using:
 - Fluid aspiration with a large-diameter needle and syringe (Video 11.1).
 - Intraoral stab incision of the pharyngeal sialocel wall with a number 11 scalpel blade.



Video 11.1. Oral endoscopic examination and rapid decompression of an obstructive pharyngeal sialocel using aspiration with a large-diameter needle and syringe. Video courtesy of Matteo Gobetti.

Figure 11.1 An 8-year-old Poodle with (a) a cervical sialocel and (b) a concomitant pharyngeal sialocel. Upon oral examination, airway obstruction due to the pharyngeal sialocel can be seen (white arrow).

Section 5 Gastrointestinal surgical emergencies

- Grasping the sialoceles with Allis tissue forceps and incising/excising it with Metzenbaum scissors (Video 11.2).

2. Emergency temporary tracheostomy (see Chapter 21).

After stabilization of the patient:

1. Marsupialization:

- a. The sialoceles wall is incised and the accumulated fluid removed using suction.
- b. The redundant tissue from the sialoceles is resected.
- c. Multiple simple interrupted sutures (3-0 to 4-0 absorbable monofilament) are placed between the remnant wall of the sialoceles and the oral mucosa (Fig. 11.2).

2. Sublingual and mandibular sialoadenectomy (ventral approach) (Videos 11.3 and 11.4):

- a. The patient is positioned in dorsal recumbency and a large area is aseptically prepared, from the midcervical region to the most rostral portion of the ventral mandible.

Video 11.2. Patient with respiratory distress. Oral endoscopic examination and identification of an obstructive pharyngeal sialoceles. Decompression was performed by excision of the redundant tissue while grasping the sialoceles. Video courtesy of Matteo Gobbetti.

Video 11.3. Sublingual and mandibular sialoadenectomy using a tunneling technique. Video courtesy of Matteo Gobbetti.

Video 11.4. Sublingual and mandibular sialoadenectomy using a tunneling technique in a toy-breed dog.

- b. A skin incision is made on the affected side, starting 4–5 cm caudal to the mandibular ramus and extending rostrally toward the mandibular symphysis. Bilateral gland removal requires a midline incision.
- c. The large inflammatory pseudocapsule can be bluntly dissected or incised to provide drainage. It can be partially or totally excised.
- d. After incising the platysma muscle, the external jugular bifurcation should be identified. The mandibular gland is located at or just cranial to this bifurcation.
- e. The capsule of the gland is exposed via blunt dissection and incised. The gland–duct complex (mandibular–sublingual) is then bluntly dissected.

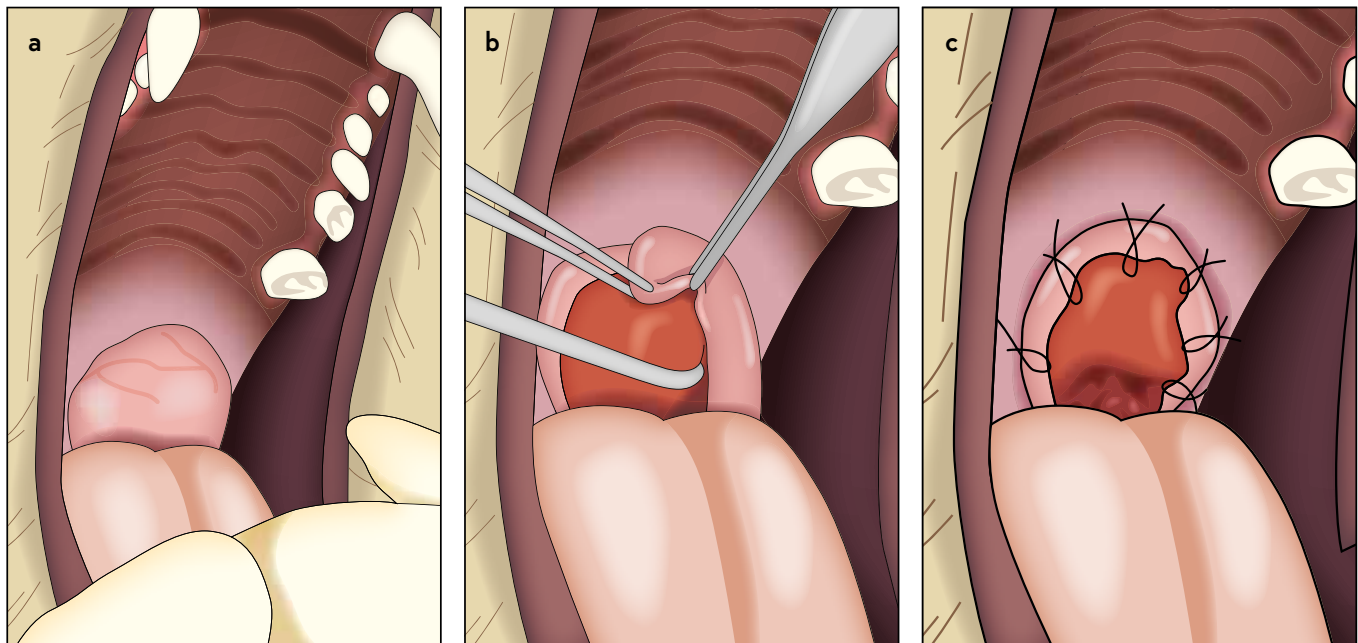


Figure 11.2 Pharyngeal sialoceles marsupialization. (a) Airway obstruction due to the pharyngeal sialoceles is present on oral examination. (b) Grasping the sialoceles with tissue forceps and incising/excising it with Metzenbaum scissors. (c) Multiple simple interrupted sutures are placed between the remnant wall of the sialoceles and the oral mucosa.

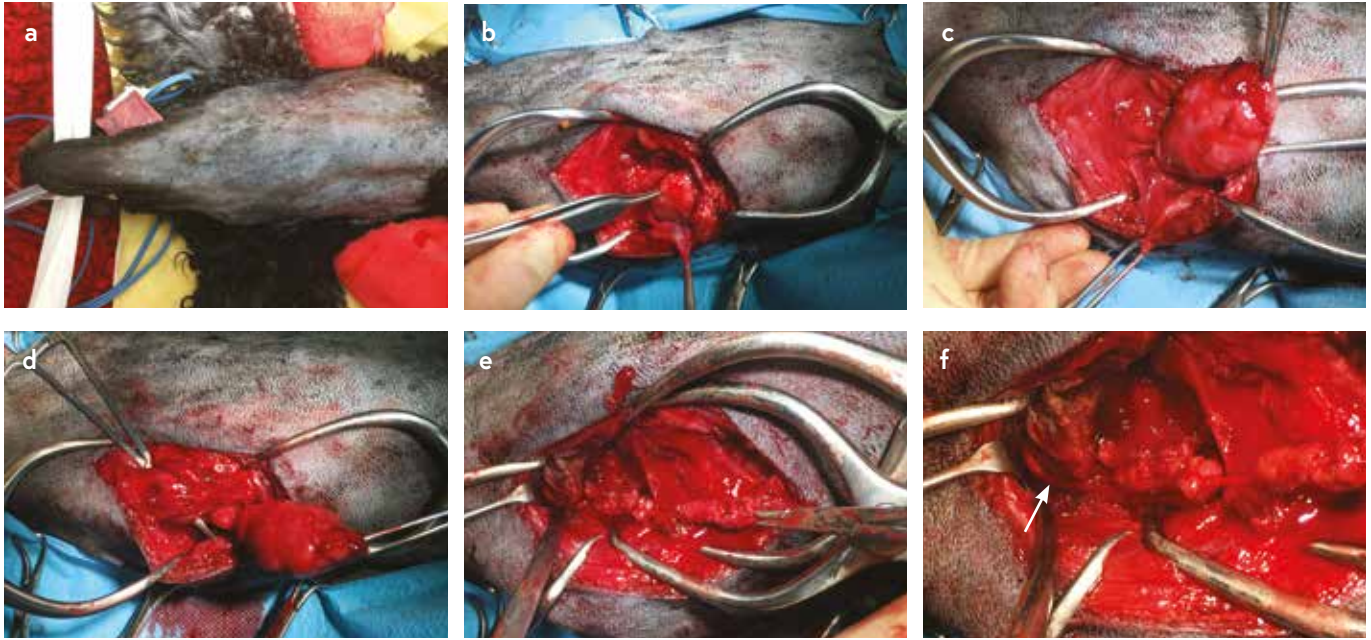


Figure 11.3 Sublingual and mandibular sialoadenectomy with tunneling technique. (a) Ventral approach. (b,c) Blunt dissection of the gland complex. (d) A hemostat is placed under the digastric muscle, from rostral to caudal, and the duct is clamped just rostral to the large glandular complex. (e) The mandibular and main sublingual glands are excised, and the remaining duct (with hemostat) is passed under the digastric muscle from caudal to rostral. (f) Dissection of the remaining sublingual gland is continued rostrally to the level of the lingual nerve (white arrow), where the duct is ligated and resected. Cranial is to the left of the images.

- f. Dissection with tunneling of the digastric muscle is preferable (Fig. 11.3). After blunt dissection of the gland–duct complex, a mosquito forceps is placed under the digastric muscle, from rostral to caudal, and the duct is clamped with mosquito forceps just rostral to the large glandular complex. The mandibular and main sublingual glands are excised and the remaining duct pulled under the digastric muscle (tunneling) with the previously placed mosquito forceps. Dissection of the remaining sublingual gland is continued rostrally to the level of the lingual nerve, where the duct is ligated and resected.
- g. Alternatively, dissection without tunneling of the digastric muscle can be performed (Fig. 11.4). Caudal traction is applied to the gland–duct complex, and the duct and gland are dissected under the digastric muscle. Rostral traction is applied to the digastric muscle with a handle retractor (Army-Navy or Senn–Miller retractor), and the salivary duct is ligated (with 2-0 or 3-0 absorbable monofilament suture) as close to the lingual nerve as possible.
- h. The mylohyoid muscle can be incised for better exposure of the rostral glandular tissue.
- i. The surgical incision is routinely closed.
- j. The decision to use a drain (as well as the type of drain) and postoperative bandage management are at the discretion of the individual surgeon.
- k. Following removal of the mandibular and sublingual salivary glands, the patient is positioned in sternal recumbency for final oral examination. If not performed earlier or if still present, redundant pharyngeal tissue can be excised with Metzenbaum scissors. Based on the surgeon's preference, marsupialization may be performed.

Postoperative management

An oral examination should be performed after surgery to evaluate the patency of the airway/larynx. The respiratory rate and pattern should be monitored during hospitalization. Standard wound care includes suture removal after 10–12 days and management of drains/bandages if present.¹

Outcome

Surgical treatment is successful in most dogs. Marsupialization has good results, but recurrence is possible. To minimize this risk, removal of the mandibular and sublingual gland–duct complex is recommended.^{1,5,6} Two different approaches for sialoadenectomy have been described (ventral paramedian and lateral), with a recent article suggesting that the ventral paramedian approach for mandibular and sublingual sialoadenectomy is associated with a lower risk of recurrence but a higher risk of wound-related complications compared to the lateral approach.³

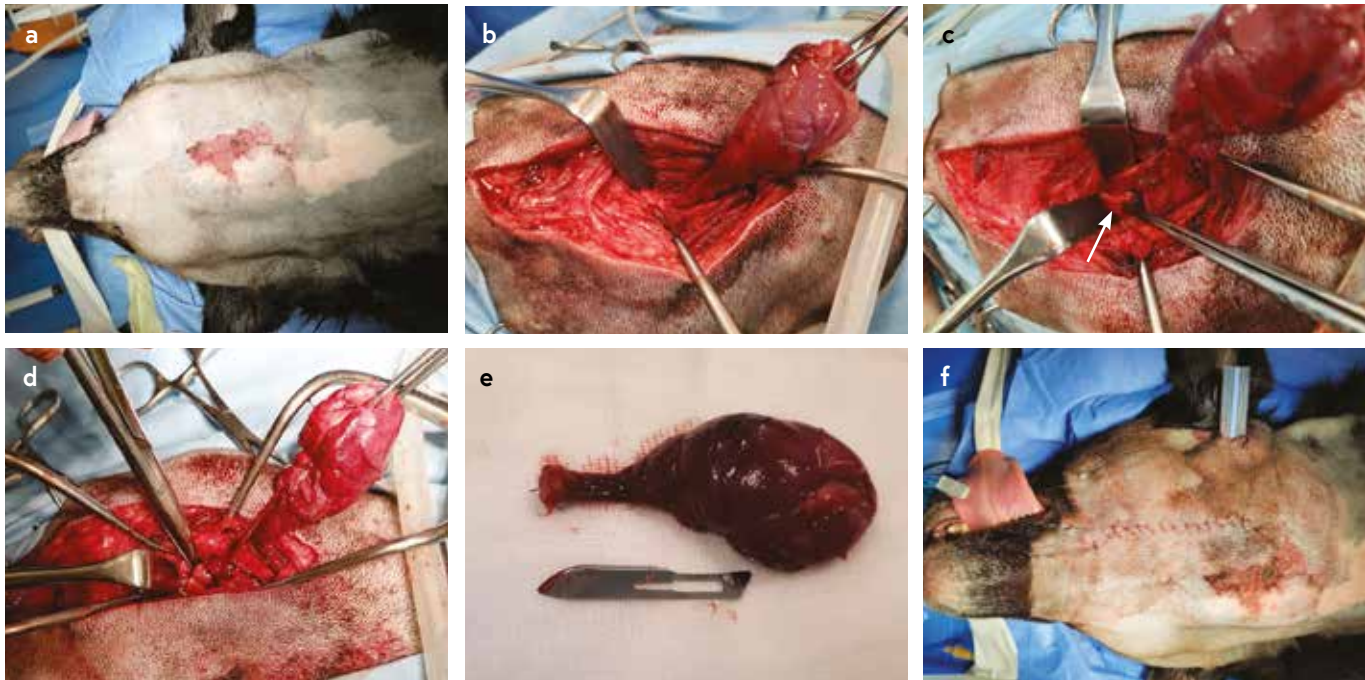


Figure 11.4 Sublingual and mandibular sialoadenectomy without tunneling technique. (a) Ventral approach. (b) Blunt dissection of the gland–duct complex. (c) Using handle retractors, rostral traction is applied to the digastric muscle for identification of the lingual nerve (white arrow). (d) The salivary duct is ligated as rostral as possible, close to lingual nerve. (e) Sublingual and mandibular gland–duct complex after excision. (f) Skin closure and passive drain placement. Cranial is to the left of the images.

Penetrating injuries to the pharynx

Penetrating oropharyngeal injuries associated with carrying, chewing, or retrieving sticks occur frequently in dogs.^{7–9} Although wooden sticks are the main cause, fishhooks, needles, bones, and grass awns have also been reported. Medium- to large-breed dogs appear to be affected most often.^{7,8} Affected animals present with either acute (<7 days) or chronic (>7 days) disease, which can result in potentially serious events.⁷ In one case series, only 12% of dogs were brought to a veterinarian with acute injury, while 82% of dogs presented with chronic disease (clinical signs for 8 days to 11 months).⁸

Clinical presentation and diagnosis

It is useful to divide the patients into acute (<7 days) and chronic (>7 days) as proposed by White and Lane in 1988,⁷ because the clinical approach is different. In case of acute penetrating injury, dogs typically exhibit signs of dysphagia, depression, pain on neck flexion, subcutaneous emphysema, oral pain, and drooling of saliva and blood.^{7–9} Chronically affected dogs often present with cervical or facial swelling, abscess formation, and discharging sinus tracts in the head and neck. Common sites of penetration include the lateral and dorsal pharyngeal walls, sublingual region, and esophagus.

Esophageal penetration has a guarded prognosis for recovery.^{7–9}

Radiography and/or computed tomography of the cervical area and thorax are recommended for the initial diagnostic workup. Ultrasound can also be used, especially helpful to identify small foreign material. After induction of anesthesia, inspection of the oropharynx using a laryngoscope and/or endoscope as well as palpation of the neck can help detect abnormalities. Tracheal and esophageal endoscopy is suggested in cases of cervical swelling or radiographic/computed tomographic signs of gas or tissue reaction within the cervical region.^{7–9}

Treatment

The type of treatment depends on the chronicity of the lesion. For acute injuries, oral exploration and retrieval of the foreign body through the entry wound are frequently possible (Fig. 11.5).⁹ A recent study described successful retrieval of stick foreign bodies in the oropharynx of dogs using rigid endoscopy, with all animals undergoing endoscopic assessment within 2 days of injury.¹⁰ However, cervical surgical exploration is recommended in acute cases if there is radiographic evidence of tissue emphysema.⁹ In chronic cases, the wound may not be obvious on transoral pharyngeal examination, and surgical exploration of the retropharyngeal space is warranted through a ventral midline approach (Fig. 11.6).^{8,9}

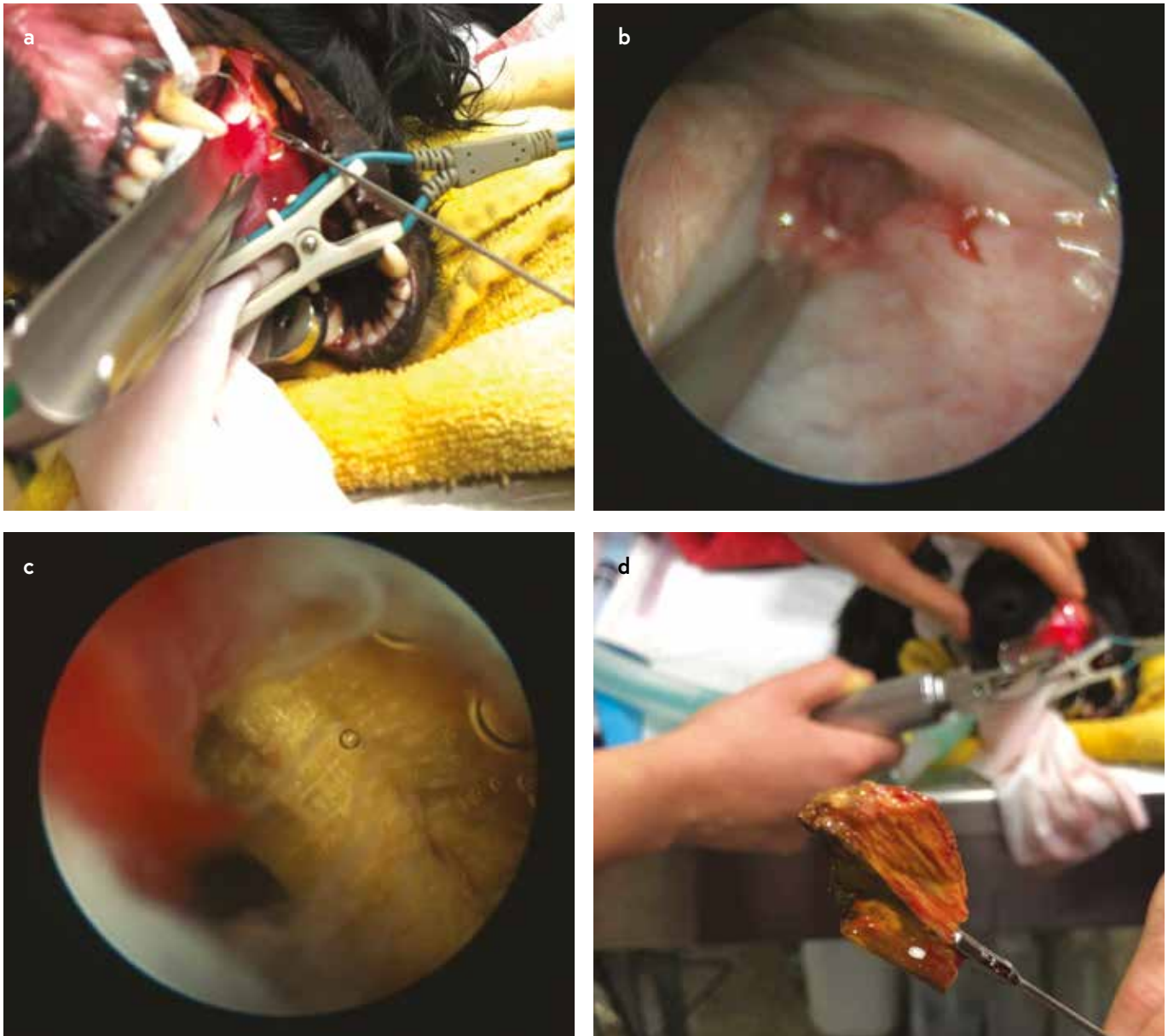


Figure 11.5 Acute stick injury. (a–c) Oral exploration and video-assisted (rigid endoscopy) foreign body removal through the oropharyngeal entry point. (d) Foreign body (wood) after extraction.

Surgical technique

Acute penetrating injury (Figs. 11.7 and 11.8)

1. Oropharyngeal exploration is performed with a laryngoscope or rigid endoscope.
2. Ventral median cervical surgical exploration is recommended in dogs with acute penetrating injuries of the oropharynx or esophagus if there is radiographic evidence of tissue emphysema.⁹
3. The wound is explored, the foreign body removed, and debridement and lavage performed.
4. After appropriate debridement, the intraoral wound can be closed or left to heal by second intention.

The decision to primarily close the wound depends on lesion chronicity, tissue viability, and anticipated drainage. If the esophagus is damaged, primary reconstruction is recommended.

5. In case of esophageal injury, a feeding tube should be placed (gastrostomy or nasogastric tube).

Chronic penetrating injury (Fig. 11.9)

1. A ventral median cervical approach is made.
2. The retropharyngeal space is explored. Attention should be paid to the recurrent laryngeal nerves, which run close and parallel to the trachea.
3. Nonviable tissue is debrided. The area should be

Section 5 Gastrointestinal surgical emergencies

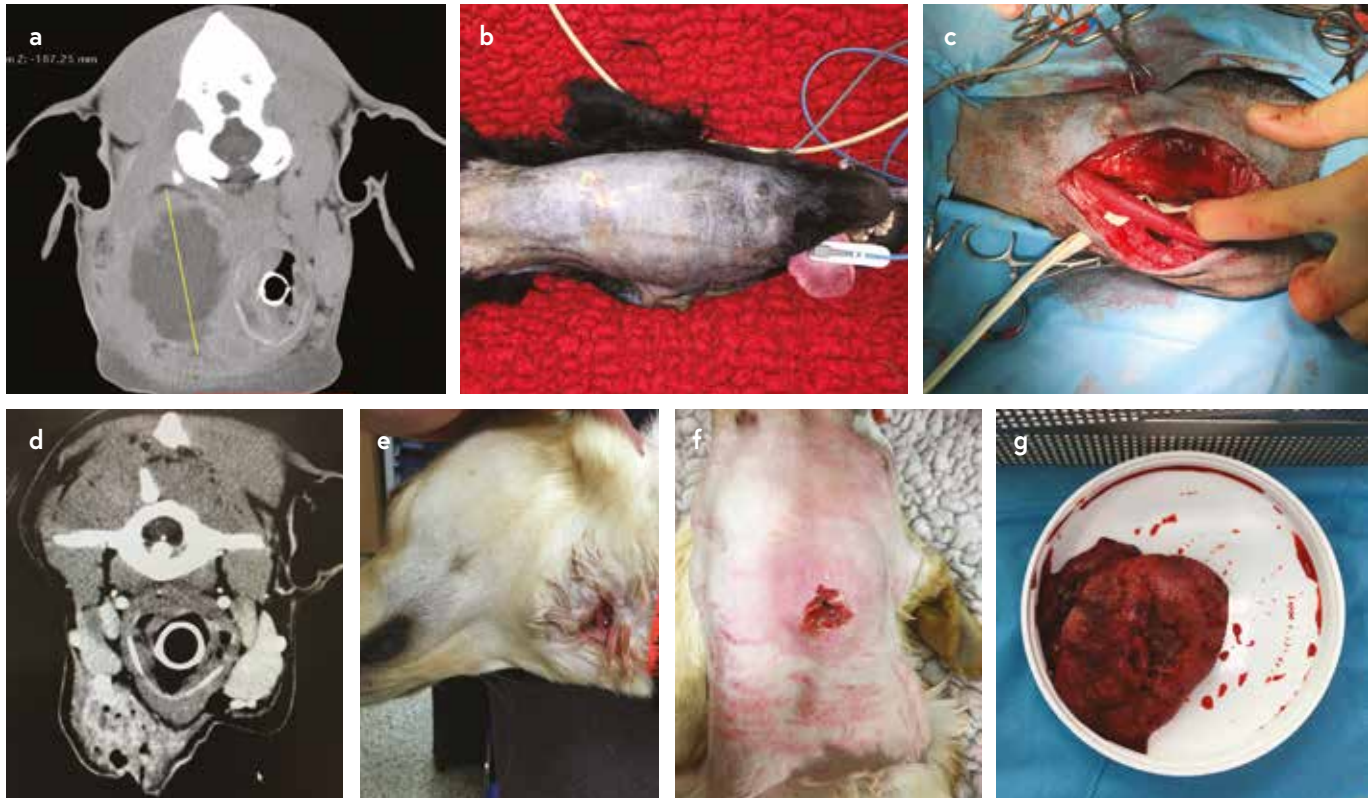


Figure 11.6 Chronic stick injuries. (a–c) First case, with a large, nonmobile, painful swelling on the ventral cervical neck. Computed tomography scan showing a large, chronic, fluid-filled cavity close to the larynx. Ventral approach to the neck, surgical exploration, debridement, and passive drain placement. (d–g) Second case, with a subcutaneous fistula. Computed tomography scan, physical and surgical exploration, and excised tissue after debridement.

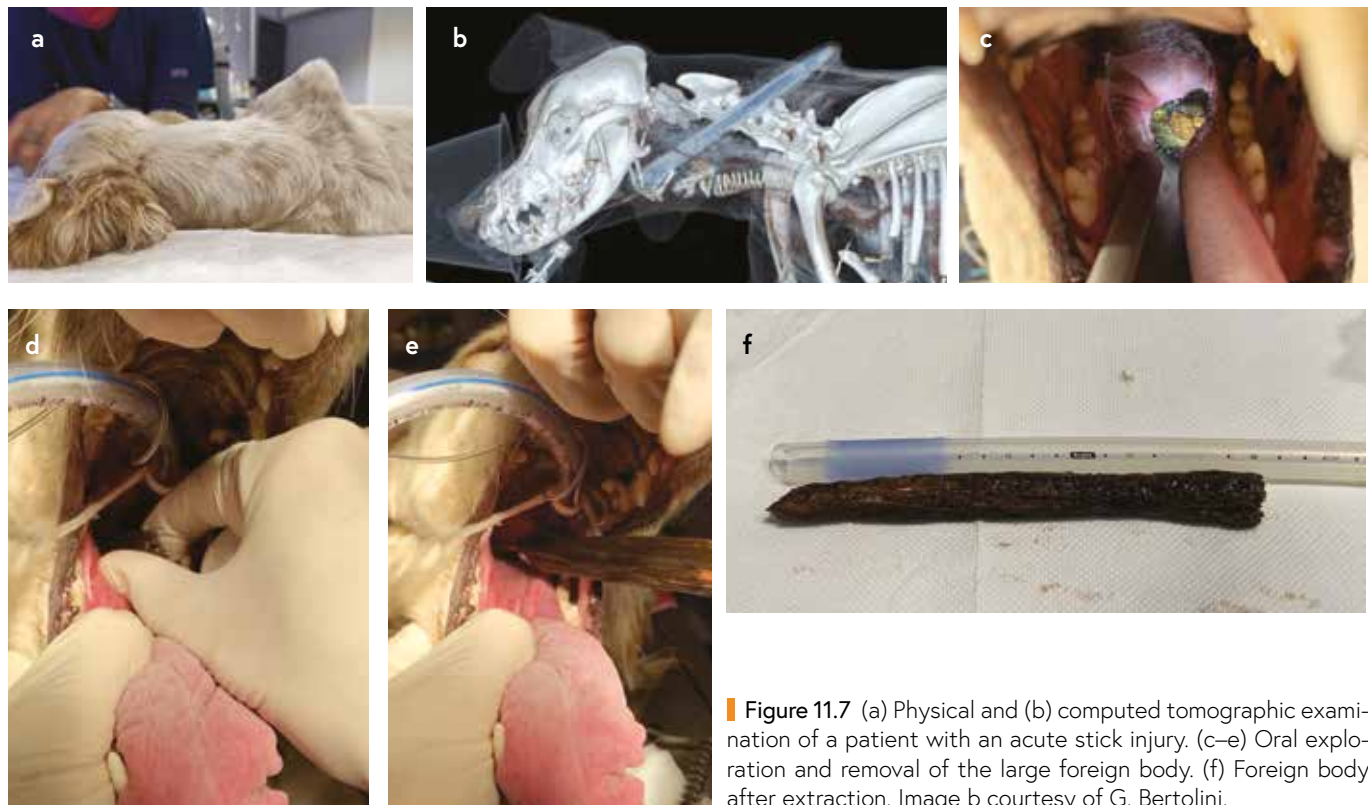


Figure 11.7 (a) Physical and (b) computed tomographic examination of a patient with an acute stick injury. (c–e) Oral exploration and removal of the large foreign body. (f) Foreign body after extraction. Image b courtesy of G. Bertolini.



Figure 11.8 Acute stick injury treated via a combined (a) oral and (b,c) ventral neck approach for removal of multiple foreign bodies.

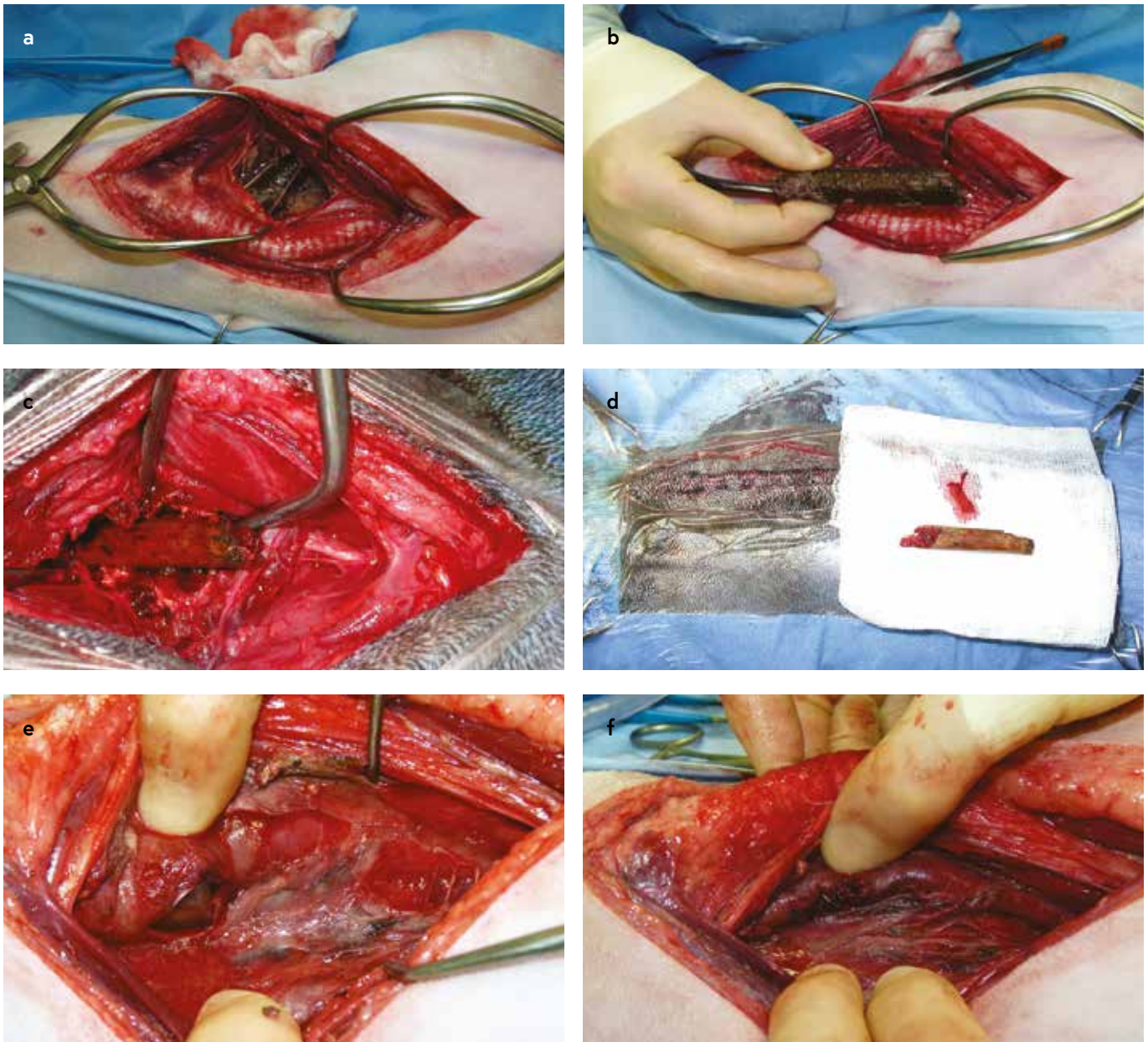


Figure 11.9 (a,b and c,d) Two cases with ventral neck exploration for chronic foreign body removal. (e,f) Ventral approach to the neck for foreign body removal and esophageal suturing in another case of stick injury with esophageal perforation.

Section 5 Gastrointestinal surgical emergencies

explored for any foreign body. Tissue and/or fluid should be sampled for cytology and culture.

4. The surgical site is copiously lavaged and a drain (active or passive) is placed.
5. Empirical administration of broad-spectrum antibiotics is recommended until culture and sensitivity testing results are available.
6. In case of penetrating esophageal injury, debridement and esophageal wall reconstruction is necessary (see below).

Postoperative management

Minimal postoperative care is required after uncomplicated surgery. The drain should be kept in place based on the daily fluid production. Standard wound care is delivered, and the sutures are removed after 10–12 days.

Outcome

Acute penetrating injuries of the oropharyngeal region, when treated appropriately, have a better prognosis than acute penetrating esophageal injuries.⁹ Aggressive surgical debridement of all sinus tracts and retrieval of foreign material does not eliminate the possibility of recurrence. The recurrence rates in chronic cases are similar regardless of whether foreign material was encountered (45%) or not (43%) during surgery.⁸

Esophageal foreign body or trauma

Obstruction of the esophagus by a foreign body should be considered an emergency because the longer an object remains in the esophagus, the higher the risk of aspiration and esophageal wall injury through pressure necrosis.¹¹ The most common types of foreign

bodies found in the esophagus are bones and plastic items.¹² In dogs and cats, fishhooks account for only 0% to 17% of cases.^{11,12} Several techniques have been described to remove esophageal foreign bodies, such as endoscopy, fluoroscopy, and surgery.^{12,13} When endoscopic retrieval is unsuccessful, a perforation is present, or if endoscopic removal carries a high risk of perforation, surgery via esophagotomy or gastrotomy is recommended.^{12–14}

Clinical presentation and diagnosis

The clinical signs of esophageal foreign body can include gagging, retching, regurgitation, vomiting, dyspnea, pain, lethargy, and inappetence. Terrier breeds, such as the English Bull Terrier and the West Highland White Terrier, are overrepresented among the affected population.^{11,15} Esophageal foreign bodies most commonly lodge at the level of the thoracic inlet, the heart base, and the distal esophagus due to extraluminal structures preventing esophageal dilation at these locations.¹⁶

Cervical and thoracic radiographs can identify most esophageal foreign bodies and may reveal radiographic indicators of esophageal perforation such as pneumomediastinum, pneumothorax, periesophageal fluid collection, and mediastinal widening (Fig. 11.10). Endoscopic examination allows direct visualization of the foreign body and permits assessment of the esophageal mucosa for signs of esophagitis, ulceration, necrosis, or perforation. Computed tomography can be also used to confirm the presence of an esophageal foreign body but has limitation in identifying periesophageal fluid and extraluminal air, which are suggestive of esophageal perforation.¹⁷

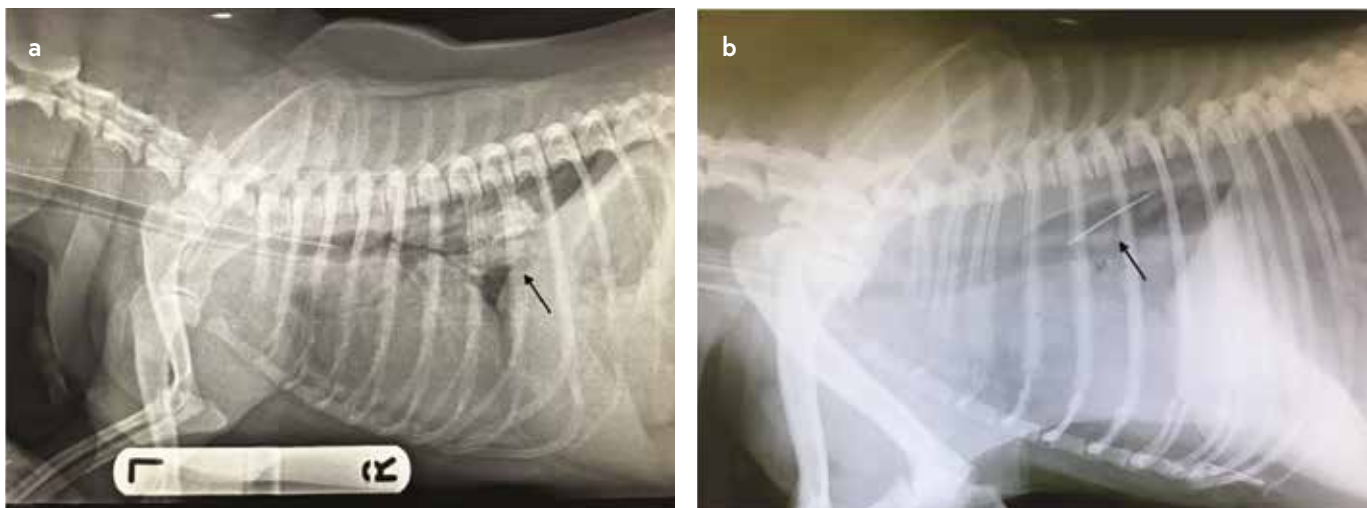


Figure 11.10 Lateral thoracic radiographs of two different esophageal foreign bodies, (a) pork bone and (b) needle, lodged in the caudal thoracic esophagus (black arrow).

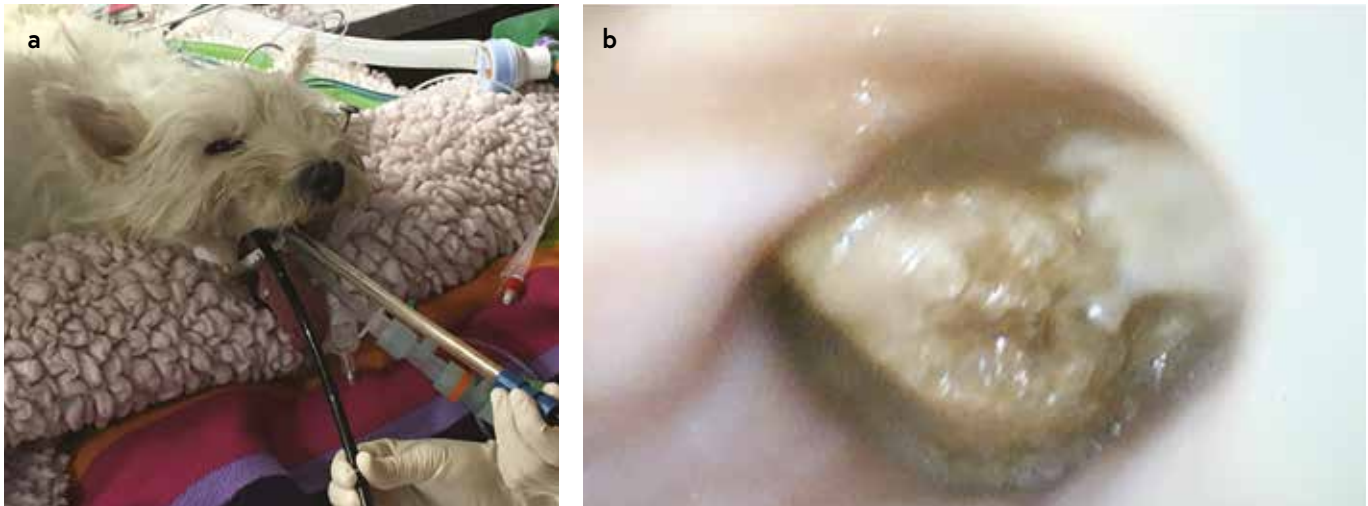


Figure 11.11 Endoscopic treatment of an esophageal foreign body.

Treatment

The treatment of choice for removal of an esophageal foreign body is esophagoscopy (Fig. 11.11), with reported success rates ranging from 68% to 97%.^{12,18} Fluoroscopy is another minimally invasive technique that can be used, with a reported success rate of 83%;¹⁹ however, it is only suitable when the foreign body is radiopaque and the necessary equipment is available. The aim of these techniques is either to retrieve the foreign body through the mouth or to advance it into the stomach. The latter can be followed by a gastrotomy (see below) in case the foreign body is not degradable by the gastric fluids.

Surgical management is indicated when minimally invasive methods are unsuccessful or unavailable, or when there is evidence of full-thickness esophageal perforation. This can be evident before, during, or after foreign body removal. Esophageal foreign bodies that remain lodged for more than 72 hours are more likely to be associated with esophageal perforation.²⁰ Small perforations of the cervical esophagus can sometimes be managed conservatively with local drainage and withholding food and water for 72 hours,²¹ while larger perforations of the cervical and intrathoracic esophagus should be surgically managed. The optimal management of dogs with esophageal perforation is still debated, but the size of the perforation is a factor to consider. One study described good survival in 10 dogs with minimal esophageal fishhook perforation treated conservatively,²⁰ and other experimental studies described that lesions <12 mm could heal spontaneously.^{18,22,23} However, because little consensus exists regarding the optimal management of dogs with esophageal perforation secondary to an esophageal

foreign body, and considering the potentially life-threatening consequences, large perforations of the cervical and intrathoracic esophagus should be surgically managed.

Surgical technique

Cervical approach (Fig. 11.12; Video 11.5)

1. The patient is placed in dorsal recumbency with the neck resting on a rolled towel, and a ventral midline approach to the neck is performed. A skin incision is made extending from the manubrium to the larynx.
2. The incision is deepened by blunt midline separation of the paired bellies of the mastoid part of the sternocephalic muscle and the underlying sternohyoid muscle.
3. Lateral retraction of these muscles with Gelpi retractors exposes the trachea and esophagus. The trachea, along with the recurrent laryngeal nerves, is retracted to the right.
4. A cranial partial sternotomy can be performed to improve caudal exposure if necessary (see Chapter 4).
5. Soft plastic tubing (e.g., a large orogastric tube) may be advanced through the mouth to aid in the intraoperative identification of the esophagus. Laparotomy sponges are used to isolate the esophagus.

Video 11.5. Cervical approach for esophageal foreign body removal.

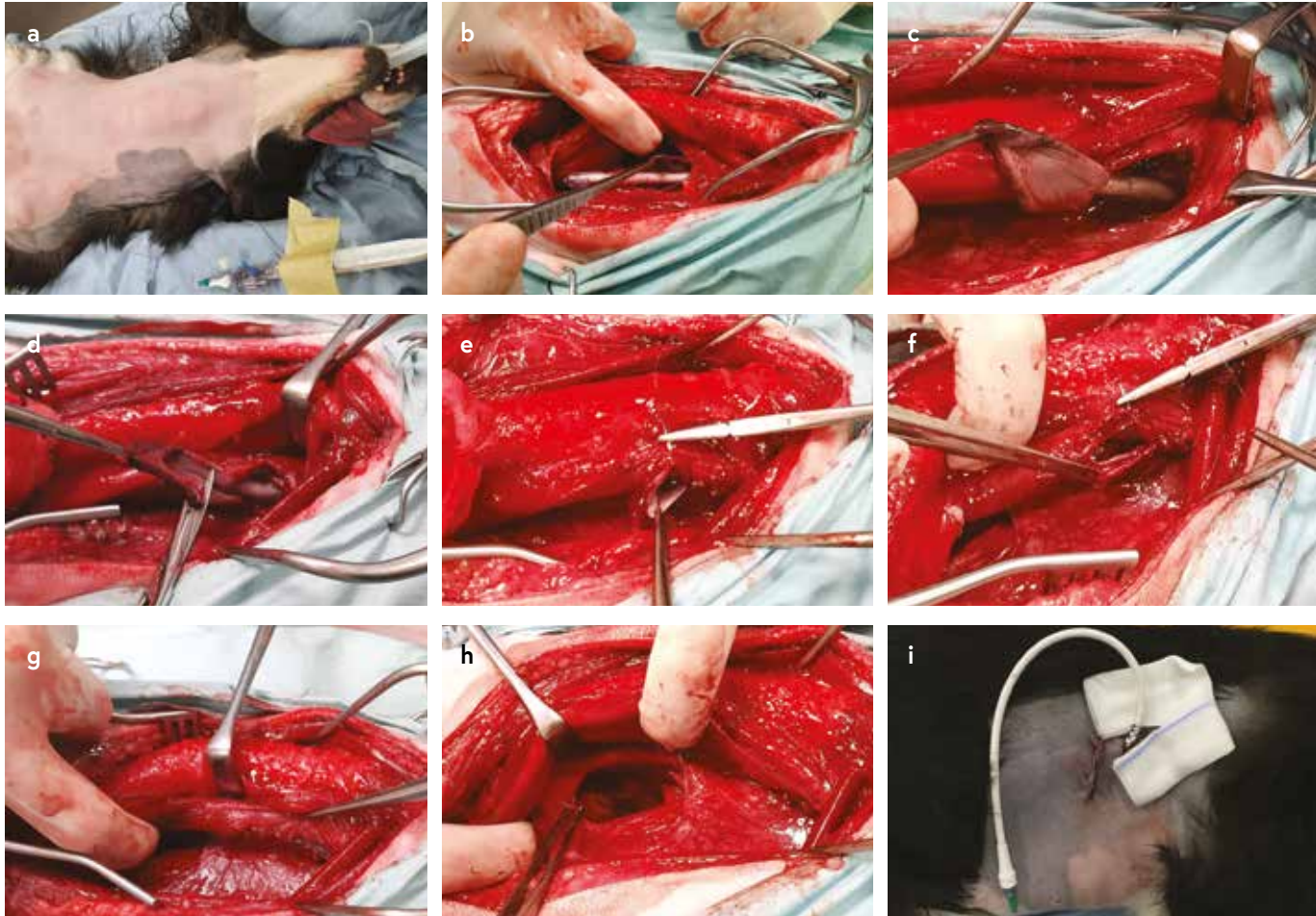


Figure 11.12 Cervical approach in a case of penetrating esophageal injury due to a foreign body (stick) with laceration of the cervical portion of the esophagus. (a–c) Ventral midline approach to the neck and identification of the esophageal laceration. An esophageal probe helps to identify the lesion. (d) Lesion debridement. (e–g) Two-layer closure of the esophageal wall. (h) Exploration, debridement, and closure of the muscular neck wounds. (i) Gastrostomy tube placement.

Transthoracic approach (Video 11.6)

1. A left-sided intercostal thoracotomy (see Chapter 4) is the preferred method to provide access to the esophagus overlying the heart base and caudal thoracic esophagus. The decision of which intercostal space to use is determined by the location of the foreign body on preoperative imaging.
2. Laparotomy sponges are used to isolate the esophagus and retract the lung lobes.

Esophagotomy (Fig. 11.13)

1. The intrathoracic esophagus is elevated using stay sutures or umbilical tape, taking care to avoid damaging the ventral and dorsal vagal trunks.
2. A longitudinal incision is made in the less inflamed area of the esophagus.
3. The foreign body is carefully removed from the esophageal lumen, and the mucosa is carefully inspected for perforations.

Video 11.6. Transthoracic approach for esophageal foreign body removal. Cranial and caudal left-sided intercostal thoracotomy.

4. Any perforation should be debrided before repair. Right-sided intrathoracic perforations can be approached through the esophagotomy incision or by rotating the esophagus with stay sutures.
5. Before repair is started, the mucosal–submucosal limit of the perforation should be visible.
6. Esophageal closure is performed using a simple interrupted suture pattern in two layers. Alternatively, a double-layer technique can be used: the mucosal–submucosal layer is closed with the knots positioned intraluminally, while the muscularis–adventitial layer is closed with extraluminal knots (3-0 or 4-0 slowly

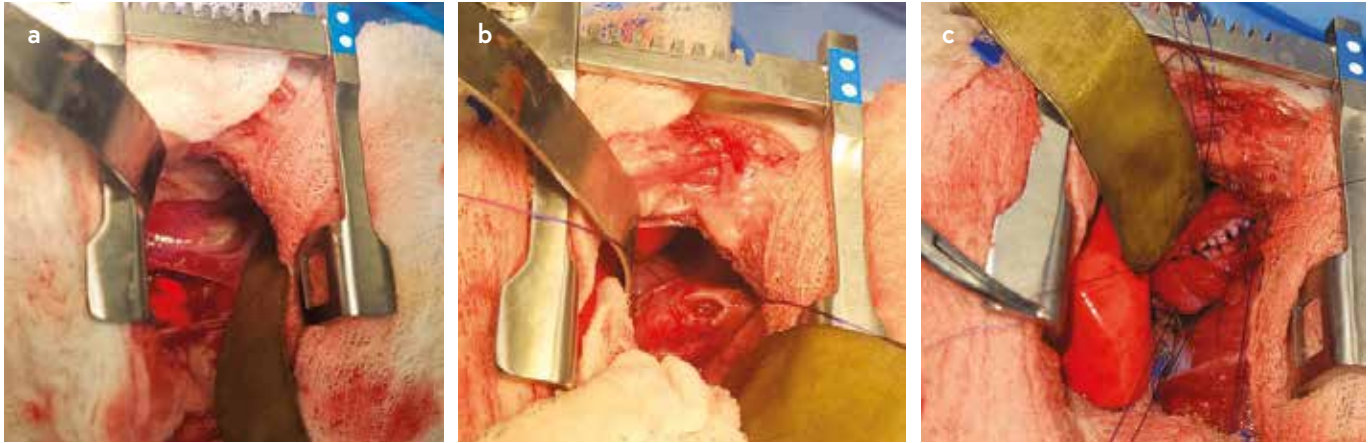


Figure 11.13 (a) Transthoracic esophageal approach via left-sided intercostal thoracotomy. (b) The intrathoracic esophagus is elevated using stay sutures and the esophagus is longitudinally incised in the less inflamed area. (c) The foreign body is carefully removed and the esophageal wall is closed in two layers with simple interrupted sutures. Images courtesy of Adrien Aertsens.

absorbable monofilament suture). Suture bites are placed 2–3 mm apart and 3 mm away from the incision/defect edges. Continuous suture patterns using a double-layer technique have also been reported.

7. A saline leak test can be performed after suturing:
 - a. The esophagus is atraumatically clamped proximal and distal to the surgical site.
 - b. Sterile saline is injected into the lumen with a needle (e.g., 22 gauge) and syringe (e.g., 10 mL) to gently distend the esophagus.
 - c. Additional sutures are placed to close any defect detected.
8. Small defects of approximately one-fourth of circumference can be primarily repaired, while larger esophageal defects are best treated via primary repair buttressed with a patch. Sternothyroid and longus colli muscle flaps can be used for a cervical esophagus patch, whereas diaphragm and intercostal muscle flaps can be used for a thoracic esophagus patch.
9. Omentalization can be performed by advancing the omentum through a diaphragmatic incision or through a paracostal approach and a subcutaneous tunnel into the thoracotomy site. The omentum is sutured around the esophagotomy site using simple interrupted absorbable monofilament sutures.
10. To avoid stricture/necrosis of the omentum and to reduce the risk of herniation, the diaphragmatic or paracostal incision is partially closed with simple interrupted sutures.
11. The thoracic cavity is copiously lavaged and a thoracostomy tube should be placed before routine closure. A gastrostomy or nasogastric feeding tube should be inserted (see Chapter 5).
12. A drain can be placed in the cervical area.

Gastrotomy for extraction of caudal esophageal foreign bodies (Fig. 11.14)¹⁴

1. A standard cranial midline celiotomy is performed to expose the stomach (see Chapter 3).
2. The stomach is retracted using 2–4 full-thickness stay sutures.
3. An incision is made on the ventral surface of the stomach, midway between the lesser and greater curvatures in the area with the least vascularity. The length of the incision along the gastric axis should be wide enough to allow one hand to be introduced.
4. Ribbon retractors are introduced into the stomach to improve visibility of the cardiac region by carefully retracting the walls of the stomach. Forceps are then introduced into the stomach and passed into the distal esophagus to grasp the foreign body.
5. Firmly lodged foreign bodies should not be forced, as attempts to extract sharp bones, for example, could perforate or lacerate the esophageal wall. In such cases, bone rongeurs and bone cutters can be used to fragment the foreign body. The distal part of the esophagus, which may be partly seen through the gastrotomy incision, is inspected and digitally palpated.
6. The stomach and abdomen are closed routinely (see gastrotomy section).

Postoperative management

Patients usually require multimodal analgesia and monitoring. Analgesia may include opioids (e.g., morphine, methadone). Fentanyl in constant-rate infusion can be used for severe pain management. Local anesthetic agents (e.g., bupivacaine or ropivacaine) can be used to block intercostal nerves. Nonsteroidal anti-inflammatory drugs (e.g., meloxicam) may be indicated in selected patients. To prevent esophagitis and gastroesophageal

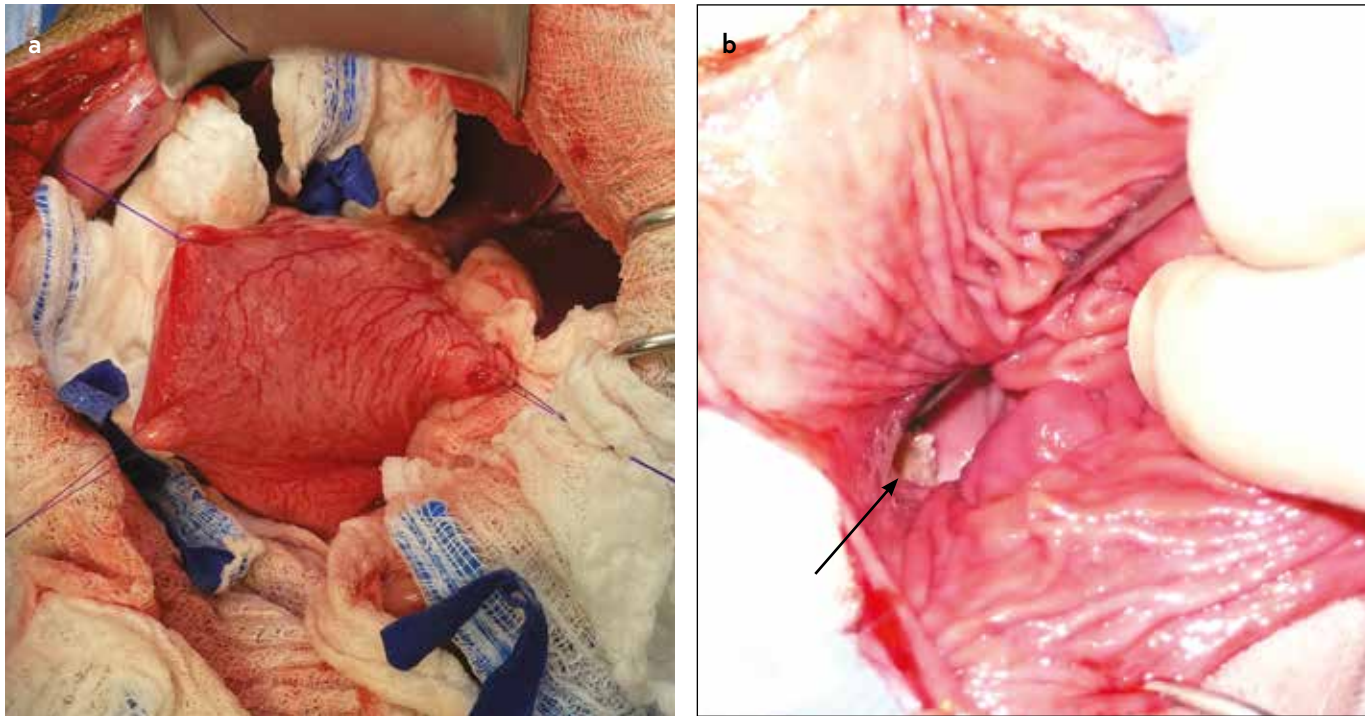


Figure 11.14 Extraction of a caudal esophageal foreign body through a gastrotomy approach. (a) Stomach retraction using stay sutures. (b) Identification of the foreign body (black arrow) in the distal esophagus after gastrotomy. Images courtesy of Adrien Aertsens and *Journal of Small Animal Practice* (2016) 57, 354–359.

reflux, omeprazole and sucralfate are used postoperatively. Broad-spectrum antibiotics (e.g., cefuroxime 15–20 mg/kg every 8–12 h) are indicated due to the high risk of aspiration pneumonia in these patients.

Vital signs including heart rate, blood pressure, respiratory pattern, and temperature should be checked for the first 24–48 hours. Pulse oximetry measurement, blood gas analysis, and thoracic imaging can be performed if indicated. Thoracostomy drains are normally maintained for 12–24 hours. Gastrostomy tubes may be helpful for administration of postoperative nutrition and medications but should be monitored and maintained for a minimum of 10 days. If a nasogastric tube has been placed instead, it should be kept in place for 5–8 days (Fig. 11.15).

Outcome

The prognosis after foreign body removal is generally excellent, except in cases of thoracic esophageal perforation. Early complications may include esophagitis, ischemic necrosis, dehiscence, leakage, and infection. Late complications include esophageal strictures and tracheo- or bronchoesophageal fistulae. The survival-to-discharge rate following surgery for the treatment of esophageal foreign bodies reportedly ranges from 50% to 93%.^{12,14,16,23} Recent studies have demonstrated a high survival-to-discharge rate in dogs undergoing surgery for the treatment of esophageal foreign bodies,

although esophageal perforation is significantly associated with a lower survival-to-discharge rate. Only 6.1% of esophagotomy incisions dehiscd, and most of the dogs that survived had good long-term follow-up with few long-term complications.¹⁸ However, these studies often combined various methods of esophageal foreign body removal, making it difficult to differentiate outcomes following minimally invasive versus surgical removal or to provide detailed information on a significant number of surgical cases.

Gastrointestinal foreign body

In veterinary medicine, the most common indication for a laparotomy is the removal of foreign bodies from the gastrointestinal (GI) tract. GI foreign bodies occur more commonly in dogs compared to cats due to their behavior of ingesting objects. Gastric foreign bodies account for 16% to 50% of all GI foreign bodies. In dogs, the larger esophageal size compared to the intestine or pyloric outflow tract results in the ability to swallow relatively large objects that then lead to obstruction.

Clinical presentation and diagnosis

Gastric foreign body

The clinical signs of gastric foreign bodies include vomiting, regurgitation (secondary to esophagitis caused by

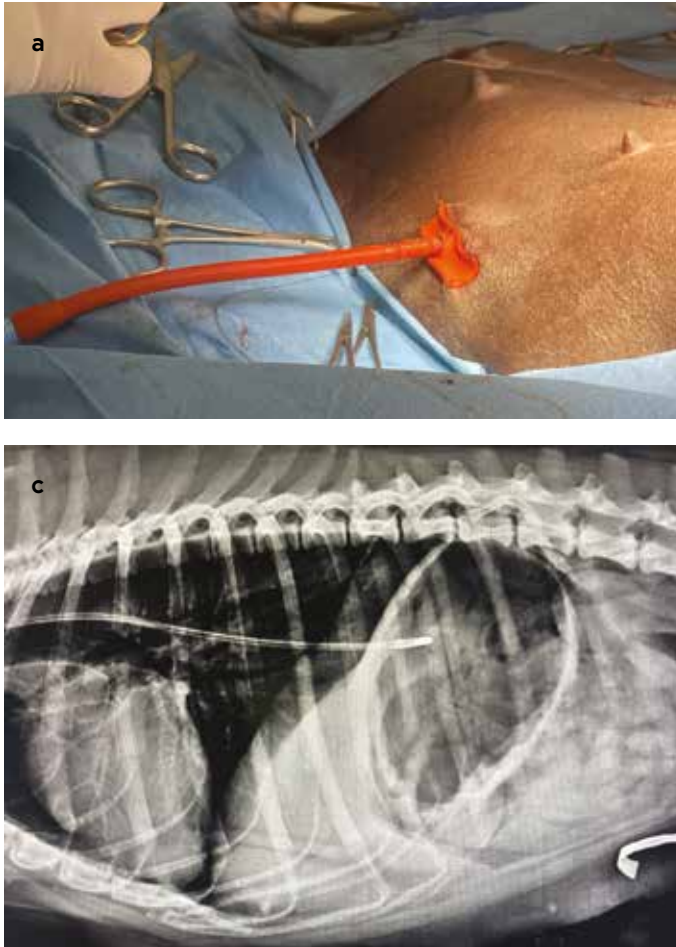


Figure 11.15 (a) Gastrostomy and (b,c) nasogastric feeding tubes.

vomiting), and abdominal pain. Abdominal distension may be noticed in patients that suffer pyloric outflow obstruction. Blood work (hematology, serum biochemistry, electrolytes) may reveal electrolyte and acid–base imbalances, with hypochloremia being the most common abnormality due to vomiting.

The initial diagnostic modality recommended is abdominal radiography. In one study, plain abdominal radiographs (Fig. 11.16) enabled visualization of 95% of gastric foreign bodies; in only two cases the foreign bodies were not observed (a piece of wood and organic material).²⁴ Contrast radiography can be beneficial in differentiating a foreign body from an intraluminal mass. The use of water-soluble iodinated contrast agents is recommended because they can be easily removed from the abdominal cavity in the presence of a ruptured GI tract. The disadvantage is that they provide poorer contrast compared to barium. The presence of free abdominal air in the abdominal cavity should prompt an emergency exploratory laparotomy due to the presence of a perforated viscus. Ultrasonography can aid in the diagnosis of GI foreign bodies, particularly when there is uncertainty about the presence of GI obstruction on radiography. If free abdomi-

nal fluid is visualized, an abdominocentesis with biochemical analysis and cytology of the fluid should be performed to look for signs of septic peritonitis (i.e., intracellular bacteria) (see Chapter 16).



Figure 11.16 Plain lateral abdominal radiograph of a dog revealing the presence of a gastric foreign body.

Intestinal foreign body

The clinical signs of an intestinal obstruction caused by foreign bodies can vary depending on the location, duration, and degree of the obstruction. The most common signs include vomiting, anorexia, lethargy, and abdominal pain. Palpation of the abdomen may reveal the presence of the foreign body. Abdominal radiography can help identify the object, particularly if it is radiopaque. However, more often, signs of mechanical obstruction such as multiple distended, gas- or fluid-filled small intestinal loops are visualized. In case of partial obstruction, these signs may be less severe. Comparing the intestinal diameter to the vertebral height can aid in differentiating between a mechanical/obstructive and functional intestinal ileus. If the ratio between the maximum dilated intestine and the narrowest point of L5 is greater than 2.0, a mechanical obstruction is highly likely and further diagnostics or exploratory laparotomy may be indicated.²⁵ Contrast radiography can be used but can be time-consuming. Ultrasonography is quicker but operator dependent, and the presence of gas in the intestines may limit the visualization of structures. In a study comparing ultrasound and radiography for identifying GI foreign bodies in 11 dogs and 5 cats, ultrasound identified all 16 foreign bodies, while radiography only identified 9.²⁶ Comparing the ability of ultrasound and radiography to identify GI foreign bodies, ultrasound revealed a bright interference associated with strong distal acoustic shadowing for all the foreign bodies.



Figure 11.17 Oral examination in a cat showing a linear foreign body trapped around the base of the tongue (white arrow).

Linear foreign body

Linear foreign bodies are more common in cats compared to dogs and include threads, stockings, strings, and carpet. They can cause a specific form of intestinal obstruction. Typically, the linear foreign body becomes anchored in a particular part of the GI tract, most commonly the base of the tongue (cats) or the pylorus (dogs). The peristaltic movements of the intestine cause the linear material to move aborally, resulting in the small intestine bunching up like an accordion. Continued peristaltic movements can lead to the linear material perforating the mesenteric side of the intestine, leading to septic peritonitis. The most common clinical signs are vomiting, anorexia, and lethargy. Linear foreign bodies usually cause partial obstruction; therefore, the clinical signs may not be as severe as with complete obstruction. In approximately 50% of cats, the linear foreign body can be identified attached to the tongue during clinical examination (Fig. 11.17). Abdominal palpation may reveal clumping of the intestines and abdominal pain.

Diagnosis can be aided by plain abdominal radiography, which shows a plicated small intestine in the cranial midabdomen. Gas pockets may be seen instead of the normal curvilinear columns. The use of contrast radiography can reveal more clearly the pleating of the intestines and, in some cases, the foreign material may appear radiolucent. On ultrasound, linear foreign bodies present as bright linear interfaces associated with shadowing, and the affected bowel segment appears plicated. Intestinal distension is normally less pronounced than with larger foreign bodies.

Treatment

Gastric foreign body

When dealing with gastric foreign bodies, it is important to consider their size and duration. This can help in decision-making, such as attempting endoscopy for retrieval. If the foreign body is too large for endoscopic removal or if it has been present for an extended period, surgical intervention should be considered. Prompt removal of the foreign body is crucial to prevent migration into the small intestine, which can lead to obstruction and devitalization of the intestine. The preferred surgical treatment for gastric foreign bodies is gastrotomy.

Surgical technique: Gastrotomy (Figs. 11.18–11.23)

1. A midline celiotomy approach is made (see Chapter 3).
2. Moistened laparotomy swabs are used to isolate the stomach from the rest of the abdomen, reducing the risk of peritoneal contamination.
3. Thorough palpation of the stomach is important to locate and assess the foreign body.

4. To provide retraction and decrease the risk of contamination, two stay sutures are placed in the stomach at either side of the gastrotomy incision, passing the needle through the submucosa to prevent tearing of the tissues (Fig. 11.18).

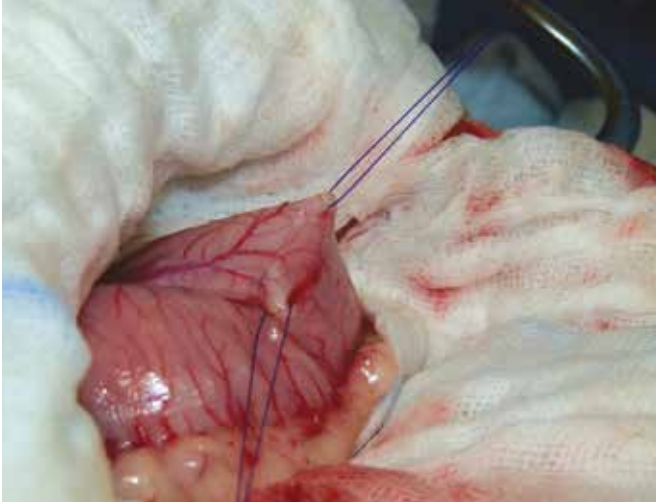


Figure 11.18 Isolation of the stomach from the abdominal cavity using moistened laparotomy swabs. Placement of two stay sutures on either side of the incision to minimize gastric fluid spillage.

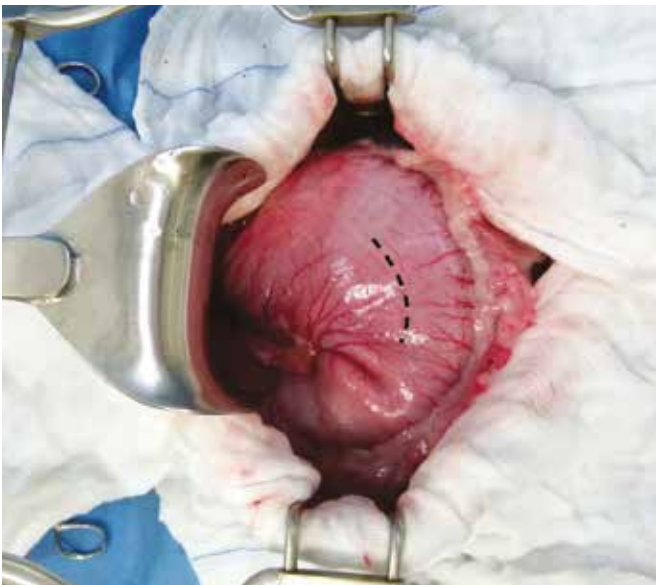


Figure 11.19 Ventral incision of the gastric body.

Video 11.7. Gastrotomy for gastric foreign body removal. After isolating the stomach and placing two stay sutures, the ventral aspect of the gastric body is incised to extract the foreign bodies.



Figure 11.20 Retrieval of a plastic ball from the stomach.

5. An incision is performed with a number 11 scalpel blade in the ventral aspect of the gastric body, parallel to the long axis of the stomach and midway between the greater and lesser curvatures, in an area without major blood supply (Fig. 11.19; Video 11.7). In case of a linear foreign body, the incision may be made over the pyloric region.
6. The length of the incision depends on the size of the foreign material, but it should be kept as small as possible.
7. The foreign material is removed using instruments such as DeBakey forceps or Allis tissue forceps (Fig. 11.20).
8. The suture pattern for stomach closure varies depending on the surgeon's preference. Typically, a two-layer closure is performed, with a simple continuous pattern involving all layers (Fig. 11.21) followed by a simple continuous pattern or inverting pattern (Connell or Cushing) incorporating the serosa and muscularis layers (4-0 or 3-0 slowly absorbable monofilament suture) (Fig. 11.22; Video 11.8).
9. Once the stomach is closed, a segment of omentum is placed over the suture site (Video 11.9).
10. In case of contamination of the abdomen, copious abdominal lavage is indicated.
11. The abdominal wall is closed routinely.

Intestinal foreign body

Intestinal foreign bodies require careful evaluation and surgical intervention. An exploratory laparotomy should be performed, with special attention to examining the entire GI tract, as there may be multiple foreign bodies or a perforated segment of intestine oral to the foreign material. Once identified, the segment is assessed for viability. Enterotomy is performed on a viable intestinal

Section 5 Gastrointestinal surgical emergencies



Figure 11.21 Simple continuous suture pattern incorporating all stomach layers.

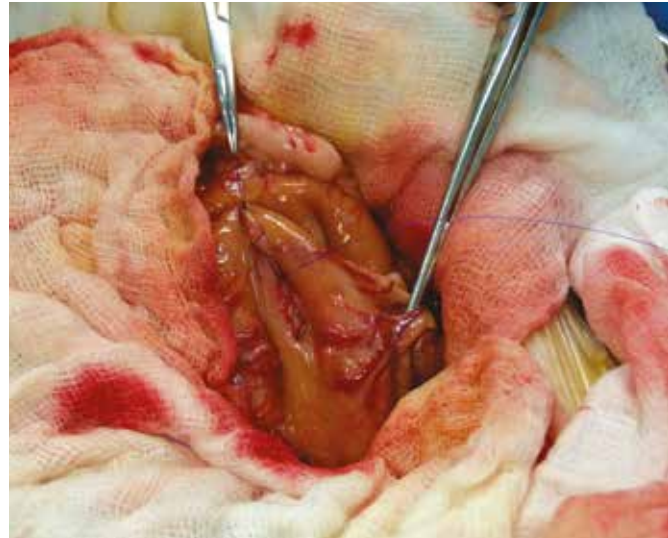


Figure 11.22 Inverting continuous suture pattern incorporating the gastric serosa and muscularis layers.

Video 11.8. Stomach closure via simple continuous suture in two layers: the first layer incorporates the mucosa and submucosa, while the second incorporates the muscularis and serosa.

Video 11.9. Use of omentum to cover the gastric incision.

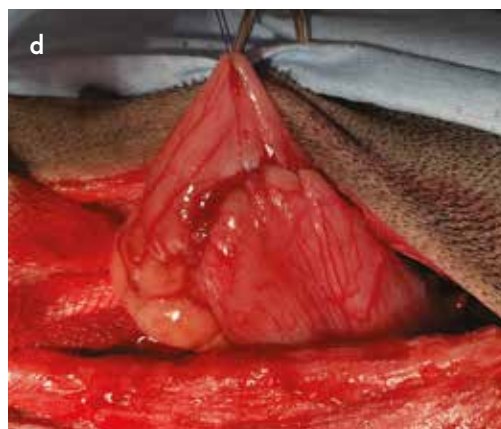
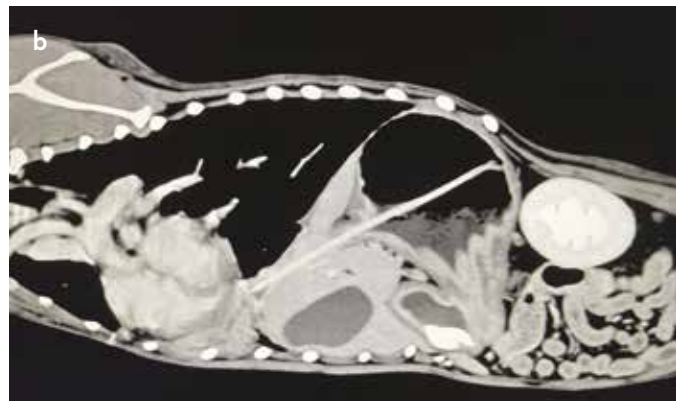
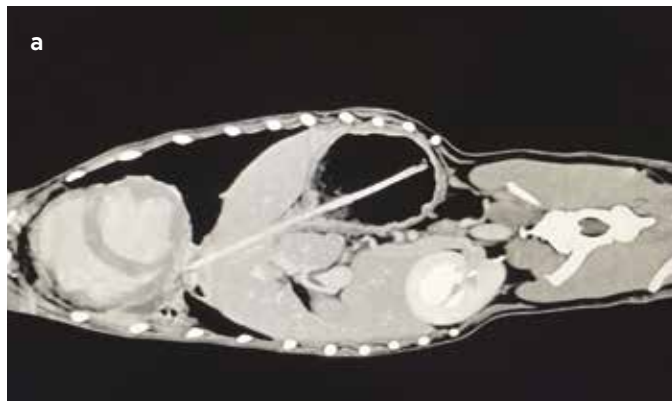


Figure 11.23 (a,b) Computed tomography scans showing a kebab skewer in the stomach. (c) Gastrotomy surgery for foreign body removal. (d) Closure of the stomach in two layers. (e) Foreign body after extraction.

portion aboral to the foreign body, while enterectomy should be performed on nonviable segments. In case of doubt, it may be worthwhile to remove the foreign material and assess the intestinal segment for a few minutes. In some cases, the intestine can appear nonviable due to the pressure from the foreign body; however, once the foreign body is removed and blood flow is restored, the appearance of the intestinal segment starts improving. If this is not the case, then an enterectomy should be performed.

Surgical technique: Enterotomy

1. A midline celiotomy approach is made (see Chapter 3).
2. The digestive tract is thoroughly examined, from the abdominal portion of the esophagus to the colon.
3. The foreign body or bodies are identified, and the presence of necrosis or perforation of the affected intestinal segment is assessed (Fig. 11.24).
4. The segment of intestine is isolated by placing moistened laparotomy swabs around it (Fig. 11.25).
5. A longitudinal incision is made on the antimesenteric border of the intestine, slightly aboral to the for-



Figure 11.24 Identification of an intestinal foreign body.



Figure 11.25 Isolation of the affected intestinal loop from the abdominal cavity using moistened laparotomy swabs.

eign body, as this area of the intestine has not been damaged by the passage of the object (Fig. 11.26; Video 11.10). The length of the incision should be sufficient to extract the foreign body without damaging the intestinal wall (Fig. 11.27; Video 11.11).

6. After foreign body removal, the incision is closed using a single-layer simple interrupted or continuous appositional suture pattern (3-0 or 4-0 absorbable monofilament; e.g., polydioxanone). Suture bites should be about 3–4 mm wide and are placed 3–4 mm apart, depending on intestinal thickness and diameter. It is very important to include the submucosal layer, as it provides the greatest strength to the closure (Fig. 11.28; Videos 11.12 and 11.13).
7. Omentum is wrapped around the enterotomy site (Fig. 11.29; Video 11.14).

Surgical technique: Enterectomy

1. A midline celiotomy approach is made (see Chapter 3).
2. The segment of intestine to be resected is identified and evaluated to determine its viability. Subjective criteria for evaluating intestinal viability include intestinal wall thickness, intestinal color, and the presence of peristalsis (pinch test) and vascular pulsation (see "Intussusception" section below).



Figure 11.26 Antimesenteric incision made aboral to the foreign body.

Video 11.10. Enterotomy. An incision is made on the antimesenteric border, aboral to the foreign material.

Section 5 Gastrointestinal surgical emergencies



Figure 11.27 Retrieval of the foreign body.

Video 11.11. Intestinal foreign body removal.



Figure 11.28 Closure of the enterotomy using simple interrupted appositional sutures.

Video 11.12. Enterotomy closure using simple interrupted appositional sutures.

Video 11.13. Examination of the enterotomy closure with DeBakey forceps to assess if more sutures are required.



Figure 11.29 Omentalization of the enterotomy.

Video 11.14. Placement of omentum covering the enterotomy site.

3. Moistened laparotomy swabs are used to isolate the segment.
4. If the segment has sufficient mobility, it should be brought out from the abdominal cavity to reduce possible contamination.
5. The length of intestine to be resected is determined:
 - Necrotic tissue: A minimum margin of 1–2 cm of healthy tissue (Video 11.15).
 - Intestinal tumors: Margin of 5–7 cm oral and ab-oral (Fig. 11.30).
 - Once decided on the margins to remove, the incision of the intestine to be sutured should be close to the main vessel irrigating the section of intestine; this will improve perfusion to the anastomosis.
6. The vessels supplying the bowel segment to be removed are double ligated with a 2-0 to 3-0 monofilament suture and resected, including the con-

Video 11.15. Assessment of multiple intestinal perforations in a dog shot with a pellet gun.



Figure 11.30 Resection of a segment of intestine with a 5 cm margin oral and aboral due to an intestinal carcinoma.



Figure 11.32 Ligation of the arcuate vessels.

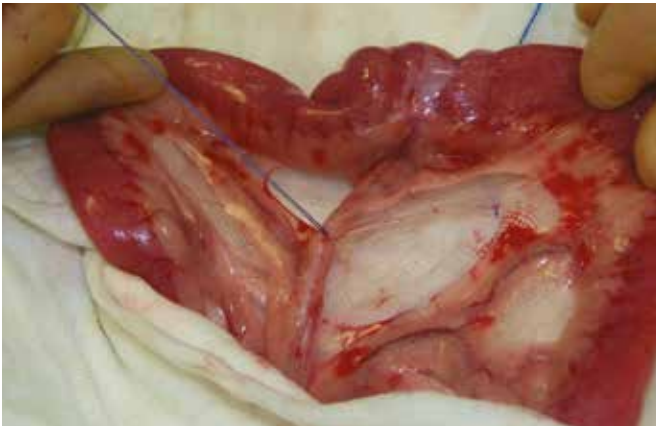


Figure 11.31 Double ligation and resection of the vessels supplying the bowel segment.

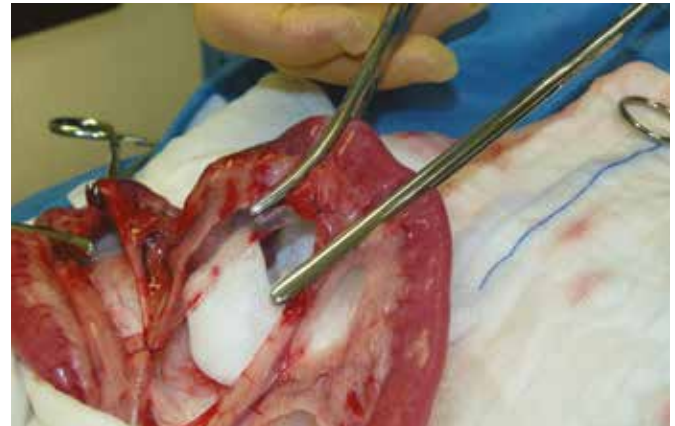


Figure 11.33 Placement of an atraumatic and a traumatic clamp on the edges of the intestine to be sutured and resected, respectively.

necting arcades in the mesenteric border of the intestine (Fig. 11.31). It is important to ligate the arcuate vessels located at the mesenteric border (Fig. 11.32).

7. Atraumatic clamps (e.g., Doyen forceps) or the assistant's fingers are placed on the edge of the intestine to be sutured and traumatic or atraumatic clamps on the edges to be resected (Fig. 11.33).
8. The bowel segment is cut at the level of the atraumatic forceps with a number 11 scalpel blade, leaving at least a 1 cm margin to facilitate suturing (Fig. 11.34; Video 11.16).

Video 11.16. Intestinal resection, ensuring no contamination and leaving enough bowel edge for suturing.

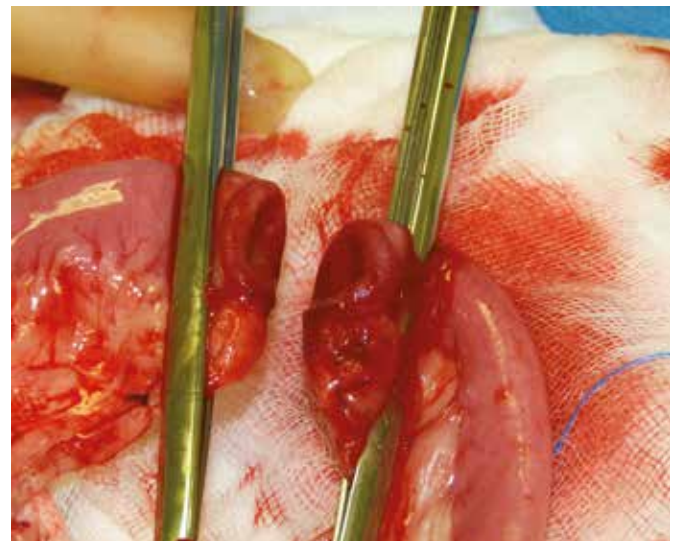


Figure 11.34 Transection of the intestinal segment at the level of the atraumatic forceps, leaving a minimum of 1 cm margin for suture placement.

Section 5 Gastrointestinal surgical emergencies

Suture end-to-end anastomosis:

1. Suturing begins at the mesenteric edge to ensure correct placement of the sutures, as this area has a higher risk of dehiscence due to the presence of mesenteric fat (Fig. 11.35; Video 11.17).
2. Once the first sutures have been placed, anastomosis is continued toward the antimesenteric edge, especially if there is disparity between lumen sizes (Box 11.1). If there is no disparity, a suture can be placed at the antimesenteric edge, followed by the remaining sutures (Figs. 11.36 and 11.37).
3. A simple interrupted appositional suture pattern, with 3-0 or 4-0 long-lasting absorbable monofilament, is used. It is important to include the submucosal layer of the intestine, as it provides the greatest strength. A single layer of interrupted sutures decreases the risk of stricture and leakage of intestinal contents and results in faster wound healing. The needle is inserted about 3–5 mm from the edge of the incision, and sutures are placed every 3–5 mm, depending on intestinal thickness and diameter. The chosen suture should have a good tensile strength for at least 2 weeks, which is when anastomotic strength is close to normal. Examples of suture materials include glycomer 631, polyglyconate, and polydioxanone.
4. Other techniques, such as anastomosis using a continuous suture pattern or a modified Gambee technique, have been described.

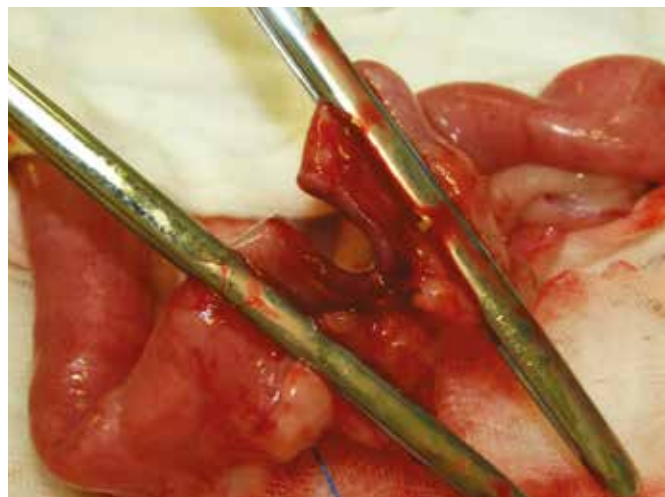


Figure 11.35 Initial sutures placed at the mesenteric side to reduce the risk of dehiscence.

Video 11.17. Placement of the first 2-3 sutures at the mesenteric side of the intestine.

5. After suturing, the anastomosis site can be checked:
 - Pushing DeBakey forceps between each suture (Video 11.18).
 - Saline leak test: Injecting saline into the intestine to see if there is any fluid leakage. The application of leak testing in surgery does not predict the likelihood of incisional dehiscence or failure; however, appropriate use of this technique may benefit novice surgeons in intestinal suturing techniques, such as suture number and spacing.²⁷

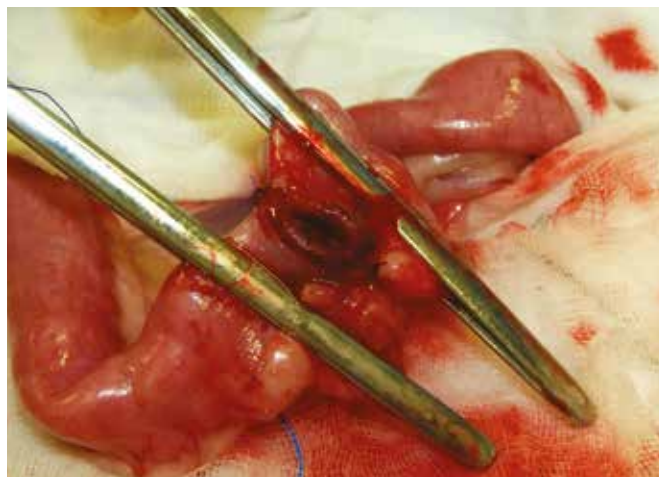


Figure 11.36 Placement of sutures at the antimesenteric border if no disparity exists between the bowel lumen sizes.



Figure 11.37 Suture placement is continued until a technically correct anastomosis is achieved.

Video 11.18. Assessment of enterectomy closure with DeBakey forceps.

- a. The bowel is atraumatically clamped 1–2 cm proximal and distal to the surgical site.
 - b. Sterile saline is injected into the lumen with a needle (e.g., 22 gauge) and syringe (e.g., 10 mL) to gently distend the bowel.
 - c. Additional sutures are placed to close any defect detected.
6. Finally, the mesentery is sutured using 3-0 or 4-0 absorbable monofilament (e.g., polydioxanone or poliglecaprone) in a simple continuous or interrupted pattern (Fig. 11.38; Video 11.19).
 7. Prior to closing the abdominal cavity, omentum is placed over the anastomosis (Video 11.20).

Box 11.1. Techniques in case of disparity between bowel lumen sizes

- The sutures in the wider lumen may be spaced further apart than those in the narrower lumen.
- The edge of the bowel segment with the narrower lumen can be cut at an angle from the mesenteric border toward the antimesenteric side to increase its surface area (Fig. 11.39).
- The antimesenteric border of the narrower lumen can be spatulated (Fig. 11.40).
- The wider lumen can be partially sutured to reduce its diameter.
- A stapling technique can be used (Fig. 11.41).

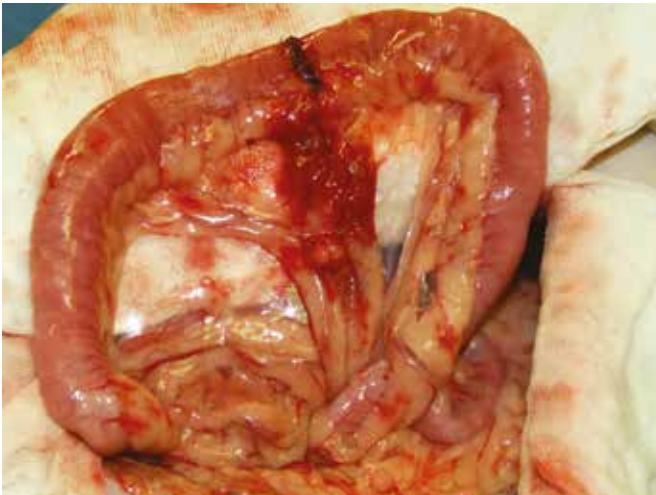


Figure 11.38 Suturing of the mesentery to decrease the risk of intestinal entrapment.

Video 11.19. Suturing of the mesentery using a simple continuous pattern.

Video 11.20. Placement of omentum over the anastomosis site.

Stapled functional end-to-end anastomosis (Fig. 11.42): Several types of anastomoses can be performed with the use of GI stapling systems. When staples, typically made of titanium, are fired, they bend into a B conformation, which improves blood flow to the incision. Two commonly used stapling systems are the GIA (gastrointestinal anastomosis) and the TA (thoracoabdominal) systems (Video 11.21). Five staple heights are available, indicated by the color of the cartridge (grey, white, blue, gold, and green) (see Chapter 6). For GI surgery, the blue and green cartridges are typically used in the intestine and the stomach (usually thicker), respectively. In the blue cartridge, the open staple height is 3.5 mm and 3.8 mm for the TA and GIA systems, respectively, and the closed staple height is 1.5 mm. In the green cartridge, the open staple height is 4.8 mm for both the TA and GIA systems, and the closed staple height is 2.0 mm. Regarding staple length, the GIA system comes in three lengths: 60 mm, 80 mm, and 100 mm, while the TA system sizes are 30 mm, 45 mm, 60 mm, and 90 mm. Another stapling system that could be used for functional end-to-end anastomosis in small dogs (<10 kg) and cats is the Endo GIA stapler with purple cartridges (length 60 mm or 45 mm; medium-thick Tri-Staple 3 mm/3.5 mm/4 mm from inside to outside line).



Figure 11.39 Angling the edge of the intestinal segment with the narrower lumen if a disparity exists between the two lumen sizes.