

**Journal of
Animal Health
(JAH)**

**REVIEW ON SURGICAL AFFECTIONS OF RESPIRATORY
SYSTEM AND THORACIC CAVITY IN DOGS**

Jiregna Dugassa

Abebe Wirtu



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^{1*}Jiregna Dugassa (DVM, MVSc, Assistant Professor),

²Abebe Wirtu (BSc, MVSc, Lecturer)

¹Department of Clinical Studies, College of Veterinary Medicine and Agriculture, Addis Ababa University, Bishoftu, Ethiopia.

²Department of Clinical Studies, College of Veterinary Medicine and Agriculture, Addis Ababa University, Bishoftu, Ethiopia.

Corresponding Authors E-Mail: Jiregnadu@gmail.com/jiregna.dugassa@aau.edu.et

Abstract

Purpose: Review on surgical affections of respiratory system and thoracic cavity in dogs

Findings: There are many surgical conditions which are conducted on respiratory system and thoracic cavity in dogs. Among these, Brachycephalic dog syndrome, tracheotomy, tracheostomy, tracheal anastomosis, thoracotomy, thoracocentesis, and precardioectomy. Before conducting any surgical condition, the nature and extent of the respiratory tract should be examined including historical information, suggestive signs of respiratory tract abnormalities, intended use of the animal, prognosis, complication, availability of the equipments, over all preoperative assessment and economic feasibility should be considered. In addition, the physical examination should include evaluation of regional symmetry of the head, neck, and thorax; evaluation of nasal airflow and patency; palpation of the nasal septum, larynx, and trachea; examination for surgical scars auscultation and percussion. Following thorough and systematic examination of the animals at rest, during and following motion may be warranted. Special examination techniques, including endoscopy, stress evaluation, and radiography, may be indicated.

Unique Contributions to Theory Practice and Policy: Even though there are many physiological derangements due to surgical intervention in respiratory system and thoracic cavity in dogs, it may be healed through primary and secondary intention of healing under aseptic surgical condition. There are also many post operative cares for animals' undergone surgical activity on respective and specific organs.

Key Words: *Respiratory System, Surgical Affection and Thoracic Cavity*

1.0 INTRODUCTION

The respiratory system is responsible for taking in oxygen and eliminating waste gases like carbon dioxide. Because dogs and cats do not sweat through the skin, the respiratory system also plays an important role in thermoregulation. Diseases affecting the respiratory tract are common in domestic animals; however, surgery required for treatment of these diseases is infrequent. Therefore, veterinarians may be reluctant to perform these surgical procedures. But the familiarity with the variety and complexity involved in various surgical procedures can reduce this anxiety. If there surgery of the respiratory tract often is considered a last resort. However, these surgeries can be performed successfully with the presence of well experienced veterinary surgeon and facilities, allowing for preservation of genetics and productivity in addition to offering significant benefits to the patient and the animal owner [1].

Normally the surgery of the respiratory system and thoracic cavity can be conducted in the form of emergency as in upper respiratory system obstruction or elective procedure as in minor stenosis from surrounding structure which cannot cause immediate loss of life to the animal. The surgery of the respiratory system can be classified as upper and lower surgical intervention. In case of surgery of upper respiratory system; surgical affections of nasal cavity, nasopharynx, larynx and trachea are included. But the lower respiratory system surgery includes the surgical affections of lungs and other respiratory organs in the thoracic cavity including associated structures such as pleura. One of the organs in the thoracic cavity which has surgical importance is heart [2]

There are many surgical conditions conducted on respiratory system and thoracic cavity in dogs. Among these; brachycephalic dog syndrome, tracheotomy, tracheostomy, tracheal anastomosis, thoracotomy, thoracocentesis, and preicardioectomy. Before conducting any surgical condition, the nature and extent of the respiratory tract should be examined including historical information, suggestive signs of respiratory tract abnormalities, intended use of the animal, prognosis, complication, availability of the equipments, over all preoperative assessment and economic feasibility should be considered. Following a thorough and systematic examination of the animals at rest, during and following motion may be warranted. In addition, the physical examination should include evaluation of regional symmetry of the head, neck, and thorax; evaluation of nasal airflow and patency; palpation of the nasal septum, larynx, and trachea; examination for surgical scars auscultation and percussion. Special examination techniques, including endoscopy, stress evaluation, and radiography, may be indicated [3].

Even though there are much surgical affection on respiratory system and thoracic in domestic and companion animals like dogs there are less surgical operations conducted in clinical veterinary surgical practices due to limited surgical facilities, technicians (anesthetists), veterinary surgeon with sub specialty on large and small animals, less awareness on such condition, less availability of well organized literature reviews specially on surgical techniques. There for the main objectives of this review are:

- ❖ To prepare review on the surgical affection of in respiratory system and thoracic cavity
- ❖ To highlight the basic techniques of common surgical affections of respiratory system

2.0 SURGICAL AFFECTIONS OF RESPIRATORY SYSTEM AND THORACIC CAVITY IN DOGS

2.1. Common Surgical Condition of the Upper Respiratory System in Dogs

Upper respiratory diseases are associated with the mouth, nasal cavity, pharynx, and cervical trachea (throat). These conditions are mainly common in cats and dogs but the symptoms may go unrecognized by owners and some can lead to emergency situations that can threaten the life of a beloved pet [4].

2.1.1. Brachycephalic airway syndrome

It is one of the most common upper respiratory diseases observed in dogs mainly affecting brachycephalic breeds (short faced dogs) due to shortened snout and face. In addition these breeds are predisposed to stenotic nares, everted laryngeal sacculles, and elongated soft palate which necessitate emergency surgical intervention [5]. The clinical sign of brachycephalic airway syndrome can include the following: noisy breathing, excessive snoring, open mouth breathing, gagging and/or choking, exercise intolerance, cyanosis (blue tongue). These symptoms are exacerbated by hot, humid weather and obesity. The concrete diagnosis is made by visual examination of the upper airway and larynx with the help of sedation or general anesthesia [6].

Treatment: Surgical by rhinoplasty (nose job).

Animal control and aesthesia: general anesthesia and dorsal recumbence.

Surgical technique: A small wedge of tissue is resected from the side of the nostril and the edges are sutured together to widen the nostrils and allow for normal respiration. Everted laryngeal sacculles occur in dogs that have compromised upper airway flow. The treatment for this problem is to remove the sacculle tissue. Elongated soft palates can vary from slight to severe. This is a very serious condition and can sometimes result in a complete obstruction of airflow. The treatment for this condition is to excise the excess tissue in order to shorten the soft palate [6].

Post-operative care: It depends on which procedure, or combination of procedures, were performed. Patients that have only had a stenotic nares repair can often go home the same day. They must wear an Elizabethan collar at all times to prevent them from rubbing or scratching at the sutures in their nose. If everted laryngeal sacculles or a soft palate were excised, the patient must spend at least one night in the hospital. These surgical procedures can cause inflammation in the throat, which requires supervision. Once home, patients must remain on a soft diet for a minimum of two weeks. They must be kept quiet and cool to allow their airways to heal and reduce inflammation [2].

Possible complications: The complications involved after surgery depends on the severity of the patient's condition. In some cases, additional surgery may be required to resect more tissue if clinical signs persist post operatively. In very severe cases where a patient has been greatly compromised by their condition, intensive care may be necessary post operatively, including a temporary tracheostomy to allow the upper airway to heal [5].

2.1.2. Tracheotomy

A tracheotomy is the surgical creation of an opening into the trachea for insertion of a tracheostomy tube and surgical intervention of trachea lumen such as to remove obstructions, collect specimens, and/or facilitate airflow. It is also indicated when the trachea has become so damaged that an appropriate airway between the mouth/larynx and lungs no longer exists. The tracheal incision may be closed or allowed to heal by secondary intention [7].

Animal control and anesthesia: animal is kept in dorsal recumbence and anaesthetized with general anesthesia

Approach and site: On the cervical trachea through a ventral cervical midline incision.

Surgical techniques: Extend the incision from the larynx to the sternum as needed to allow adequate exposure. Separate the sternohyoid muscles along their midline, and retract them laterally. Dissect the peritracheal connective tissue from the ventral surface of the trachea at the proposed tracheotomy site. Take care to prevent traumatizing the recurrent laryngeal nerves, carotid artery, vagosympathetic trunk, jugular vein, thyroid vessels, or esophagus. Immobilize the trachea between the thumb and the forefinger. Make a horizontal or vertical incision through the wall of the trachea. Place cartilage-encircling sutures (2-0 polypropylene (Prolene) around adjacent cartilages to separate the edges and allow lumen inspection or tube insertion. Suction blood, secretions, and debris from the tracheal lumen [7].

Closure: After completion of the procedure, appose the tracheal edges with simple interrupted 3-0 or 4-0 polypropylene sutures. To close the tracheal incision, place sutures through the annular ligaments encircling adjacent cartilages or through the annular ligaments only (Figure 1.). Lavage the surgical site with saline. Appose the sternohyoid muscles in a simple continuous pattern with 3-0 or 4-0 absorbable suture (e.g., polydioxanone (PDS), polyglyconate (Maxon), pleglicarpone 25 polyglactin 910 (Vicryl) etc.). Appose the subcutaneous tissues and skin routinely [8].

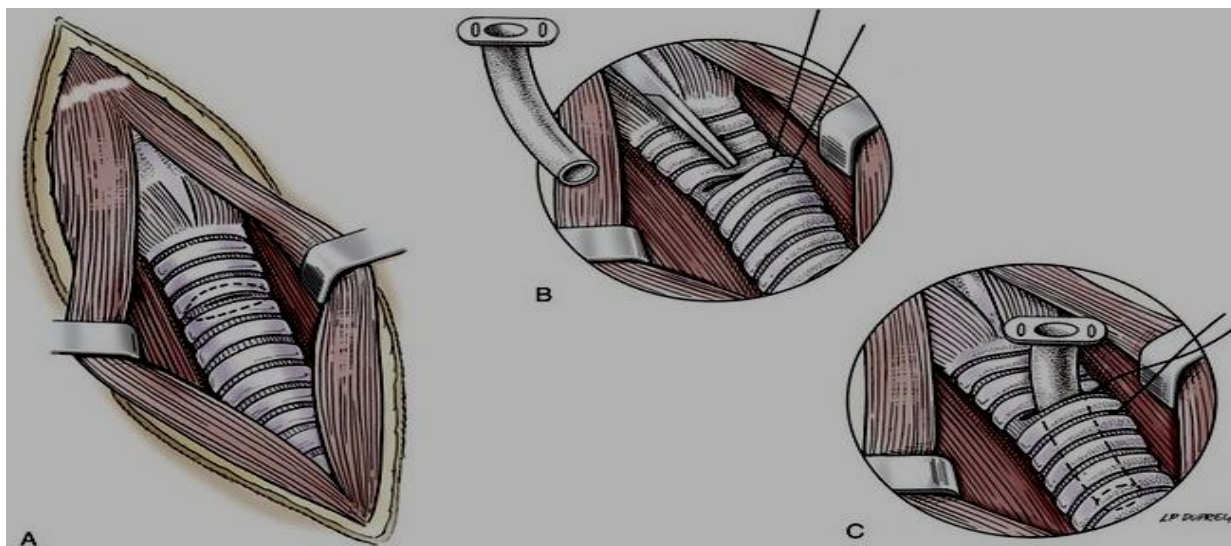


Figure 1. Tracheotomy with tube tracheostomy in dog.

A, Make a transverse incision through the annular ligament. Excise a small ellipse of cartilage from each tracheal cartilage adjacent to the tracheotomy incision to minimize tube irritation (dotted line). Facilitate tube placement by (B) depressing the proximal cartilages with a hemostat and (C) elevating the distal cartilages with an encircling suture. Insert a tracheostomy tube that does not completely fill the lumen.

Post operative care: Administrations of anti pain, antibiotic, use fly repellants and use of Elizabethan collar to prevent scratching of the surgical area.

2.1.3. Tracheostomy

Tracheostomy allows air to enter the trachea distal to the nose, mouth, nasopharynx, and larynx. Prior to tracheostomy, a tracheotomy is performed to insert a tube (temporary tracheostomy) or create a stoma (permanent tracheostomy) to facilitate airflow. A non reactive tube that is no larger than half the size of the trachea should be selected. Cuffed or cannulated autoclavable silicone, silver, or nylon tubes are recommended. In an emergency situation, a standard endotracheal tube can be used, we should have to be sure that the tube is not inserted too far into the respiratory tree, and that the cuff is not inflated. Polyvinyl chloride and red rubber tubes are irritating and should be avoided. If the animal is to be placed on a respirator, a cuffed tube is necessary [6].

Temporary tracheostomy: A temporary tracheostomy is most commonly performed to provide an alternate airflow route during surgery or as an emergency procedure in severely dyspneic patients. Tube tracheostomies usually are maintained for only a short time.

Animal control anesthesia: animal is kept in dorsal recumbence and administered with general anesthesia [9].

Incision site: Make a ventral midline incision from the cricoid cartilage extending 2 to 3 cm caudally. As an alternative, make a vertical tracheotomy across the ventral midline of cartilages 3 through 5. Place cartilage-encircling sutures (2-0 polypropylene (Prolene) around adjacent cartilages to separate the edges and allow for tube insertion [9].

Surgical technique: After making incision on the surgical area, separate the sternohyoid muscles and make a horizontal (transverse) tracheotomy through the annular ligament between the third and fourth or fourth and fifth tracheal cartilages. Do not extend the incision around more than half the circumference of the trachea. Suction blood and mucus from the lumen, widen the incision if necessary, and insert the tracheostomy tube. Facilitate tube placement by opening a hemostat in the incision, or depress the cartilages cranial to the horizontal incision. Alternatively, place tension on the caudal suture to open the incision. Resect a small ellipse of cartilage if tube insertion is difficult. Appose the sternohyoid muscles, subcutaneous tissue, and skin cranial and caudal to the tube. Secure the tube by suturing it to the skin or tying it to gauze that is tied around the neck [9].

Permanent tracheostomy: Permanent tracheostomy is the creation of a stoma in the ventral tracheal wall by suturing tracheal mucosa to skin. Tracheostomas are maintained for life, or until the stoma is surgically closed. Tracheostomy tubes are not needed to maintain lumen patency after this procedure. The major aims of tracheostomy tube management are to prevent tube

obstruction, to facilitate removal of airway secretions, and to minimize the risk of airway trauma or nosocomial pneumonia [10].

Indication: Permanent tracheostomies are recommended for animals with upper respiratory obstruction causing moderate to severe respiratory distress (e.g., laryngeal paralysis, laryngeal collapse, upper airway neoplasia) that cannot be successfully treated by other methods.

Animal control and anesthesia: the same as in temporary tracheostomy.

Incision site and approach: ventral cervical midline incision is conducted to expose the proximal cervical trachea.

Surgical technique: Create a tunnel dorsal to the trachea in the area of the third to sixth tracheal cartilages. During incision precaution is important to prevent on traumatizing the major structures such as: laryngeal nerves, carotid artery, vagosympathetic trunk, jugular vein, thyroid vessels, and esophagus. Using this tunnel, appose the sternohyoid muscles dorsal to the trachea with horizontal mattress sutures to create a muscle sling to reduce tension on the mucosa-to-skin sutures (Figure 2 A.). Beginning with the second or third tracheal cartilages, outline a rectangular segment of tracheal wall three to four cartilage widths long and one-third of the circumference of the trachea in width. Incise the cartilage and annular ligaments to the depth of the tracheal mucosa. Elevate a cartilage edge with thumb forceps, and dissect the cartilage segment from the mucosa. Excise a similar segment of skin adjacent to the stoma (excise larger segments of skin if the animal has loose skin folds or abundant subcutaneous fat).

Closure: Suture the skin directly to the peritracheal fascia laterally and the annular ligaments proximal and distal to the stoma with a series of interrupted intradermal sutures (3-0 or 4-0 polydioxanone or polypropylene). Make an I- or H-shaped incision in the mucosa. Fold the mucosa over the cartilage edges and suture it to the edges of the skin with approximating sutures to complete the tracheostoma (Figure 2 B). Use simple interrupted sutures at the corners and a simple continuous pattern to further appose skin and mucosa (using 4-0 polypropylene suture) (see Figure 2 B). Alternatively, make a full-thickness H-shaped incision in the ventral trachea to create two tracheal flaps that are reflected cranially and caudally and sutured directly to the skin.

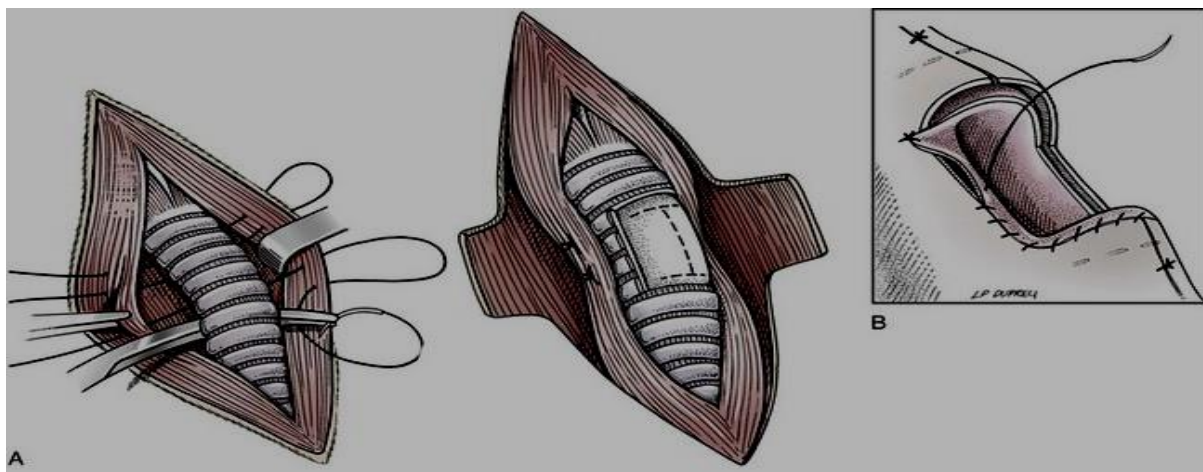


Figure 2. Permanent tracheostomy

(A) Deviate the trachea ventrally by apposing the sternohyoid muscles with mattress sutures dorsal to the trachea. Excise a rectangular segment of ventral tracheal wall without penetrating the mucosa. Note the dotted line where the I-shaped incision is made after the cartilage segment is removed. Excise loose skin adjacent to the stoma. (B) Use intradermal sutures to appose the skin to the annular ligaments and peritracheal tissues (*dashed lines*). Appose the tracheal mucosa to the skin with three or four interrupted sutures; complete the closure in a simple continuous pattern.

Post operative care: Owners should be warned that these animals must be restricted from swimming, and that vocalization is diminished or absent after this procedure. Furthermore, ongoing care of the site will be necessary to keep it clean.

2.1.4. Tracheal resection and anastomosis

Depending on the extent of injury, tears in the tracheal wall that occur as a consequence of bite wounds or endotracheal intubation may be allowed to close spontaneously, may be closed primarily, or may be resected and the tracheal ends anastomosed. Depending on the degree of tracheal elasticity and tension, approximately 20% to 50% of the trachea in an adult dog (approximately 8 to 10 rings) may be resected and direct anastomosis achieved [11].

Indication: Removal of a tracheal segment may be necessary to treat tracheal tumor, stenosis, avulsion, or trauma.

Animal control and anesthesia: as in the case of tracheostomy.

Surgical techniques: The split-cartilage technique is preferred because it is easier to perform and results in more precise anatomic alignment with less luminal stenosis than many other techniques. Imprecise anastomosis and tension across the suture site are considerable risk factors in the development of tracheal stenosis. Accurate and meticulous surgical technique is crucial for reconstruction of the trachea.

Expose the involved trachea through a ventral cervical midline incision, lateral thoracotomy or median sternotomy. Mobilize only enough tracheas to allow anastomosis without tension. Preserve as much of the segmental blood and nerve supply to the trachea as possible. Place stay sutures around cartilages cranial and caudal to the resection sites before transecting the trachea. Resect the diseased trachea by splitting a healthy cartilage circumferentially at each end or by incising annular ligaments adjacent to the intact cartilages (Figure 3 A)). Use a No. 11 blade to split the tracheal cartilages at their midpoint. Transect the dorsal tracheal membrane with Metzenbaum scissors. Pre place and then tie three or four simple interrupted sutures (3-0 or 4-0 polypropylene (Prolene) or polydioxanone (PDS), in the dorsal tracheal membrane (Figure (3 B)) Retract the endotracheal tube into the proximal trachea during resection and placement of sutures in the dorsal tracheal membrane. Remove blood clots and secretions from the lumen, and advance the tube distal to the anastomosis after placing dorsal tracheal membrane sutures. Complete the anastomosis by apposing the split cartilage halves or adjacent intact cartilages with simple interrupted sutures beginning at the ventral midpoint of the trachea. Space additional

sutures 2 to 3 mm apart. Place three or four retention sutures to help relieve tension on the anastomosis [12].

Place and tie these sutures so that they encircle an intact cartilage cranial and caudal to the anastomosis, crossing external to the anastomotic site (Figure (C)). Lavage the area and appose the sternohyoid muscles in a simple continuous pattern.

Closure: Close the subcutaneous tissues and skin routinely. Alternatively, consider a simple continuous pattern for anastomosis because it has similar biomechanical strength to a simple interrupted pattern augmented with encircling sutures in the neighboring cartilage rings [8].

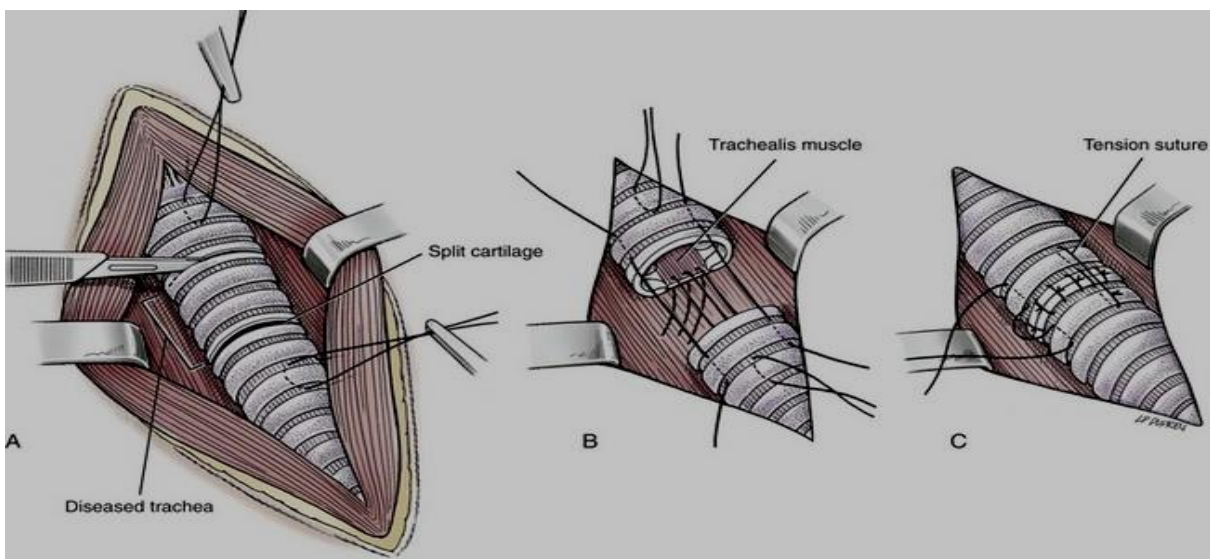


Figure 3. Tracheal resection and anastomosis.

(A) Place stay sutures cranial and caudal to the resection sites. Split the cartilages with a No. 11 blade, and transect the trachealis muscle with Metzenbaum scissors. (B), Appose the trachealis muscle with three or four interrupted sutures, then approximate the split cartilages. (C), Place three or four tension-relieving sutures around cartilages adjacent to the anastomosis.

If tension-relieving sutures do not adequately relieve tension at the anastomosis, further mobilize the trachea, make partial-thickness incisions through annular ligaments proximal and distal to the anastomosis, or restrict head and neck movement after surgery. Prevent full extension of the neck by placing a suture from the chin to the manubrium or by fixing a muzzle to a harness to maintain mild to moderate cervical flexion. Maintain the muzzle for 2 to 3 weeks. Diseased trachea that exceeds the limits of resection and anastomosis may be managed with permanent tracheostomy, intraluminal silicone tubes, grafts, or prostheses with variable success [12].

Post operative care: After tracheal resection and anastomosis, exercise and neck extension should be restricted for 2 to 4 weeks. Animals should be kept quiet and observed for signs of respiratory distress after ventriculocordectomy. Some animals gag and cough. Vocalization should be discouraged for 6 to 8 weeks.

2.1.5. Ventriculocordectomy

Ventriculocordectomy is removal of the vocal cords to alter vocalization, remove masses, or enlarge the ventral glottis for dogs [13].

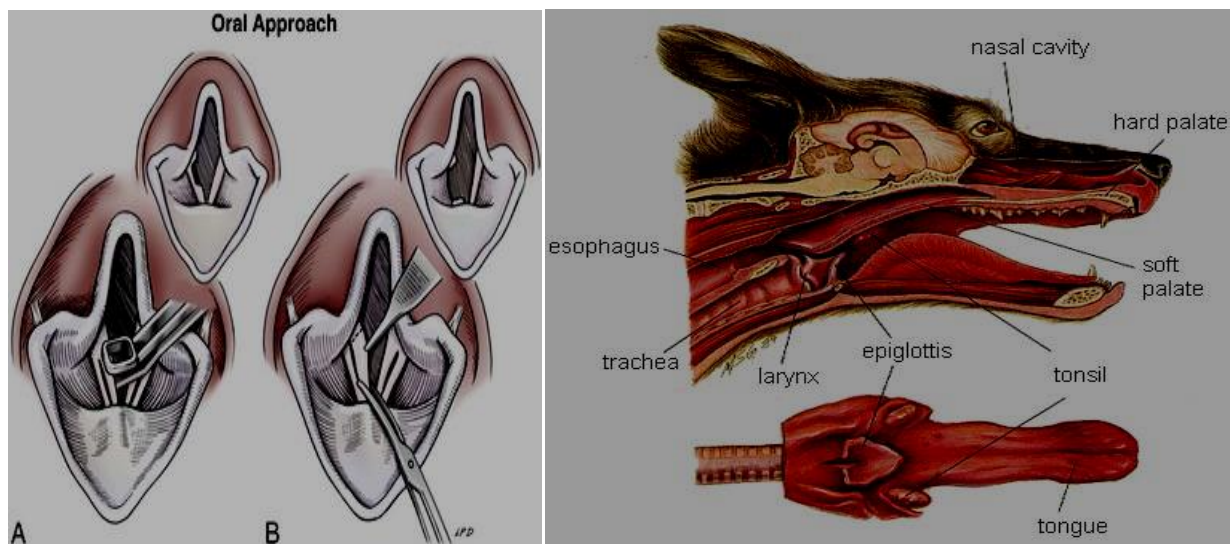
Indication: Dogs with laryngeal paralysis. Ventriculocordectomy performed to widen the ventral glottis requires that more vocal fold be resected than is required for debarking.

Approach: The procedure may be performed through an oral or ventral (laryngotomy) approach.

Animal control and anesthesia: Position the patient in ventral recumbency with the neck extended for oral approach and Position the patient in dorsal recumbency with the neck extended over a rolled towel for laryngotomy (ventral approach). Animal is anaesthetized with general anesthesia and maintained by using a tube tracheostomy, manipulating the endotracheal tube to the contralateral side of the larynx, or using injectable anesthetic agents.

Oral approach: after controlling and positioning the animal in correct position, Suspend the maxilla and pull the mandible ventrally to maximally open the mouth.

Surgical techniques: Extend the tongue from the mouth to get maximum exposure of the glottis. Retract the cheeks laterally to improve visualization. Avoid placing of padding or hands in the region of the larynx because this may distort the nasopharynx. Remove the central margin of the vocal cord for debarking with a laryngeal or uterine cup biopsy forceps (Figure 4. A). To widen the glottis, use long-handled Metzenbaum scissors and remove as much of the vocal fold extending into the laryngeal lumen as possible (Figure 4. B). with either technique, maintain 1 to 2 mm of mucosa at the dorsal and ventral aspects of the vocal cord. Control hemorrhage with pressure. Remove blood clots and secretions with suction or sponges. Allow the incision to heal by secondary intention.



Source [14].

Figure 4. For ventriculocordectomy (oral approach)

A) Remove the central portion of the vocal fold with laryngeal cup forceps or uterine biopsy forceps. B) For laryngeal paralysis or devocalization, remove most of the vocal fold with Metzenbaum scissors. Dorsal and ventral commissures remain intact.

Laryngotomy approach: Position the patient in dorsal recumbency with the neck extended over a rolled towel (Figure 5. A-C).

Surgical technique: Expose the larynx using a ventral midline cervical approach, beginning rostral to the basihyoid bone and extending caudally to the proximal trachea. Separate and retract the paired sternohyoid muscles. Identify the midline of the thyroid cartilage. Ligate and divide the laryngeal impar vein if necessary. Incise the cricothyroid ligament with a No. 15 or No. 11 blade. Extend the incision along the midline of the thyroid cartilage as needed to expose the vocal folds. Excise the entire vocal fold from the arytenoid cartilage dorsally and the thyroid cartilage ventrally. Close the defect by apposing the mucosa in a simple continuous appositional pattern using 4-0 to 5-0 monofilament absorbable suture. Appose the cricothyroid ligament and thyroid cartilage with simple interrupted sutures. Appose the sternohyoid muscles in a simple continuous pattern with 3-0 or 4-0 monofilament absorbable suture. Close the subcutaneous tissues and skin routinely [15].

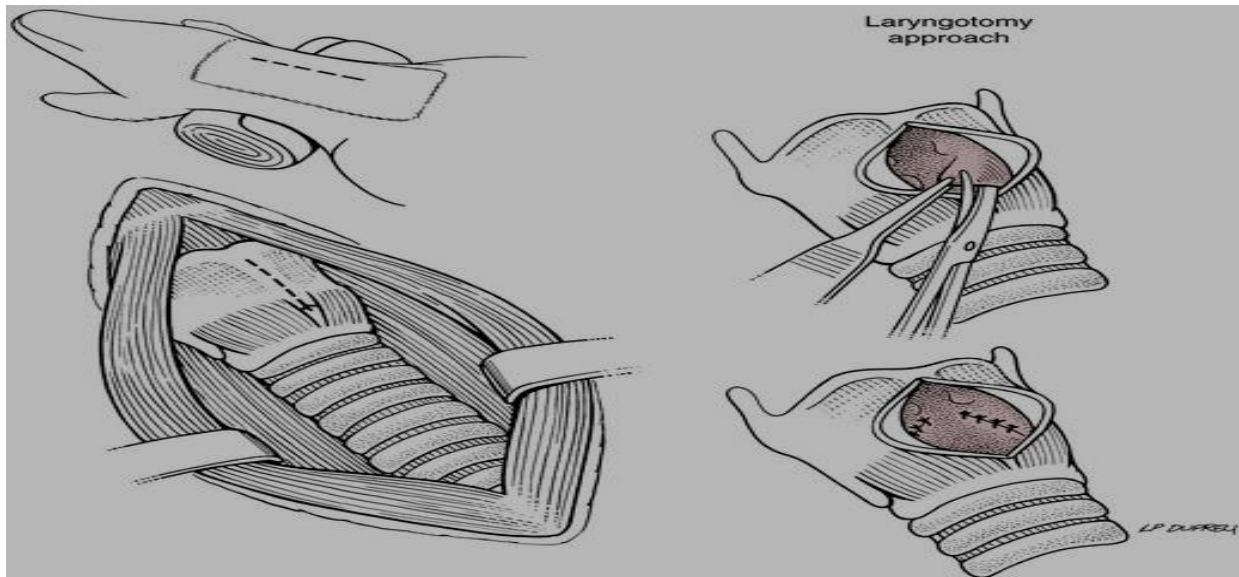


Figure 5. ventriculocordectomy (laryngotomy approach), position the patient in dorsal recumbency with the neck extended over a rolled towel. Expose the larynx, identify the midline of the thyroid cartilage and the cricothyroid ligament, and then incise with a scalpel blade (dashed lines). Expose the vocal folds and excise them. Close the defect by apposing the mucosa in a simple continuous appositional suture pattern.

2.2. Surgical Healing of the Respiratory Tract

Laryngeal wounds heal by re-epithelialization if mucosal edges are in apposition. Epithelial cells at the wound margins extend and spread over the wound until it is covered. Constant motion

associated with breathing and head movement inhibits primary healing. Laryngeal wounds with gaps heal by secondary intention, first filling with granulation tissue and then re-epithelializing. Secondary intention healing may cause scarring across the glottis. Restricting surgery to one side of the larynx and leaving epithelium at the intact dorsal and ventral commissures may prevent scarring [16].

Tracheal epithelium responds immediately to irritation or disease by increased production of mucus. If the irritation continues, cells desquamate and hyperplasia of goblet cell occurs to increase the protective mucous layer so that superficial wounds heal by re-epithelialization. Healing begins within 2 hours after sloughing of superficial cells. Intact ciliated columnar cells surrounding the defect flatten, lose their cilia, and migrate over the wound. Mitosis begins about 48 hours after injury in the ciliated columnar and basal epithelial cells. Organization and differentiation begin after 4 days. Squamous cells replace ciliated and goblet cells if injury recurs without healing. Full-thickness tracheal mucosal wounds with a gap between mucosal edges fill with granulation tissue before re-epithelialization. Full-thickness wounds may heal with scar tissue protruding into the lumen. Scar tissue narrows the lumen and may interfere with transport of mucus. A 20% reduction in lumen diameter may reduce mucociliary clearance by more than 50% [17].

2.3. General Postoperative Care and Complication of Respiratory System Surgery

2.3.1. Post operative care

Patients must be closely monitored during anesthetic recovery for hemorrhage, coughing, gagging, or aspiration. They should be kept in tubated as long as possible and re intubated or has a tracheostomy tube placed if respiratory distress occurs after ex tubation. Supplemental oxygen should be provided if necessary during recovery, and pain should be minimized by postoperative analgesics. Inserting a nasal oxygen catheter at the end of surgery facilitates oxygen delivery. Positioning the patient in sternal recumbency may facilitate respiration. Postoperative corticosteroids (dexamethasone 0.5 to 2 mg/kg IV, IM, or SC) is essential. Prophylactic antibiotics can be discontinued immediately after surgery. Water may be offered 6 to 12 hours after surgery; soft food made into meatballs may be offered 12 to 24 hours postoperatively if gagging, regurgitation, or vomiting does not occur. Meat balls should be fed one at a time for 5 to 7 days after nasopharyngeal or laryngeal procedures to slow ingestion. Exercise should be restricted for 4 weeks. A harness rather than a collar should be used for 2 to 4 weeks to prevent incision, tracheal or laryngeal trauma [18].

After rhinotomy, animals should be recovered in a slightly head-down position, they should be kept quiet, and some sneezing should be expected. Breathing sounds are typically harsh and resonant after this procedure. Initially, nasal discharge is expected to be bloody, but it should gradually become serous and diminish in volume after the nasal cavity has re-epithelialized (generally within a week). If bleeding continues after surgery, the nasal cavity can be packed with sterile gauze. If gauze strips are used, the end of the gauze can be exited from the nostril or a dorsal stoma and sutured to the side of the face. The packing is removed 1 or 2 days after surgery. Feed soft food for a minimum of 7 to 14 days following surgery and give supportive therapy [19].

Intensive postoperative care is required after tube tracheostomy. The animal must be observed closely to prevent asphyxiation secondary to tube obstruction or dislodgment. Clearance of mucus is inhibited in these animals, and mucosal irritation leads to increased production of mucus. Tube cleaning may be required every 15 minutes if the trachea is irritated. Sterile technique (i.e., gloves and instruments) should be used to clean tracheostomy tubes. Secretions may be removed by inserting a sterile suctioning cannula into the tube lumen and distal trachea. When cannulated tubes are used, the inner cannula may be removed and cleaned while the outer tube is suctioned. A new tube should be used if these techniques do not adequately remove secretions. Tracheostomy tubes may be removed when an adequate airway and spontaneous ventilation have been established. After removal of the tube, the tracheostomy site should be allowed to heal by secondary intention [8].

Management of permanent tracheostomy in the short term is usually less demanding than management of tube tracheostomy. Initially the tracheostoma should be inspected every 1 to 3 hours for accumulation of mucus. When mucus begins to occlude the tracheostoma, or when respiratory effort increases, the site should be suctioned as described previously for tube tracheostomy. Mucus at the stoma may be removed by aspiration or by gentle wiping with a sponge or applicator stick. Only a moderate amount of mucus is expected to accumulate during the first 7 to 14 days after surgery unless the animal has severe tracheitis. By 7 days, the cleaning interval usually increases to every 4 to 6 hours, and after 30 days, twice-daily stomal cleaning usually is sufficient. However, smoke and other noxious stimuli increase mucus production and necessitate more frequent cleaning. Hair should be clipped as needed from around the stoma to prevent matting of the hair with mucus. Exercise and housing should be restricted to clean areas [6].

2.3.2. Complications

Acute respiratory obstruction caused by mucosal swelling, edema, irritation, and increased mucus production and/or laryngeal or tracheal collapse may occur after upper respiratory surgery and must be relieved promptly. Infection can be a problem because the nose, nasopharynx, larynx, and trachea have a resident bacterial flora. Using strict aseptic technique and lavaging contaminated tissues usually prevent infection [7].

Injury to the recurrent laryngeal nerve may cause laryngeal spasms, paresis, or paralysis, leading to aspiration pneumonia. Mucostasis may occur after nerve damage. Gentle tissue handling, appropriate dissection, and careful tissue retraction prevent nerve damage. Complications associated with rhinotomy include excessive blood loss, subcutaneous emphysema, gagging, coughing, and/or vomiting associated with aspiration of blood and exudates [5].

Intensive monitoring of a patient with a temporary tracheostomy tube is required to avoid life-threatening complications, particularly in smaller animals. Complications associated with tube tracheostomy include gagging, vomiting, coughing, tube obstruction, tube dislodgment, emphysema, tracheal stenosis, tracheal malacia, and tracheocutaneous or tracheoesophageal fistula. Some animals occlude the tracheostomy tube when the neck is flexed, and when they sleep with bedding. Major complications (occlusion, dislodgment) were reported in 44% of cats

with temporary tracheostomies [7]. Cuffed tracheostomy tubes and endotracheal tubes may cause pressure necrosis of the tracheal mucosa or cartilages, which may result in tracheal strictures.

Animals with permanent tracheostomy have high complication and mortality rates primarily caused by occlusion of the stoma from mucus, blood, or stricture. In particular, cats are at high risk for acute occlusion and sudden death [6]. The long-term main complication of permanent tracheostomy is stomal occlusion from accumulated mucus, skin folds, or stenosis. Mucus accumulation, coughing, and gagging may also occur because of tracheal irritation.

Complications after tracheal resection and anastomosis may include hemorrhage, voice change, fistula formation, and cartilage malacia. Malacia is uncommon, and the other complications are manageable. Dehiscence occurs after tracheal anastomosis if excessive postoperative tension or neck movement is present. Subcutaneous emphysema, acute respiratory distress, hemoptysis, and subcutaneous swelling suggest dehiscence. Excessive anastomotic tension and secondary intention healing may cause tracheal stenosis. Excessive dissection may cause ischemic necrosis of the remaining trachea. Traumatizing the recurrent laryngeal nerves may cause laryngospasm, laryngeal paresis, or laryngeal paralysis [8].

After ventriculocordectomy, scar tissue may form within the larynx and trachea, causing obstruction weeks postoperatively. Clinical signs of obstruction are not usually apparent until luminal compromise approaches 50%. Scar tissue forms across the larynx as the result of mucosal damage or with second intention healing near the dorsal and ventral commissures. Other complications include edema, hemorrhage, cough, gag, stenosis, and altered vocalization. Mucosal edema may partially obstruct the glottis and can be reduced by pretreatment with corticosteroids. Stenosis may occur at the dorsal or ventral commissures of the glottis after ventriculocordectomy if intact mucosa is not preserved in these areas, and healing occurs by secondary intention. Ventriculocordectomy is expected to alter the normal bark, making it lower pitched and harsher. Resumption of a near-normal bark may occur within months after removal of only the vocal fold margin and secondary intention healing [5]

2.4. Surgical Affection of Thoracic Cavity in Dogs

The choice of surgical approach depends largely on the type of access needed for the thoracic surgery. Intercostals' thoracotomy and median sternotomy are the two most commonly performed approaches in small animals. In both methods clipping and preparing a large enough area to anticipate placement of a thoracostomy tube and the potential need to extend the incision is very crucial during operation [2].

I) Intercostal thoracotomy: Intercostal thoracotomy approach is one way of the operation to expose a specific region of a hemithorax. It provides good access to the hilar area of the lungs and the heart. Additionally, exposure of the mediastinum and a portion of the ipsilateral thoracic cavity are achieved [20].

Site: Spaces available for performing an intercostal thoracotomy are the third through the tenth, although the fourth through the sixth intercostal spaces are more frequently entered. During the incision, using the lateral thoracic radiograph to determine the appropriate intercostal space is also important. It is important to remember that when performing a lung lobectomy, center the approach over the hilus of the lung not over the lesion (cranial lobe - 4th or 5th, middle lobe -

5th, caudal lobe - 6th intercostal space). Use a 4th intercostal thoracotomy incision (5th in the cat) to expose the heart in the dog. Use the 8th intercostal space to expose the caudal esophagus.

Techniques: after preparing the surgical site in aseptic manner, incise the skin parallel to the ribs and have the incision extend from just ventral to the costovertebral junction to just dorsal to the sternum. Incise the latissimus dorsi muscle with scissors parallel to the skin incision. Verify intercostal space identification by counting caudally from the first rib. Incise the serratus ventralis muscle parallel to its fibers to expose the desired intercostal space. Incise the intercostal muscles midway between ribs to avoid the intercostal vessels and nerve. Bluntly puncture the pleura to allow the lungs to fall away from the lateral thoracic wall before extending the intercostal incision with Mayo scissors. The intercostal muscle incision should extend ventral to the costochondral junction to assure adequate exposure. Insert rib retractors over laparotomy sponges to protect skin and muscle

Closure: Close the intercostal space by placing heavy (usually 0 or #1 suture) absorbable sutures (polydioxanone or polyglyconate) circumcostally to appose the ribs. Pre-place these sutures to help avoid traumatizing adjacent structures. Close the serratus ventralis and scalenus muscles as a separate layer. Close the latissimus dorsi muscle separately with a simple continuous pattern of absorbable material incorporating the fascia as much as possible. Close the subcutaneous tissue and cutaneous trunci muscle together. Close the skin in routine fashion.

II) Median sternotomy: This approach is advantageous in that it allows access to the entire thoracic cavity. It is indicated when exploration of both sides of the thoracic cavity is necessary. But some structures in the dorsal thoracic cavity (e.g., hilus of lung lobes) are more difficult to reach through this approach [21].

Site: Median sternum. It can be combined with a ventral midline celiotomy or a caudal cervical approach, if more exposure is needed. Exposing cranial or caudal mediastinal masses and performing a more complete subtotal pericardiectomy is enhanced through a median sternotomy compared to a lateral thoracotomy. Avoid incising the entire length of the sternum, as postoperative sternal instability and pain seem to be increased compared to leaving at least one sternebra intact at either end.

Techniques: Incise the skin and subcutaneous tissues over the sternum with a scalpel. Incise the pectoral muscles with scalpel to expose the sternebrae. Cut the sternum on midline with an oscillating saw, taking care to limit penetration of the saw blade. Use the handle of a spay hook to protect underlying tissues once the thoracic cavity is entered. Protect the tissues with moistened laparotomy sponges, and position retractors to achieve adequate visualization. Place a thoracostomy tube prior to closing the incision.

Closure: Close the sternal incision by placing stainless steel wire (approximately 20 gauges) in a figure-eight pattern to appose each incised sternebra. Pre-place these sutures to aid visualization. Close the pectoral muscles and subcutaneous tissues in separate layers, usually in a simple continuous pattern. Close the skin in routine fashion.

2.4.1. Common Thoracic Surgery in Dogs

The most frequently encountered thoracic wall conditions that have surgical implications are traumatic and neoplastic conditions.

Indications: Rib fractures occur commonly in small animals, particularly after blunt trauma may be from dog fights. An example of an injury that may require surgical intervention is flail chest. Flail chest occurs when several adjacent ribs have been fractured in at least two places and a segment of chest wall is unstable. Stabilization of the unstable portion of chest wall may be necessary to improve ventilation. Place percutaneous sutures around the ribs and attach them to an external fixation device that spans the traumatized portion of chest wall [22].

Another indication is when there is a Neoplasm of the thoracic wall which may arise from pleura, ribs, musculature, or subcutaneous tissue. Soft tissue sarcomas (e.g., fibrosarcoma, hemangiopericytoma) involving the thoracic wall are encountered relatively frequently in veterinary patients. Primary tumors of the ribs or sternum are encountered less commonly. Surgical resection with wide margins of grossly normal tissue is the treatment of choice [21].

2.4.2. Exploratory thoracotomy

The principles for performing an exploratory thoracotomy are similar to those for performing an exploratory laparotomy. being thorough, consistent, and efficient surgeon is vital. Exploration of the thoracic cavity focuses on two body systems: cardiovascular and respiratory. Craniocaudal visualization of the ventral aspect of the thoracic cavity is best accomplished through a median sternotomy, while dorsoventral visualization of a specific region of a hemithorax is enhanced by an intercostal thoracotomy [2].

2.4.3. Thoracostomy tube placement

A thoracostomy tube may be placed at the time of thoracotomy or as a separate procedure. Guidelines for tube selection suggest that cats will usually accept a 14 to 16 Fr tube. Dogs accept tubes ranging from 14 to 16 Fr (< 7 kg body weight), 18 to 22 F (7 to 15 kg body weight), 22 to 28 Fr (16 to 30 kg body weight), and 28 to 36 Fr (> 30 kg body weight).

Technique: Place a thoracostomy tube before closing the thoracotomy incision so that its skin exit point and thoracic wall entry point are offset. Cut additional holes in the thoracostomy tube near its end. Do not position the thoracostomy tube in the primary incision. Match the size of the tube to the patient size and its intended use. During a lateral thoracotomy, plan to have the tube enter the thoracic wall two inter costal spaces caudal to the primary thoracotomy incision. During a median sternotomy, tube placement is somewhat more challenging, as tunneling of the tube can be more difficult. Place the tube subcostally and lateral to the midline. Position the fenestrated end of the thoracostomy tube at the level of the second sternbrae and near the ventral aspect of the thoracic cavity. Connect the exterior of the thoracostomy tube to a three-way stopcock (requires an adaptor). Use suture to secure the tube to the skin using a friction suture pattern [23].

Placement technique as a separate procedure

Provide pleural drainage when sufficient air or fluid is present within the pleural space to cause respiratory distress. Perform thoracentesis initially for both diagnostic and therapeutic reasons. Use a thoracostomy tube when there is sufficient accumulation of air or fluid to warrant repeated pleural evacuation. A single thoracostomy tube is usually sufficient to control the pleural cavity in most dogs, although bilateral tubes may be used in dogs with pyothorax. Commercially available chest tubes are easier to insert because they contain a metal stylet. Risk of injury to underlying tissues may be increased when thoracostomy tubes are placed as a separate procedure compared to placing them in conjunction with a thoracotomy [24].

Create a small skin incision just larger than the tube diameter at the dorsal aspect of the caudal thorax (usually 9th to 11th intercostal space). Advance the tip of the tube subcutaneously about two inter costal spaces before inserting the tube into the pleural cavity. Use a controlled thrust to insert the end of the tube just through the chest wall. Remove the trocar, and advance the tube so that its end is level with the second intercostal space. Position the tube so that its tip is located in the ventral chest. Quickly insert an appropriately-sized adaptor and 3-way stopcock in the end of the tube. Place a friction suture to hold the tube in place securely. Evacuate the pleural cavity, and bandage the thoracostomy tube in place [25].

2.4.4. Pleural cavity

The pleurae are the serous membranes that cover the lungs and line the thoracic cavity, completely enclosing a potential space known as the pleural cavity. The parietal pleurae are the portions of the pleura that line the walls of the thoracic cavity, whereas the visceral, or pulmonary, pleura invest the lungs and line their fissures, completely separating the different lobes. Thoracocentesis (or thoracentesis) is a surgical puncture of the thoracic wall to remove air (pneumothorax) or fluid (pleural effusion) from the pleural space [26].

Surgical anatomy: Each pleural cavity is only a potential space unless air or fluid collects between the parietal and visceral pleurae, preventing normal lung expansion. In a normal animal, only a capillary film of fluid exists to moisten the mesothelial cells that line its pleural surface. Therefore, except for this capillary fluid, the visceral pleura are contacted with the pleural lining of the thoracic wall. The pleurae of dogs contain smooth muscle fibers and a network of elastic fibers and are more delicate than in other domestic animals. The sub serosa is composed of collagen and elastic fibers, which in the visceral pleura communicate with underlying lung. Fluid secreted into the pleural cavity normally is reabsorbed by lymphatics underlying the parietal pleura. Thickening of the pleura (i.e., fibrosing pleuritis) may prevent reabsorption of fluid, resulting in pleural effusion [21].

Preoperative Concerns: Respiratory function should be carefully monitored in patients with pleural cavity or diaphragmatic abnormalities. Qualitative assessments of respiratory function include monitoring the respiratory rate and pattern plus capillary refill time and color. Animals with pleural cavity disease usually have a restrictive respiratory pattern (i.e., rapid, shallow respirations). Cardiovascular parameters (i.e., heart rate and rhythm) should also be evaluated. Intravenous fluids should be provided to dehydrated animals or those drinking insufficient fluids to maintain hydration. Care should be taken to avoid causing over hydration and pulmonary

edema, which further compromise respiration. Monitoring central venous pressure may be useful in some patients [27].

Most dyspneic animals allow thoracentesis with minimal restraint; general anesthetics are contraindicated. The animal should be allowed to remain in sternal recumbency, and oxygen should be provided by a face mask, flow-by, or nasal insufflation if the animal will tolerate it. A negative tap does not rule out pleural effusion or pneumothorax (i.e., the fluid may be in pockets, there may be exudate plugging the needle, or the needle may be too short). If there is no evidence of third space disease or if removal of fluid or air from the chest does not help in alleviating dyspnea, then it may be underlying pulmonary disease such as pneumonia, pulmonary edema, pulmonary contusions and pulmonary neoplasia) [28].

Anesthetic Considerations: Respiratory patients should be managed with extreme care until they have been intubated and ventilation can be assisted. Premedication with any drug that causes hypoventilation is contraindicated. Additionally, every attempt should be made to minimize stress to the patient prior to induction. Oxygen support, even while placing an intravenous catheter, may be necessary. Pulse oximetry with a sensor that can be secured to the tail can be especially helpful with perioperative monitoring of the respiratory distressed patient. Prior to induction, the anesthesia provider should be prepared with airway devices, anesthesia machine, and monitors, as well as induction and emergency drugs. If possible, positive pressure ventilation should be performed with lower tidal volumes, lower peak ventilation pressures, and higher respiratory rates. Dogs with respiratory insufficiency should be maintained with inhalation anesthetics (i.e., isoflurane or sevoflurane) because, inhalational anesthesia is advantageous because it allows rapid recovery and more precise control of anesthetic depth than does maintaining anesthesia with longer-acting intravenous anesthetics. Nitrous oxide should not be used in patients with pneumothorax or diaphragmatic hernias because it rapidly diffuses into air-filled spaces (i.e., pleural cavity or gas-filled organs), causing further lung compression or organ enlargement [25].

Surgical techniques: Treatment of pleural cavity disease varies, depending on the underlying etiology. For traumatic pneumothorax intermittent needle thoracentesis may be sufficient in some animals to prevent dyspnea while the lung heals, but chest tubes occasionally are required. With some types of pleural effusion tube thoracentesis and thoracic lavage are mandatory in the primary treatment of most affected animals [2].

Needle Thoracentesis: Needle thoracentesis is performed with a small-gauge butterfly needle (No. 19 to No. 23) attached to a three-way stopcock and syringe, or an over-the-needle catheter attached to an extension tubing, three-way stopcock, and syringe (Figure 6.). Be sure the needle is long enough to penetrate to the pleural space in large or obese animals. In such animals, a catheter rather than a butterfly needle may be needed. The appropriate site for thoracentesis should be selected based on the physical examination or, if available, radiographs or ultrasound. The mediastinum in dogs and cats is thin and permeable to fluids, and aspiration of one side of the thorax typically drains the contralateral hemithorax adequately. With some diseases, particularly chylothorax and pyothorax, unilateral effusions may occur as a result of thickening of the mediastinum associated with chronic inflammation [26].



Source [29].

Figure 6. A small-gauge butterfly needle (*lower*) or an over-the-needle catheter attached to extension tubing (*upper*), and a three-way stopcock and syringe are used for needle thoracentesis.

Unless there is a reason to go elsewhere, perform thoracentesis at the sixth, seventh, or eighth intercostal space, near the level of the costochondral junction (Figure 7.). Clip the selected site and perform a local anesthetic block if needed (this is rarely the case). Aseptically prepare the site, and introduce the needle into the middle of the selected intercostal space. Carefully avoid large vessels associated with the posterior aspect of the rib margins. Advance the needle into the pleural space. Aspirate fluid while the needle is being advanced to allow prompt recognition of the appropriate depth of needle placement. If you feel the heart beating or lungs rubbing across the tip of the needle, withdraw the needle and reassess the situation. With the bevel of the needle facing inward, orient the needle against the rib cage to prevent damage to the lung surface. Gently aspirate fluid and place 5-ml samples in an ethylenediamine tetra-acetic acid (EDTA) tube and a clot tube for a cell count and biochemical parameters, respectively. Also, make six to eight direct smears for cytologic evaluation. Submit samples for aerobic and anaerobic cultures.



Source [29].

Figure 7. Thoracentesis is performed at the sixth, seventh, or eighth intercostal space, near the level of the costochondral junction.

2.4.5. Pericardiectomy in Canine

Pericardiectomy is the removal of the pericardium (heart's sac). This is major surgery and is performed via a thoracotomy (opening the chest between the ribs). The purpose of pericardiectomy is to remove as much of the inflamed pericardium as possible – this means the pericardial sac no longer constricts the heart and it removes much of the source of the hemorrhage. During surgery, the heart can be visually examined to double check for a tumour that may not have been detected on ultrasound [30].

Indication: Acute or chronic pericardial effusion, recurrent haemorrhage into the pericardial sac or when the pericardium becomes fibrosed (thickened and restrictive) resulting in constriction of the heart. The heart is then unable to pump and circulate blood normally, leading to symptoms of heart failure. The role of the pericardial sac is minor and a dog can live without it. Pericardiectomy may improve survival in some dogs but the prognosis varies greatly, depending on the underlying cause.

Diagnosis: Based on history, general physical examination, clinical findings, radiography, electrocardiography and fluid analysis.

Treatment: Pericardiectomy.

Approach: Traditional surgical approaches include median sternotomy or right lateral thoracotomy. The advantages of open thoracotomy include complete removal of the pericardium below the level of the phrenic nerve, accurate identification of masses arising from the right atrium, and the ability to excise the right auricular appendage when the mass is isolated to that part of the heart but its disadvantage is that heart is not directly visualized, it may be more predisposed to serious complications than when other techniques are used [31].

Animal control and anesthesia: Animal is kept in dorsal recumbence under general anesthesia.

Surgical techniques: Pericardiectomy becomes an option if pericardiocentesis fails to treat the condition. It can be a definitive treatment of idiopathic pericardial effusion and a palliative treatment of malignant pericardial effusion. Because, surgical intervention is important to remove the pericardial sac, manage of traumatic pericardial effusion, resect a mass of uncertain origin and obtain a biopsy specimen.

Thoracoscopy will be performed on the dog in dorsal recumbency and three, 5-10 mm incisions, two in the intercostal spaces and one subxyphoid, were used for camera and instrument access. On initial evaluate the pleural fluid encountered and if there remove with suction. Other abnormalities encountered may include moderate erythema of pleural surfaces, aerated left lungs and patchy consolidation in right cranial and middle lungs. Mediastinal lymph nodes may be soft and of normal size. Observe and palpate the heart consistency and the pericardium (thickness vs and opaqueness). Inflammation and tissue distortion within the pleural and pericardial surfaces should also be assessed. Visibility of the ventral aspect of the heart will be improved by removing mediastinum in the area. Use a tissue sealing device (LigaSure™) which will be used to seal. Then cut the tissue and prevent hemorrhage from obscuring the field of view. The

pericardium will be grasped and endoscopic metzenbaum scissors will be used to grasp the pericardium and perforate it, allowing for escape of fluid. The perforation was enlarged using the LigaSure device to remove pericardium from the apex of the heart.

The scope was introduced into the pericardial sac and a limited evaluation of its interior and the atria did not reveal further abnormalities. The removed pericardium will be saved for biopsy. The thorax will be lavaged with warm saline. A 20 French thoracic drainage tube was placed through the subxyphoid instrument portal and secured to the skin.

Because of the poor long-term prognosis for affected patients, many owners decline surgery when a right atrial mass is detected using echocardiography or pulmonary metastasis is detected using thoracic radiography. The main objective is to allow drainage of the pericardial fluid into the pleural space, which allows superior lymphatic drainage and may reabsorb the accumulating effusion, and to prevent the recurrence of cardiac tamponade [31].

Closure: All three portals were closed in three layers using interrupted absorbable suture and skin staples. The thorax was evacuated of residual fluid and air and the dog was moved to ICU for recovery.

Post operative care: Most patients are able to return home within 2 to 5 days, although each individual patient recovers differently. Your pet will return home wearing a chest bandage to protect the wound until suture removal. Keeping the bandage clean and dry to protect the surgical site is vital. Ensure your pet receives the daily antibiotics provided. Your pet should be kept very quiet until suture removal 10 to 12 days after surgery (by your own vet). Following this, exercise must be restricted for another 3 to 4 weeks, after which there can be a gradual return to normal exercise [26].

Prognosis and post operative complications: Pericardiectomy has a success rate of approximately 80 to 90% - resulting in a resolution of the symptoms for many years. However complications can occur – the most common is continuing haemorrhage leading to inflammation of the chest cavity resulting in breathlessness. The mortality rate, during or after surgery, is considered low (< 5%). For best results, the procedure should be performed by a veterinary surgeon experienced in this surgery. Intravenous fluids should be provided prior to surgery and for at least 24 hours post-operatively, thought to reduce the risks of thromboembolism and thus reduces the risk of mortality [27].

Potential complications of pericardiectomy also include hemorrhage, damage to neurovascular structures, heart or lungs, herniation of the heart through the pericardial window, and eventual reattachment of the pericardium to the heart resulting in return of clinical signs. When planning thoroscopic procedures the potential need for conversion to an open thoracotomy in case of operative complications should always be discussed with clients and surgical prep performed with this possibility in mind. The surgical goal is always to safely remove as much pericardium as possible, either via a subtotal pericardiectomy or a large window [32]

3.0 CONCLUSION AND RECOMMENDATIONS

Like other domestic animals there are much surgical affection of respiratory system and thoracic cavity in domestic animals. Among them: Brachycephalic syndrome, tracheotomy,

tracheostomy, surgical anastomosis of trachea and pericardioectomy are the common ones. These all surgical techniques requires sophisticated equipments and technical skills, well experienced surgeon and anaesthetists to provide safe pre anaesthetic assessment, intraoperative and post operative management of animals. Even though these are the affections and can hamper the life of dogs if left untreated, it is less developed in veterinary practice especially in developing country. So depending on the above conclusion the following recommendations are forwarded.

- ❖ Well knowledgeable, experienced surgeon and anesthetists are vital and plays crucial role on the outcome of these surgical interventions.
- ❖ Animal owner perception on fear of the prognosis will be minimized through creation of awareness about the success out comes and dissemination of information through medias.
- ❖ Government should provide and import basic surgical facilities specifically designed for these purpose.

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