

Case report of brachycephalic obstructive airway syndrome in brachycephalic dogs from Veterinary Specialist Service Hospital, Australia

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ABSTRACT

This report aimed to study symptoms and causes of brachycephalic obstructive airway syndrome (BOAS) in brachycephalic dogs and to determine appropriate surgical procedures for these symptoms by reviewing literatures and examining four case studies conducted at Veterinary Specialist Service Hospital, Underwood, Queensland, Australia. The cases included a 6-year 3-month old Staffordshire Bull Terrier (case 1), a 1-year 5-month old French Bulldog (case 2), an 8-month old French Bulldog (case 3), and an 8-year 8-month Pug (case 4). Those dogs went to the Veterinary Specialist Service in a worsen state of respiratory problems, including the upper respiratory noise (case 1, 2, 3), decrease in exercise tolerance, respiratory struggling (case 1, 3), regurgitation (case 1), coughing, sleeping difficulty, respiratory stridor (case 2), nasal discharge, dyspnea, bloating, and tachypnea (case 4). Examinations revealed the causes including the elongated soft palate (case 1, 2, 3, 4), stenotic nostrils (case 2, 3, 4), tonsils inflammation (case 3) and everted laryngeal saccules (case 4). After surgery, the dogs were recovered in intensive care unit within 2 days, and then discharged. Scheduled re-examination one week later showed improvement in the respiratory health in all cases. Overall, major complications occur in 10% of cases; however, this surgery is vital and can be totally applied in Vietnam where brachycephalic dogs have become a popular companion.

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1. Introduction

Congenitally, brachycephalic dogs are characterized with a shortened head, which is brachycephalic syndrome also known as brachycephalic conformation of the skull (Bjorling et al., 2000). The syndrome consists of anatomic abnormalities including stenotic nares, tortuous turbinates, caudally displaced maxillae, elongated soft palate, everted laryngeal saccules, and hypoplastic trachea (Ackerman, 1999; Koch et al., 2003). The abnormal skull's anatomy narrows the lumen of upper respiratory tract, thus

lead to asphyxiation and collapse during excitement, hot weather or exercises (Koch et al., 2003; Packer et al., 2012). Moreover, the displaced maxillae and the elongated soft palate interfere with laryngeal functions resulting in respiratory stridor, open-mouth breathing, inspiratory dyspnea, exercise intolerance, noisy breathing, suffocating and coughing (Ackerman, 1999; Dupre, 2008). According to skull measurements, the typical brachycephalic breeds include Chihuahua, Bulldog, King Charles Spaniel, Pug, Boston Terrier, Maltese, Pekingese, Miniature Pinscher, Shih Tzu, Yorkshire Terrier, and Boxer,

Lhasa Apso, Shar Pei (Koch et al., 2003). In recent years, the brachycephalic dogs have become the popular breeds in many countries as well as in Vietnam, which inevitably leads to an increase in BOAS cases (Best et al., 2016).

Treatment-wise, hypoplastic trachea, foreshortened maxillae, and narrow rima glottidis are unchangeable. For the case of tortuous turbinate, the surgery can remove a little piece in turbinate to make the airway more ventilated but it is dangerous and expensive with long surgical time. However, the surgery can also affect the patient's olfactory ability, therefore, it is often deemed unnecessary. For the remaining anomalies, there are safer procedures to relieve the symptoms of BOAS, which include trimming the stenotic nares, resecting the elongated soft palate, removal of the everted laryngeal saccules, and removal of the tonsils (depending on the specific situation).

In general, the surgery of stenotic nares includes nares amputation, wedge resection (alarplasty) and alapexy (Fossum, 2013). Specifically, in wedge resection, stenotic nares are resected easily by cutting the V-shaped section of the nares with the No.11 scalpel blade. Wedge resection is less surgical time than alapexy, less incisional bleeding than amputation. However, this procedure can be failed if flaccidity of the cartilage occurs, mobility of the dorsolateral cartilage increases, depigmentation or asymmetrical nose presents. Resection of elongated soft palate is normally performed using Metzenbaum scissor. Electrosurgery can also be used instead; however, may cause swelling in post-operative care. In some cases that tonsils inflamed or obstruct the airway, tonsils can be removed by Metzenbaum scissor or scalpel blade. Then, at the base of the everted tissue, using the tip of a long-handled, curved Metzenbaum scissors transects the everted laryngeal saccules.

To determine which surgical procedures are suitable for the patients, clinical examination and diagnosis are conducted. In clinical examination, the stenotic nares, the size of the trachea and the obstructive inspiratory dyspnea with stertor can be determined by observation and palpation. After that, diagnostic radiography and bronchoscopy rule out abnormal respiratory and cardiology diseases. The surgical procedure should be performed as soon as possible for dog that is above 4 months of age since the nasal tissues are mature enough to hold sutures.

2. Materials and Methods

2.1. Case 1

2.1.1. History

Dog 1 was a six-year-three-month-old male neutered Staffordshire bull terrier breed dog. Noisy breathing was observed by owner; however it became worse during the past year, together with exercise intolerance, heat intolerance, and respiratory struggle during excitement. The dog would occasionally regurgitate white foam, despite eating and drinking normally without coughing or sneezing, or changing in bark.

2.1.2. Clinical examination

Clinical examination revealed lean body condition, noticeable upper respiratory noise, pink mucous membrane, good airflow through both nostrils; elongated soft palate was observed. Based on the result, the dog was diagnosed with signs of BOAS. The obstruction of airway was likely due to elongated soft palate and small probability of laryngeal paralysis, with recommendation for BOAS surgery and arytenoid lateralization.

2.1.3. Laboratory test

The result of the blood test was 37% and 70 for packed cell volume and total protein respectively, which is ordinary according to the normal range of PCV (37-55%) and normal range of TP (55-75). This test is quick, easy and it is a common preoperative test because it gives information of the patient's status about anemia, blood protein, hydration status.

2.1.4. Radiograph

Findings in thoracic radiographs were unremarkable (Figure 1). The result of imaging diagnosis showed that there were no cardiology and respiratory problems such as heart base tumor, nasopharyngeal, laryngeal, tracheal masses; and secondary changes to the lungs, such as bronchiectasis and probable hypoplastic trachea.

2.1.5. Bronchoscopy

The upper airway was examined with bronchoscopy showing the arytenoids moved bilaterally.

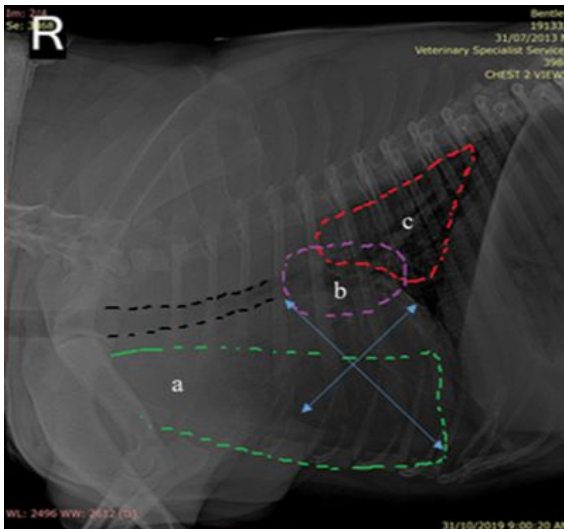


Figure 1. The right lateral thorax radiography (Dog 1). Ventral side (a), Perihilar (b), Dorsocaudal (c) and diffuse of lungs assessed for bronchopneumonia, especially aspiration pneumonia, pulmonary edema, pulmonary haemorrhage. Vertebral heart size (VHS)= 8 (< 10.7), heart size was normal. Tracheal hypoplasia was rejected (black line) and no hiatus hernia, no abnormalities in vertebral body.

ally, hence arytenoid lateralization was deemed unnecessary.

2.1.6. Surgery

The surgical procedure included general anesthesia, upper airway exam, thoracic radiographs and elongated soft palate resection. The patient was then pre-oxygenated for 5-10 minutes and slowly induced with Alfaxalone 30mg IV, and intubated with a cuffed ET tube. Circulation, heart rate, oxygenation, ventilation, blood pressure values including systolic arterial pressure, diastolic arterial pressure, mean arterial pressure and the anesthetic maintenance was updated every five minutes using intraoperative monitoring system.

First, the patient was placed in sternal recumbency with the mouth fully opened and the chin was not allowed to have contact with the table's surface. Next, the mucosal surfaces should not be scrubbed to protect from irritation and edema; the endotracheal tube was secured to the lower jaw ensuring free access to the soft palate. Then, the surgeon began to scrub and prepared the soft palate kit when everything was in position (Figure 2).

1.	Debakeys: 1X-long, 1 Normal
2.	Rat tooth Forceps Long
3.	Adson Forceps
4.	No.7 Scalpel Handle
5.	Suture Scissors
6.	Metzenbaum's: 1x Short, 1x x-Long
7.	Laheys x 2 Short
8.	Needle Drivers – 1 Short, 1 X-Long
9.	Artery Forceps: 3 x Small, 1 x Large
10.	Laheys x 1 Long
11.	Allis Tissue Forceps x 1
12.	Swabs
13.	Kidney Dish
14.	Hand Towels

Figure 2. List of surgical instruments for BOAS surgery.

For elongated soft palate resection, the resection was done with scissors, the surgeon placed stay suture of 3-0 Monocryl at the proposed site of resection. Next, the surgeon resected one third of the soft palate with Metzenbaum scissor, then apposed the mucosa with 3-0 Monocryl simple continuous suture pattern; the procedure was then repeatedly continued between excision and suturing until the resection was completed (Figure 3). During the resection, there was mild hemorrhage, which was put under control by tying a swab to a thread and placed the swab in the surgical area.

2.1.7. Post-operative care

After surgery, the patient was moved to the Pet intensive care unit (PICU) to recover overnight with close monitoring. Postoperative care included the late extubation, analgesic protocol, nasal oxygen supplementation, close monitoring of the breathing. Upper airway obstruction in post-surgery was concerned due to inflammation and swelling. After surgery, Medetomidine was needed for anxiety, with transition to Tramadol Oral the next day. Post-surgery medications: Methadone 0.1 - 0.2 mg/kg SC and Medetomidine CRI at 1 µg/kg/h. After 2 days in the PICU, the dog swallowed the food trial and was discharged.

2.2. Case 2

2.2.1. History

A one-year five-month-old female French bulldog was examined for a history of some upper respiratory noise and coughing. The dog ate quickly and sometimes slightly choked on food. Otherwise, the dog had not shown any significant respiratory difficulty.

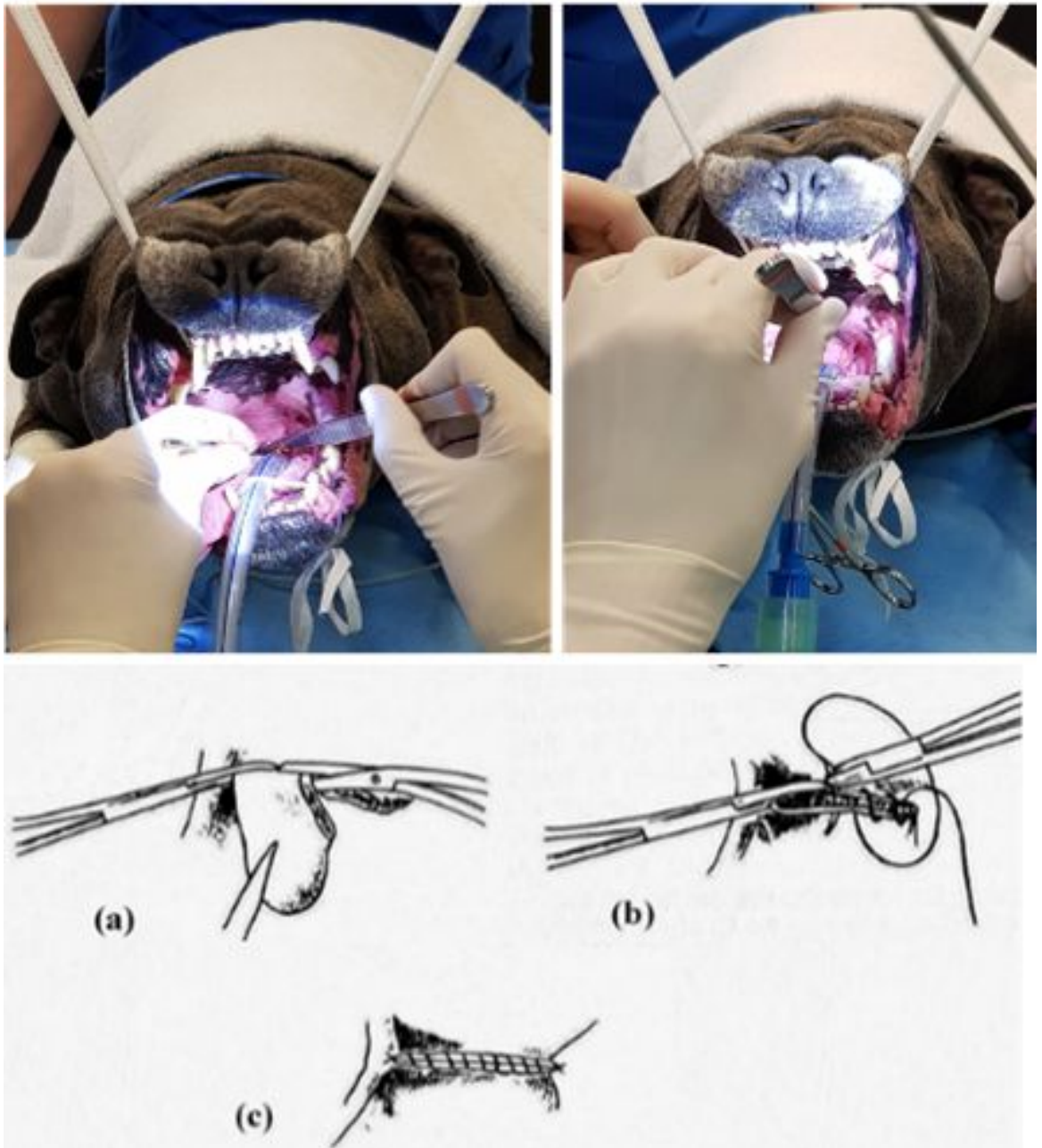


Figure 3. Elongated soft plate resection (Dog 1). (a) Transected one-third of the palate, then (b) apposed the mucosa with sutures. (c) Continue alternating excision and suturing until the resection was completed (Bjorling et al., 2000).

2.2.2. Clinical examination

On initial physical examination, the dog possessed congenital traits of brachycephalic breeds. Due to observational heavy open-mouth breathing, respiratory stridor, and difficulty sleeping, elongated soft palate was considered as a main

cause. The dog nostrils were congenital stenotic. Thoracic auscultation showed normal cardiac and bronchovesicular sounds, however there was a slight upper airway noise. Based on clinical examination, the first diagnosis was BOAS and surgery therapy was recommended.

2.2.3. Laboratory test

The result of PCV/TP was normal at 45/74 based on normal range.

2.2.4. Radiograph

The radiograph was conducted to detect other diseases; especially aspiration pneumonia because of the dog's eating routine. The findings were unremarkable (Figure 4).

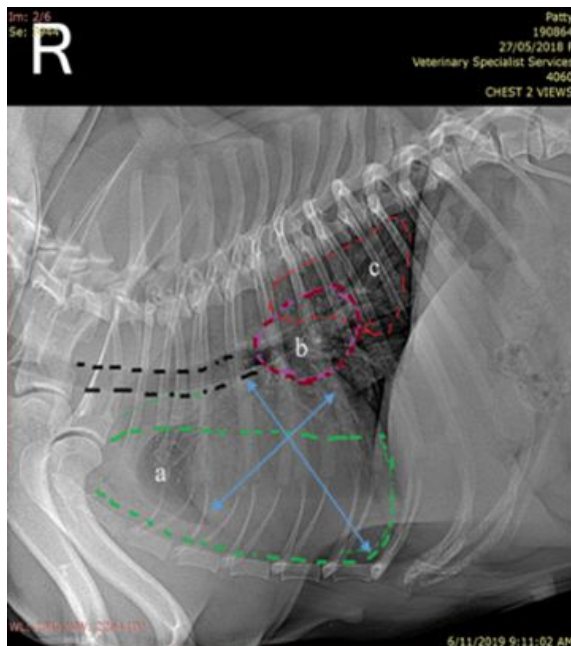


Figure 4. The right lateral thorax radiography (Dog 2). No hiatus hernia, no abnormalities in vertebra, lungs, trachea. Heart size was normal (VHS = 9 < 10,7).

2.2.5. Bronchoscopy

During bronchoscopy, laryngeal paralysis was ruled out; no laryngeal saccules were observed. Main bronchus and secondary bronchi were observed no abnormalities (Figure 5).

2.2.6. Surgery

The treatment regimen included the resection of elongated soft palate and the resection of stenotic nares.

During soft palate resection surgery, a stay suture of 4-0 Monosyn was placed in the caudal midpoint of the soft palate, allowing it to

be pulled rostrally. Two additional stay sutures were placed to either side of the soft palate to mark the intended line of resection, level with the caudal tonsillar crypts. The left side of the soft palate was cut with Metzenbaum scissors, then 4-0 Monosyn simple continuous pattern was used to appose the nasal and oral mucosal cut edges of the soft palate. The process was repeated to remove the remaining soft palate. Next, for stenotic nares resection, wedge resection was performed to permanently enlarge the external nares. Using an 11 scalpel blade, a triangular wedge of tissue was removed from the lateral aspect of the nares. Closure was achieved with 4-0 Monocryl, absorbable sutures placed in a simple interrupted pattern (Figure 6).

2.2.7. Post-operative care

After surgery, dog 2 was moved to the PICU for recovery. IV Hartmann's was maintained, meloxicam 1.5 mg/mL was used once per day when eating to reduce postoperative inflammation and pain; cephalothin 1 g/mL IV was supplied. Day 2 in PICU, the patient was stable and swallowed the food trial. The patient was discharged and went back home with administered meloxicam 1.5 mg/mL once per day.

2.3. Case 3

2.3.1. History

An eight-month-old male neutered French bulldog was examined for a history of upper respiratory noise with decreased exercise tolerance. Similar to case 1, the dog struggled on hot days and during excitement. The main presenting problem was mild upper respiratory stertor.

2.3.2. Clinical examination

The dog possessed anatomic abnormality of brachycephalic dog breeds, false positioning of the teeth, open-mouth breathing. Thoracic auscultation showed normal cardiac and bronchovesicular sounds. Based on clinical examination, the dog was diagnosed with BOAS.

2.3.3. Laboratory test

The result of PCV/TP was normal at 33/70 based on normal range.

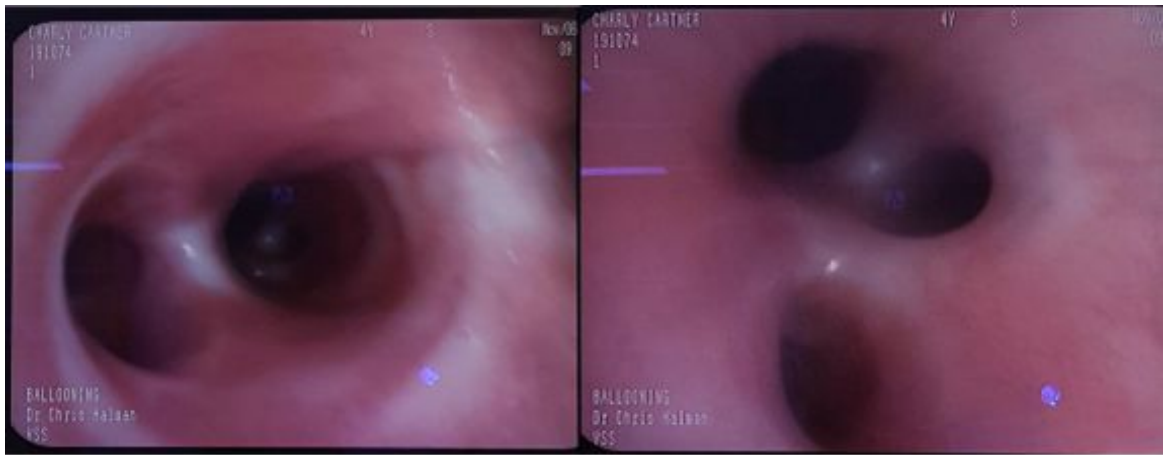


Figure 5. Bronchoscopy (Dog 2). Images of (a) main bronchus and (b) secondary bronchi showed no abnormalities.

2.3.4. Radiograph

Imaging diagnosis showed no other problems (Figure 7).

2.3.5. Bronchoscopy

Oral examination showed the inflammation of tonsils, moderate elongation of soft palate and bronchoscopy showed erythema around arytenoids; there was no evidence of laryngeal sacculae eversion or laryngeal collapse, laryngeal paralysis was ruled out.

2.3.6. Surgery

According to diagnosis, the surgeon decided on resection of stenotic nares, resection of elongated soft palate, and tonsils removal. During resection of elongated soft palate, the tip of the soft palate was grasped with allis tissue forceps and a stay suture placed at the site of resection for manipulation. The soft palate was resected approximately one third of the width of the soft palate with Metzenbaum scissors. Closure achieved using 4-0 Monosyn in a simple continuous suture pattern. During resection of stenotic nares, the margin of the nares was grasped with forceps. A V shaped incision was made medially and the second incision laterally. The wedge of tissue was removed and haemorrhage controlled with pressure. The ventral margin of the nares and the mucocutaneous junction were aligned and sutured closed using 4-0 Monosyn in a simple continuous pattern. For Dog 3, the airway was too small, the

tonsils were tonsillitis, obstructed the airway. The surgeon proceeded to remove the protruded tonsils (Figure 8).

2.3.7. Post-operative care

After surgery, the dog was moved to the PICU. The dog was noted allergic to Cephalothin, recovered well from anesthesia and surgery, had one regurgitation but was comfortable. The dog continued to be hospitalized in ICU overnight for close monitoring post brachycephalic general anaesthesia and was monitored for risk of aspiration pneumonia. Day 2 in PICU, the dog swallowed food trial well, was bright and alert. Dog 3 showed no regurgitation or emesis, but did have an episode of hypersalivation which was responsive to Maropitant administration which was used the previous night. The patient went back home with Meloxicam 0.1 mg/kg PO SID when eating.

2.4. Case 4

2.4.1. History

Dog 4 was an eight-year eight-month-old female Pug with a history of hemivertebrae and ataxia problems. The dog had a surgery to place plate and decompress at two-year old. Based on the hospital transfer record of Dog 4, carprofen injection was used for reducing spinal pain. In the present time, the dog had nasal discharge, dyspnea and bloating; these episodes gradually became more serious and worsened.

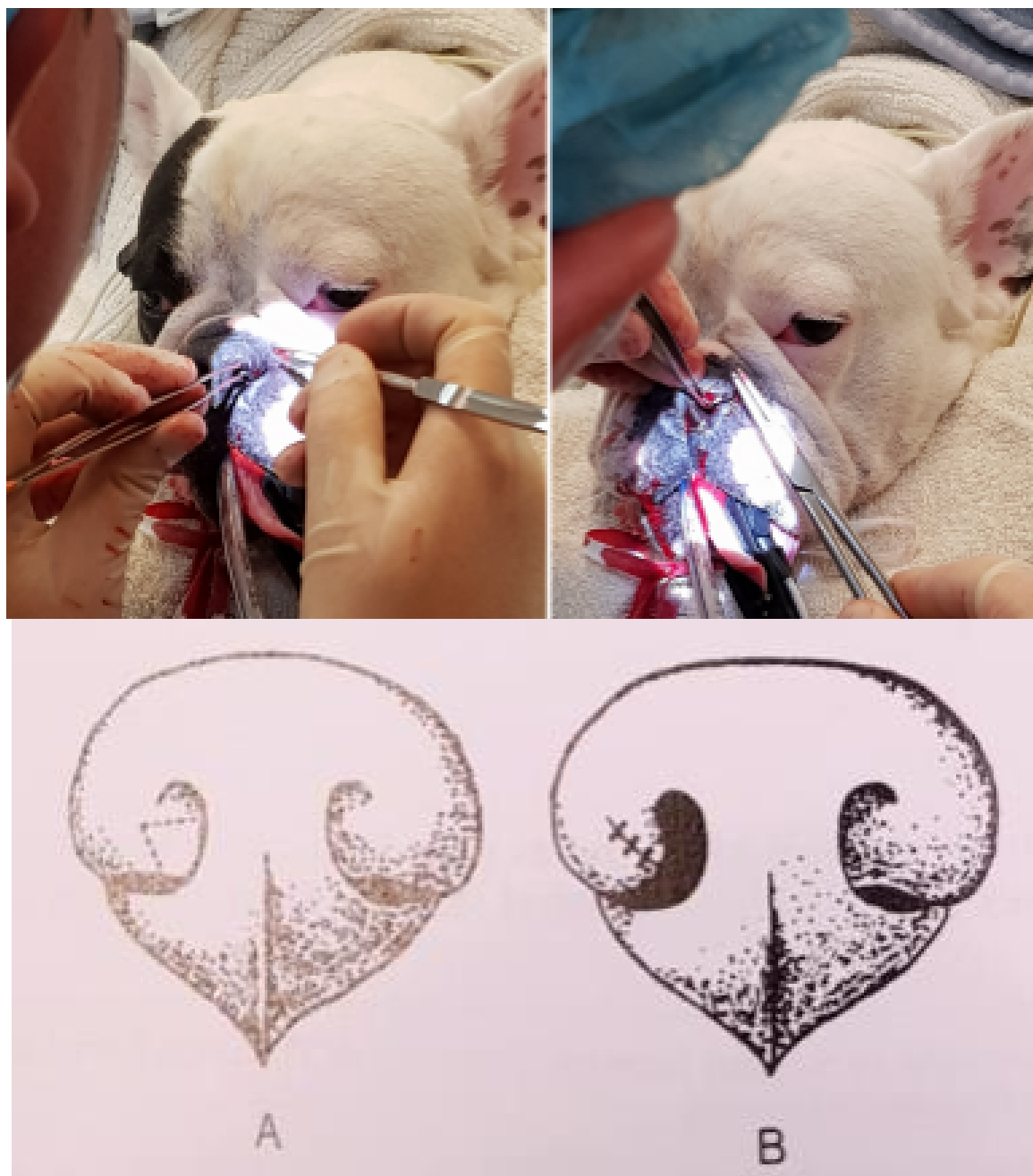


Figure 6. Trimming of stenotic nares (Wedge resection) (Dog 2). (A) Made a V-shaped incision around the nares with a No. 11 scalpel blade, the first incision was located medially and the second incision laterally. (B) Closed incisions with 4-0 Monocryl, absorbable sutures placed in a simple interrupted pattern (Bjorling et al., 2000).

2.4.2. Clinical examination

Tachypnea and moderate respiratory effort were observed. The nares were narrowed, although not severely. Upper respiratory tract noise was increased.

The dog was examined in four days later for assessment of BOAS following an episode of acute dyspnea and bloating before. At this point, clinical signs were consistent with secondary airway obstruction to BOAS. The obstruction was likely associated with elongated soft palate, stenotic

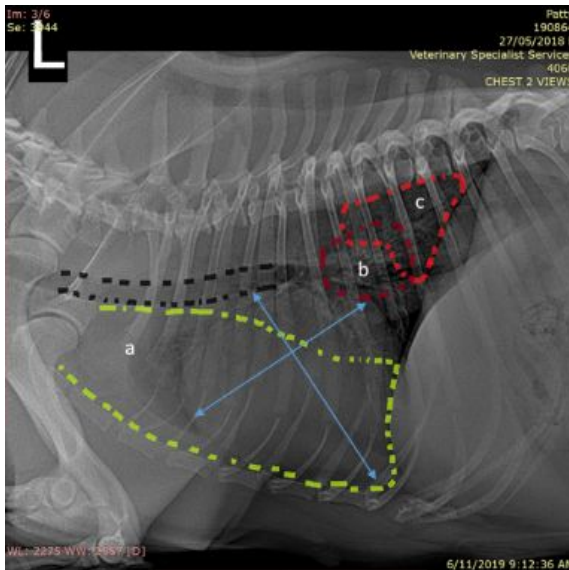


Figure 7. The left lateral thorax radiography (Dog 3). Heart size was normal (VHS = 9 < 10,7). No hiatus hernia, no abnormalities in lungs, trachea.

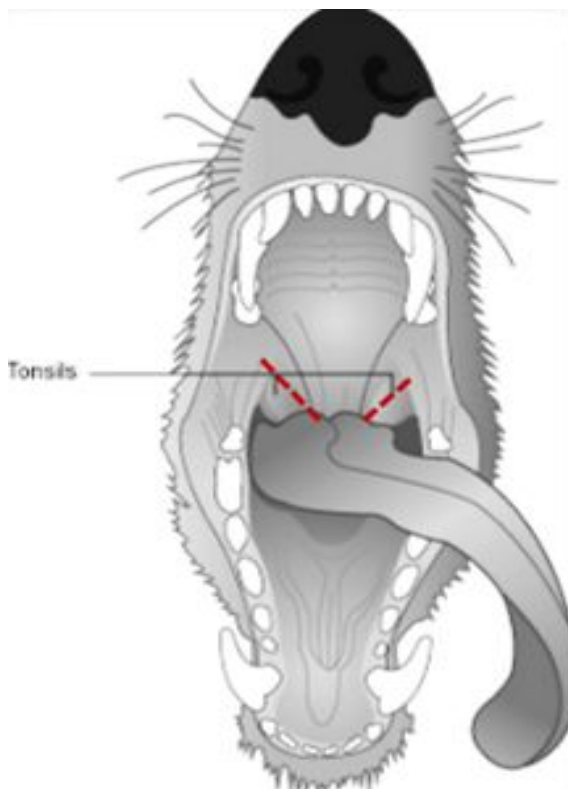


Figure 8. Tonsillectomy (Red lines). Tonsils are removed by forceps and Metzenbaum scissor (Ward & Hunter, 2009).

nares and secondary airway abnormalities. Furthermore, the bloating and associated dyspnea noted might also be in part due to gastrointestinal causes, such as a hiatal hernia. Other causes of airway obstruction or respiratory distress could not be ruled out but were investigated prior to surgery.

2.4.3. Laboratory test

The PCV/TP test result was normal at 40/70. The ALT in biochemical blood test was higher than normal and this was a caution to use medicine in its treatment (Table 1).

Table 1. The result of biochemistry test (Dog 4)

Test	Result	Unit	Lowest value	Highest value
HEM	29.0			
LIP	109.0			
ICT	0.0			
ALB	37.0	g/L	25.0	44.0
ALP	33.0	U/L	20.0	150.0
ALT	156*	U/L	10.0	118.0
AMY	464.0	U/L	200.0	1200.0
TBIL	4.0	μmol/L	2.0	10.0
BUN	6.1	mmol/L	2.5	8.9
CA	2.64	mmol/L	2.15	2.95
PHOS	1.27	mmol/L	0.94	2.13
CRE	82.0	mmol/L	27.0	124.0
GLU	5.1	mmol/L	3.3	6.1
NA ⁺	147.0	mmol/L	138.0	160.0
K ⁺	4.6	mmol/L	3.7	5.8
TP	74.0	g/L	54.0	82.0
GLOB	37.0	g/L	23.0	52.0

2.4.4. Radiograph

Radiographs revealed some evidence of peri-implant lucency which was suggestive of loss of implant stability, but surgical site comfort and palpation was unremarkable (Figure 9). Lung fields were normal with no evidence of aspiration pneumonia.

2.4.5. Bronchoscopy

Evaluation of the pharynx showed a small central white nodule; different diagnosis was likely an inflammatory nodule.

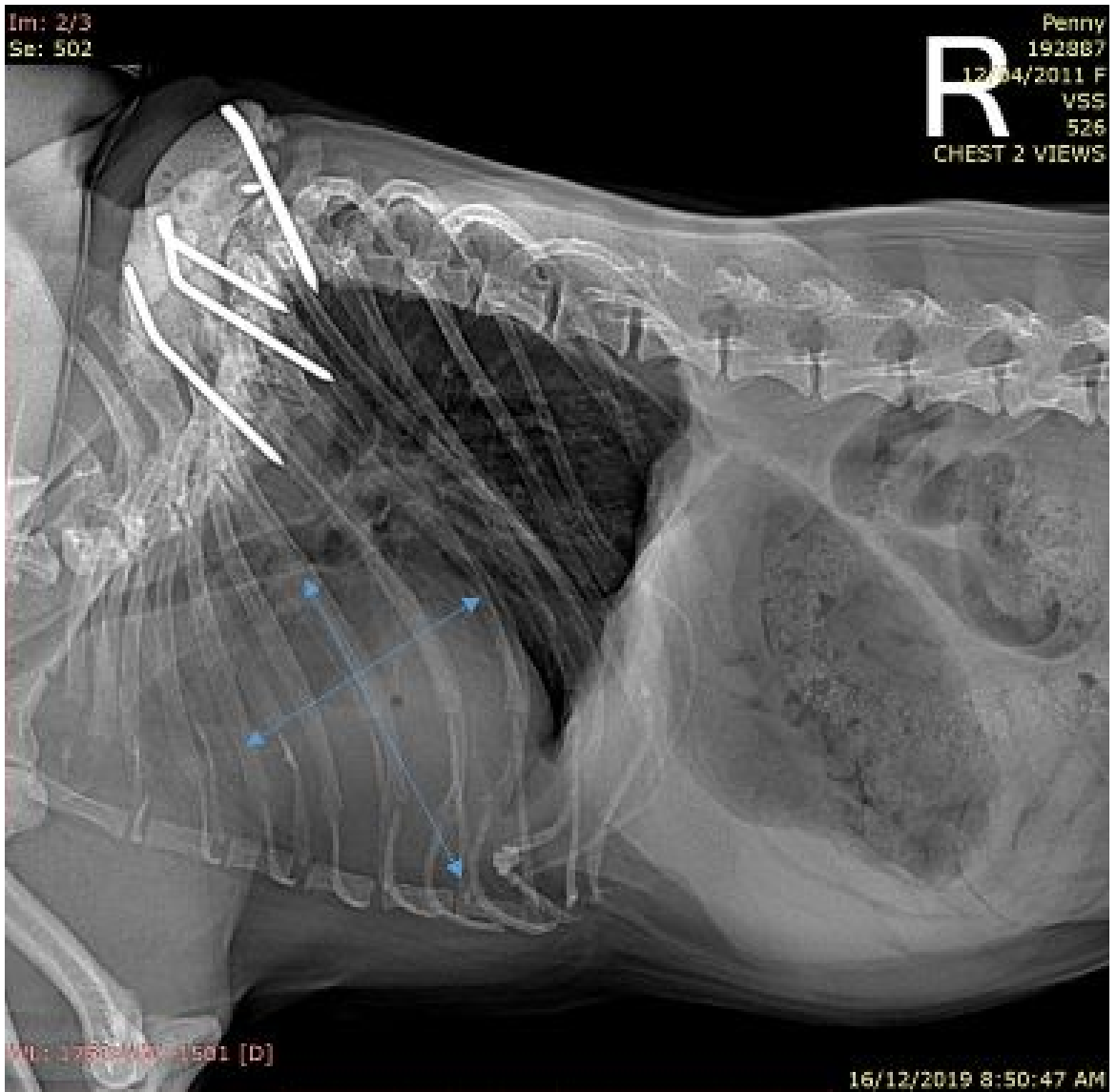


Figure 9. The right lateral thorax radiography (Dog 4). Radiography showed no abnormalities in trachea, lungs, heart, no hiatus hernia. Based on the hospital transfer record, the dog had surgical treatment of hemivertebrae.

2.4.6. Surgery

Surgery was recommended for the dog to reduce resistance to inspiration by conducting a combination of alarplasty, soft palate resection and laryngeal sacculotomy if required. First, in staphylectomy, right angle forceps were used for positioning the soft palate and resected using Metzenbaum scissors. Closure achieved using 4-0 Monocryl simple continuous suture pattern. Second, in removal of the laryngeal saccules, the surgeon temporarily extubated Dog 4. The everted

laryngeal saccules were cut off with Metzenbaum scissors (Figure 10). Last, trimming of stenotic nares was performed. A wedge resection of the nares was removed using an 11 scalpel blade. Closure was achieved using 4-0 Monocryl simple interrupted suture pattern.

2.4.7. Post-operative care

After surgery, the dog recovered quickly from anaesthetic but then the dog presented dyspnea; thus the oxygen supplement was used. The dog

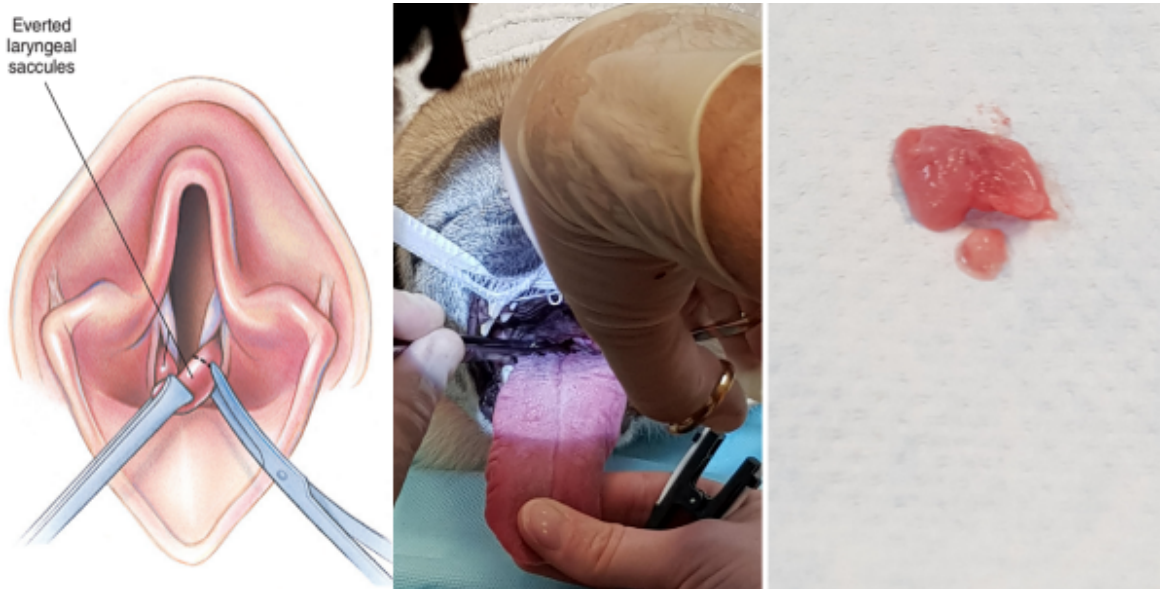


Figure 10. Resection of everted laryngeal sacculles (Dog 4). Using Metzenbaum scissor cut off the everted laryngeal sacculles (Fossum, 2013).

initially only got inspiratory flow with its mouth held open and tongue out. As recovered from anaesthetic, inspiratory flow was improved but continued to have occasional episodes where the dog retched and moved but then recovered itself. Day 2 in PICU, the dog swallowed the food trial in the morning and then was discharged with omeprazole 10 mg tablet to be given a half twice a day. For the first couple of days, the dog had some difficulty breathing through the nose resulting in self-waking during sleep, causing sleep difficulty. After day 3, the problem was resolved, the dog started to breath well and the gastric reflux seemed to be settled.

3. Discussion

Surgery for BOAS should be planned in the morning, after that, observation is recommended for all day. In post-operative care, surgeries complications include bleeding, swelling, edema, wound problems, aspiration pneumonia and even death. Furthermore, post-operative problems can become more complicated, lead to difficulty breathing and respiratory distress (Fossum, 2013). It is treated, depending on severity, with a combination of sedation, oxygen therapy, intubation, temporary or permanent tracheostomy or mechanical ventilation (Holt et al., 1994; O'Dwyner, 2017). Those sort of major com-

plications occurred in 10% of cases, and a small number of dogs do not survive to discharge, typically due to severe aspiration pneumonia.

4. Conclusions

BOAS is a set of health problems, mainly in the upper respiratory system, that present predominantly in brachycephalic dog breeds. This is the result of congenital malformation of the skull of such breeds leading to various anatomical abnormalities including stenotic nares, tortuous turbinates, caudally displaced maxillae, elongated soft palate, everted laryngeal sacculles, and hypoplastic trachea. These abnormalities consequently cause obstruction in nasal cavity, larynx and/or pharynx. Dogs with BOAS may show signs of having respiratory noises, observable nostril stenosis, eating difficulties, regurgitation, sleep dyspnea, sleep apnea, heat intolerance, exercise intolerance and/or collapsing. Correspondingly, the main focus of BOAS surgeries is to unblock the airway. Surgical procedures may include staphylectomy for the case of elongated soft palate, laryngeal saccullectomy for the case of everted laryngeal sacculles, alarplasty for the case of stenotic nares, and tonsillectomy for the case of everted/hypertrophy tonsils. Postoperative results from the case studies show the clear improvement in respiratory health in all discussed

cases.

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