ENDOSCOPIC ASSISTED DIAGNOSIS OF VARIOUS DISEASE CONDITIONS IN SMALL ANIMALS

THESIS

By

Manpreet Singh

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CHAUDHARY SARWAN KUMAR

HIMACHAL PRADESH VISHVAVIDYALAYA

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Dr Amit Kumar
(Assistant professor)

Department of Veterinary Surgery and Radiology
DGCN College of Veterinary and Animal Sciences
CSK Himachal Pradesh Krishi Vishvavidyalaya
Palampur (H.P.) India-176062

CERTIFICATE-I

This is to certify that the thesis entitled, “Endoscopic assisted diagnosis of various disease conditions in small animals” submitted in partial fulfillment of the requirements for the award of the degree of Master of Veterinary Science in the discipline of Veterinary Surgery and Radiology of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur is a bonafide research work carried out by Manpreet Singh (V-2019-30-015) son of S. Avtar Singh under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been fully acknowledged.

Dr. Amit Kumar
Major Advisor

Place: Palampur
Date:

CERTIFICATE-II

This is to certify that the thesis entitled, "Endoscopic assisted diagnosis of various disease conditions in small animals" submitted by Manpreet Singh (V-2010-30-015) son of S. Avtar Singh to CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur in partial fulfillment of the requirements for the degree of Master of Veterinary Science in the discipline of Veterinary Surgery and Radiology has been approved by the advisory Committee after an oral examination of the student in collaboration with an External Examiner.

(Dr. Amit Kumar)
Chairperson

(Dr. Deepak Kumar Tiwari)
External Examiner

(Dr. Adarsh Kumar)
Member

(Dr. SP Dixit)
Dean PG nominee

(Dr. Surender Kumar)
Member

Professor & Head
Deptt. of Vety. Surgery
& Radiology
DGCN COVAS, CSKHPKV,
Palampur

Head of the Department

Dean, Postgraduate Studies

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Place:

Date: (Manpreet Singh)

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LIST OF ABBREVIATIONS

ABBREVIATIONS	MEANING
%	Percentage
^{0}C	Degree Celsius
^{0}F	Degree Fahrenheit
ALP	Alkaline phosphatase
ALT	Alanine Aminotransferase
AST	Aspartate Aminotransferase
BAA	Butorphanol, Atropine, Acepromazine
BAL	Bronchoalveolar lavage
BAOS	Brachiocephalic airway obstructive syndrome
BNC	Bayonet Neill–Concelman
Bpm	Beats per minute
BUN	Blood urea nitrogen
CHPG	Chronic Hypertrophic Pyloric Gastropathy
Cm	Centimetre
CRL	Croup rump length
CRP	C-reactive protein
CT	Computed tomography
DEC	Deep ear cleaning
EDTA	Ethylenediamine tetra-acetic acid
ESS	Endoscopic severity scores
et al	And others
FB	Foreign body
FNAC	Fine Needle Aspiration Cytology
Fr	French gauge
GA	General Anaesthesia
GIT	Gastro Intestinal Tract
GUE	Gastric ulceration and erosions

HEC	Horizontal Ear Canal
i.e.	That is
I/M	Intra-muscular
I/V	Intra-venous
Inj.	Injection
Kg	Kilogram
Lbs	Pound
LCD	Liquid Crystal Display
LED	Light-emitting diode
mAs	Milliampere-seconds
Mg	Milligram
MHz	Mega Hertz
Ml	Millilitre
Mm	Millimeter
MNC	Mononuclear cells
NTSC	National Television Standards Committee
OTIS	Otitis index scoring
PAL	Phase Alternating Line
PMN'c	Polymorphonuclear cells
Pvt. Ltd.	Private Limited
RUT	Rapid urease test
S/C	Sub-cutaneous
TFT	Thin-film transistor
Tid	Ter In Die (Three Times a Day)
TVCC	Teaching Veterinary Clinical Complex
TVT	Transmissible venereal tumor
USB	Universal Serial Bus
VEC	Vertical Ear Canal
w/v	Weight/Volume
Wt	Weight

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Department of Veterinary Surgery and Radiology
CSK Himachal Pradesh Krishi Vishvavidyalaya
Palampur (H.P.)

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Abstract

In this study, 124 endoscopies were performed to standardize the technique and clinical application of different types of endoscopies in small animals. Out of which the video-otoscopy was carried out in 59 cases (dogs) presented with a history of head shaking, ear scratching and ear discharge. Thirty-one dogs presented with symptoms of vomiting, regurgitation, inappetence, diarrhoea and hematochezia underwent GIT endoscopy (esophago-gastro-duodenoscopy and colonoscopy). The upper respiratory tract including trachea endoscopies were done in 24 dogs showing clinical signs such as nasal discharge, epistaxis, sneezing, chronic cough and change in voice. The urethro-cystoscopy was done in 10 dogs having symptoms like urinary obstruction, stranguria and hematuria. General anaesthesia was proved to be the prerequisite for performing almost every type of endoscopy. The patient preparation was done by fasting (24 hours), colonic lavage and multiple enemas for performing an efficient colonoscopy. The different recumbency of patients and techniques were standardized for performing efficient endoscopy. Moreover, the normal mucosal details were visualized to differentiate it from the affected one in clinical cases. The lengths of different landmarks of upper GIT from a canine tooth of the maxilla was also done in dogs with variable body weights in the standardization phase. The various lesions and abnormalities found in clinical cases of video-otoscopy were erythema (47 ear canals), ceruminous gland hyperplasia (15), exudates (25), stenosed ear canal (11), hypertrophy of tragic's (8), edema (8), aural myiasis (5) and growths (6). The different GIT affections diagnosed in gastro and colonoscopy were megaesophagus, esophageal diverticulum, extramural esophageal mass, gastric ulceration and erosions, gastritis, gastric foreign body, colitis and colorectal tumours. The conditions such as nasal tumour (7), fungal rhinitis (2), allergic rhinitis (1), chronic rhinitis (1) nasal leech infestation (1), brachycephalic syndrome (1), soft palate tumour (1), a mucosal proliferation of larynx and trachea (1) diagnosed by upper respiratory tract endoscopy including trachea. The various urethral calculi (5) were visualized in urethro-cystoscopy. The endoscopy was proved as a very effective diagnostic tool which facilitated superior collection of biopsy from different sites for making confirmatory diagnosis. In addition, it was also utilized for foreign body retrieval from stomach and nasal cavity which avoided the need of surgery along with reduction of complications associated with conventional methods.

(Manpreet Singh)
Student

(Dr Amit Kumar)
Major Advisor

Head of the department

Professor & Head
Deptt. of Vety Surgery
& Radiology
DGCN COVAS, CSKHPKV,
Palampur

CHAPTER 1

Introduction

Disease diagnosis is the most important part of small animal clinical practice. Diagnostic modalities are the backbone of disease diagnosis. In this modern era of clinical practice, there are various diagnostic modalities such as Radiography, Ultrasonography, intra-luminal imaging in form of Endoscopy, Computed Tomography, Magnetic Resonance Imaging (MRI) and exploratory Laparotomy used routinely for clinical diagnosis of various disease conditions in small animals. Among them, endoscopy is one of the emerging, minimal invasive and advanced diagnostic modalities in veterinary clinical practice to examine the body cavities or orifices to diagnose different pathological conditions. It is commonly used for disease investigation in human medicine but the cost of instrumentation or technique does not make it a very suitable method for disease investigation in veterinary medicine in Indian context.

Endoscopy derived its name from Greek word *endo* meaning “inner” and the *skopien* meaning “to view or observe with a purpose”. The endoscopy is the intraluminal live imaging of different hollow organs. Endoscopy provides good ability to visualize the inner lining of many visceral organs in a quicker and more efficient manner than common imaging modalities like radiography or ultrasonography. It facilitates the conformational diagnosis of intra-mural lesion of different types of hollow organs like esophagus, stomach, duodenum, trachea, bronchi, vagina, colon and external ear canal etc. Moreover, endoscopy gives superior method of obtaining biopsies. It helps in documentation of lesions for research purpose, clinical purpose and for communication between the colleagues (Angus and Campbell, 2001). Endoscopy is less time consuming and sometime eliminates the need of surgery (Juvet et al 2010).

Currently the different flexible and rigid endoscopies are being used in small animal veterinary practice (Tams and Rawlings 2011). Flexible endoscopy is utilized in organs with tortuous lumen. The ability of making different manoeuvrings by flexible endoscope facilitates proper examination of all the important parts of these organs such as esophagus, stomach, duodenum, colon, trachea and bronchi. Moreover, it also

provides the precise diagnosis with the help of endoscope guided mucosal tissue biopsy in an easier way. Rigid endoscopy is utilized for examination of ear canal, nasal cavity, urethra and urinary bladder in female dogs. The rigid endoscope also facilitates endoscope guided biopsy, retrieval of foreign body and superior cytology sample collection. So, the present study is designed to standardize and further clinically utilize the endoscopic infrastructure available in the department with following objectives.

Objectives

1. Standardization of various endoscopic procedures in small animals.
2. Clinical application of endoscopy in small animals.

CHAPTER 2

Review of literature

The literature review has been categorized under following subheadings:

2.1 Video-otoscopy

2.2 Gastro-intestinal tract endoscopy

2.3 Upper respiratory tract including trachea endoscopy

2.4 Urethroscopy and cystoscopy

2.1. Video-otoscopy:

Angus and Campbell (2001) documented that the video -otoscopy was an amazing tool for the diagnosis and management of acute and chronic otitis externa and media in dogs and cats among various modalities commonly used for diagnosis and therapeutic purposes of ear canal. It was reported that the enhanced illumination and magnification provided the practitioner with detailed information for diagnosis and prognosis. The working channel facilitated sampling, improved efficacy of deep ear cleaning and decreased risks of iatrogenic injury to structures of the ear. Also, the photographic documentation of clinical cases enhanced the medical record, communication with colleagues, and client education.

Cole (2004) evaluated the external ear canal for any mass, exudate, foreign body and tympanic membrane for any rupture or patency in dogs and cats. He documented that the video otoscopy provided enhanced visualization of structures of ear, aids in retrieval of foreign bodies, collection of biopsy sample from masses and performing surgical interventions such as myringotomy. He also reported that initially there was difficulty in complete otoscopic examination in otitis externa cases, which later became possible after treatment with anti-inflammatory or otic flushing.

Rosser (2004) reported that the otitis externa was the most common disease condition of canine external ear canal with multi-factorial etiology. The primary causes of otitis externa were the factors that directly irritates the mucosal lining of ear canal.

He opined that the successful treatment of these dogs required specific identification and treatment.

Griffin (2006) described the detailed of anatomy of normal ear canal of dogs. The study also explained the techniques of various video-otoscopic guided interventions and their usage for diagnosis as well as management of ear affections.

Saridomichelakis et al. (2007) found that otitis externa was the multifactorial dermatological disorder with incidence of 20% in small animal practice. The primary etiologies include atopic dermatitis, grass awns, ectoparasite etc. The predisposing factors for otitis externa included pendulous ears or obstructive ear canal and the bacterial or fungal as the most common secondary infections.

Greci et al. (2011) documented some rare affections of ear in dogs suffering from chronic otitis such as middle ear cholesteatoma. The conditions were presented with symptoms like otorrhea, otodynia and pain on temporomandibular joint and signs of neurological abnormalities. An invasive non-vascularized lesion involving the tympanic cavity and the bulla were observed under computed tomography. The video-otoscopy detected a pearly growth or white/yellowish scales in or protruding from the middle ear cavity.

Tabacca (2011) documented the techniques and interpretation of diagnostic tests for failure in epithelial migration both in human and dogs. Epithelial migration was the process for migration of superficial epithelium along with cerumen from the tympanic membrane to the outer ear. It facilitated clearing of ear wax from ear canal to maintain normal hearing function. It was investigated by putting a drop of ink on tympanic membrane and determine its speed and pathway of ink towards the ear pinna by video-otoscopies in the following days. This test helped in diagnosing the failure of epithelial migration in dogs and humans. Epithelial migration had multiple etiologies such as otitis externa, keratosis obturans, external ear canal cholesteatomas and middle ear cholesteatomas.

USUI et al. (2011) observed the otitis externa in 27 toy poodles and 40 miniature dachshunds using a video otoscope. A distinct concavity (external tympanic concavity) was observed at the junction between the ventral part of the external surface of the tympanum and the ear canal to which a considerable amount of hair and debris had

adhered. The pattern of hair growth observed in the external tympanic concavity was characterized according to the breed of dog. It was concluded that all the toy poodles presented had curly hairs, while the miniature dachshunds had upright or flat-lying hairs.

Souza et al. (2013) documented that the canine otoacariasis was the common parasitic disorder of dog's ear canal caused by *Otodectes cynotis.* The study was performed on 35 dogs and the sensitivity of true result between video-otoscopy, conventional otoscopy and cerumen examination under a microscope for diagnosis of mite infestation were compared. The ear mites were diagnosed through video otoscopy in 41 ears. The affected ear canals (n=41) were confirmed by means of cerumen examination under a microscope. The conventional otoscopy was able to diagnose mites in only twenty-seven ears (27/69). It was concluded that the video otoscopy technique was superior to the conventional otoscopy, and equivalent to the gold standard for detection of *O. cynotis* in canine ear canal.

Guerin et al. (2015) performed the video-otoscopy-guided tympanostomy tube placement in 12 Cavalier King Charles's Spaniel type dog breed with middle ear effusion and assess its clinical outcome. Twenty-two tympanostomy tubes were placed successfully in 12 dogs under video-otoscopic guidance using a rigid endoscope and grasping forceps. It was observed that there was improvement in hearing in 9 dogs (three dogs achieved normal hearing and six showed partial improvements).

USUI et al. (2015) reported the *Pseudomonas aeruginosa* infection, along with three complex ceruminous adenomas in left ear canal of 7-year-old shih-Tzu dog suffering from otitis media. It was suggested that although the total ear canal ablation could be done in such cases, yet the complete cure was achieved in the case without total ear canal ablation. Video-otoscope guided diode laser was used to excise the complex ceruminous adenomas along with continuous cleansing of the tympanic cavity and ear canal using a Luer-lock adaptor.

Kamaljyoti et al. (2017) investigated the prevalence of *Malassezia* in 115 dog ears. An otoscopic examination and microbiological isolation, were performed for diagnosis. It was observed that the *Malassezia* infection was found in 19.1% of cases

of otitis externa. Males were more commonly affected with 68.2 % (n=15) than females with 31.8% (n =7). Labrador, Beagle and Cocker Spaniel were the most commonly affected breeds having *Malassezia* related otitis externa. The prevalence was relatively higher in rainy season (July-August) 63.6% followed by summer (April-June) 18.2%, winter (December-March) 13.6% and autumn (September-November) 4.6%. The most common signs were head shaking, frequent itching and malodour. It was concluded that *Malassezia* infection was a common finding in dogs affected with otitis externa and could be diagnosed using otoscopy and microbiological isolation.

Gupta (2017) studied the various diagnostic techniques for management of ear affections in dogs. The application of three imaging techniques video-otoscopy, conventional radiography and ultrasonography was standardized and adapted clinically. It was concluded that the Video-otoscopy allowed the better visualization and documentation of ear canal. Tympanic membrane was visualized as a thin transparent sheet like structure. The working channel facilitated sampling, improved efficiency of cleaning procedures and decreased the risk of iatrogenic injury to structure of middle and inner ear.

Ettinger et al. (2017) reported the incidence of otitis externa was 5-12 per cent which included various types of otitis such as erythematous in which there was inflammation of ear canal without pus. Whereas, the erythematous-cerumen was the inflammation of ear canal along with pus discharge. The suppurative otitis had erosive ear canal along with pus. The hyperplastic changes in ear canal which narrows the diameter of canal were termed as stenotic otitis.

Stephan et al. (2019) documented that the video-otoscopy was one of the efficient diagnostic and treatment modalities for diagnosis in chronic and recurrent cases of otitis externa. Out of 20 cases diagnosed with video-otoscopy,17 cases showed good prognosis in follow-up reappraisal after deep ear cleaning of ear canal along with systemic and topical treatment.

Bajwa (2019) reported the presence of secondary bacterial or fungal infection within ear canal due to ceruminous gland hyperplasia. These gland secretions

increased the moisture and altered the normal pH of ear canal, hence, in turn leads to flare up of perpetuating factors.

Reinbacher et al. (2020) used the video otoscopy guided myringotomy needle for collection of samples from middle ear in dogs. The samples were processed for cytology and bacterial culture for detection of otitis media. All ears were flushed and instilled with fluorescent dye, which was then suctioned out along with the remaining fluids. The samples were collected from middle ear with myringotomy needle. Microorganisms were detected in 4 middle ear samples and 15 external ear canals. It was concluded that the samples collected by myringotomy had high contamination rate, indicating that the suitability of this method for detection of otitis media in patients with concurrent otitis externa was questionable, and chances of iatrogenic spread were high.

2.2 Gastro-intestinal tract endoscopy:

Happe et al. (1982) studied an experimental group of 41 dogs. Among them seven were clinically healthy dogs and remaining suffered from upper gastrointestinal disease signs, nine dogs had endoscopic signs of duodeno-gastric reflux and 13 dogs had a positive duodeno-gastric reflux test and both seen in seven dogs. Duodeno-gastric reflux was characterized by thick red rugal folds, bile-stained gastric material and petechia in the antral mucosa with histological signs of gastritis. Two dogs with potential duodeno-gastric reflux had endoscopic reflux gastritis. It was concluded that the excessive duodeno-gastric reflux act as predisposing factor in canine gastritis.

Armstrong and Hardie (1990) performed percutaneous endoscopic gastrostomies (PEGs) in 32 feline and 22 canine patients. The median duration for which the PEG tubes were in place was 18 days (range, 0-320 days). It was observed that out of 44, 19 gained weight, 6 remained static and 19 lost weight during the PEG feeding period. It was concluded that the percutaneous gastrostomy was relatively safe, effective procedure and should be given early consideration for medium- or long-term enteral nutritional support in appropriate canine and feline patients.

Leib et al. (1993) diagnosed the five dogs with symptoms of chronic vomiting with chronic hypertrophic pyloric gastropathy (CHPG) based upon their endoscopic images and histopathology of biopsy. Endoscopically, it was observed that there were

several patterns of enlarged mucosal folds that surrounded and obstructed the pyloric canal. They concluded that the gastric and duodenal neoplasia or antral polyps may resemble the endoscopic appearance of CHPG but could be differentiated on the basis of histopathology.

Jergens et al. (1998) conducted prospective endoscopic study on 85 dogs and 23 cats. The endoscopic guided cytology sample were collected by either brush or touch technique for confirmation of type of lesion. The two techniques were compared for their diagnostic accuracy. It was concluded that the cytologic examination had higher sensitivity, specificity, and predictive values of positive and negative. The study showed that the brush cytology had more accuracy in detecting cellular infiltrates in the lamina propria, whereas the touch technique was more likely to detect acute mucosal inflammation. Moreover, the cytologic examination of exfoliative specimens obtained during endoscopy was useful, quick and reliable adjunct to histologic examination of biopsy specimens in the diagnosis of gastrointestinal tract disease in dogs and cats.

Willard (2001) performed proctoscopy, colonoscopy and ileoscopy techniques on dogs and cats with signs of chronic large bowel or rectal disease. Ileoscopy was typically performed in patients with signs of either large or small bowel disease. The passage of endoscope into the ileum was the tedious process and possible only under some instances.

Zoran (2001) explained the different manoeuvring of endoscope according to various anatomical landmarks of gastrointestinal tract. The evolution in endoscopic technology had also mirrored the evolution in computers and imaging modalities. The original fiberoptic endoscopes, although still available, were giving way to video endoscopy that provide spectacular images and an ability to generate hard copy images for medical records, teaching purposes, and research data that was previously not possible.

Moore (2003) documented the advantages and disadvantages of endoscopy. The endoscopy was considered as very safe, minimally invasive and effective tool in the diagnosis and treatment of various gastrointestinal (GI) disorders. The sensitivity of the technique for evaluation of mucosal disorders of the GI tract was found to be very high. Therapeutically, endoscopic retrieval of foreign body avoided highly invasive

surgeries like gastrotomies and laparotomy. The dark side of this modality was that clinician missed the functional disorders of gastrointestinal tract and also lesions of jejunum and ileum of small animals due to the lack of reach at these spots. The biopsies collected might undergo misdiagnosis in the cases of lymphosarcoma in cats which could be accurately diagnosed with full thickness biopsy.

Boston et al. (2003) reported the development of gastric ulcers and erosions, on concurrent administration of meloxicam and dexamethasone for 3 days in 20 healthy dogs. Seven days prior to treatment, five regions of the gastroduodenal area were scored by 2 investigators. Dogs were randomly divided into 4 treatment groups. Animals were treated with saline-saline, dexamethasone-saline, saline-meloxicam, and dexamethasone-meloxicam in group 1-4 respectively. On day 5, each dog was re-evaluated by endoscopy and histologic examination of biopsy specimens. They further concluded that the total endoscopic score of the dexamethasone-meloxicam group was significantly greater than the scores of the other groups. In healthy dogs, meloxicam appears to be safe with regard to adverse effects on the gastrointestinal tract. Concurrent administration of dexamethasone and meloxicam was more likely to cause gastric erosions than meloxicam administration alone.

Sapierzyniski et al. (2003) evaluated the occurrence of gastric Helicobacter-like organisms (GHLO) and gastritis in the gastric mucosa of dogs suffering from gastric disorders. Endoscopy guided samples of the gastric mucosa were collected from thirty animals, suffering from gastrointestinal symptoms e.g., vomiting, abdominal pain and inappetence. It was observed that the GHLO infection and gastritis were present in 63.3% and 36.6% of dogs respectively. Apart from this some other mucosal changes like fibrosis in the lamina propria, degenerative changes of the gastric glands and hyperplasia of the parietal cells were observed on histopathological examination. It was concluded that GHLO infection could be the reason for gastritis and parietal cell hyperplasia in some dogs. Moreover, the study also showed that the microscopically found gastritis was not that much frequent in dogs examined by endoscopy.

Leib et al. (2004) performed flexible colonoscopy in 355 dogs with signs of large-bowel diseases and recorded the frequency and types of adverse events that encountered during flexible colonoscopy. Major complications recorded were life

threatening conditions such as fatal aspiration of GoLYTELY (polyethylene glycol 3350, an osmotic laxative, and electrolytes) colonic lavage solution, colonic perforation, and excessive haemorrhage after biopsy of an adenocarcinoma with rigid forceps occurred in 3 dogs. Vomiting of GoLYTELY occurred with the administration of 4.6% of doses in 6.5% of dogs. They opined that while administering GoLYTELY, clinicians should be prepared to rapidly remove the orogastric tube and mouth speculum if vomiting occurs to reduce the potential for aspiration. Overall, minor or major complications were developed in 30 procedures. Flexible colonoscopy appeared to be a safe procedure in dogs with signs of large-bowel diseases

Leib and Duncan (2005) documented that the Helicobacter spp. are spiral bacteria commonly present in the stomach of dogs and cats. The bacteria could be identified by histologic assessment or rapid urease testing of gastric biopsy samples or by evaluating gastric brush cytology specimens. In RUT (commercially available kit test), gastroscopy guided biopsy taken was anchored on the kit, the change in the colour was observed. The speed of colour change also depends upon the number of helicobacter organisms present in the sample. This study revealed the procedures as well as advantages and disadvantages of available diagnostic tests for gastric *Helicobacter spp*. in dogs and cats.

Evans et al. (2006) documented that the endoscopy assisted biopsy collection from colon in cats was a simple and quick method for procuring histopathological sample. The accuracy of results between endoscopic biopsy (EB) and full thickness biopsy by laparoscopy or laparotomy specimens for diagnosis of alimentary tract lymphosarcoma was compared. It was observed that the gastric biopsy specimens were accurate with results of lymphosarcoma in 3 of the 4 cats with gastric lymphosarcoma but evaluation of EB specimens led to an incorrect diagnosis of IBD in one cat with small intestinal lymphosarcoma. It was concluded that EB specimens were useful for diagnosis of gastric lymphosarcoma but were not able to differentiate between IBD and lymphosarcoma.

Tyagi (2006) determined the gastric ulceration and erosion index in pilot study on the basis of the number and severity of gastric lesions. During endoscopy all the

areas of stomach were examined for gastric ulceration and erosion lesions. The criteria of gastric lesion number scoring were categorized as zero if no lesion was present, one if 1-2 lesions were present, two if 3-5 lesions were present. Gastric disease in which 6-10 lesions were present scored as three, and more than 10 lesions were scored as fourth category. The other criteria for interpretation was based on the level of gastric lesion severity in which different scores were given according to haemorrhage and depth of ulceration. The net gastric–ulcerations-erosions (GUE) index was summative of gastric lesion number score and gastric lesion severity score.

Gianella et al. (2009) retroprospectively studied the follow ups of endoscopic assisted removal of foreign bodies from esophagus and stomach in 102 dogs. It was observed that the endoscopy was successful in retrieval of foreign bodies in 92 dogs whereas, in remaining dogs gastrotomy was done for the removal of foreign bodies. The post-endoscopic complications were also evaluated in these dogs. Thirteen dogs showed various complications like perforation (n=8), esophageal stricture (n=1) and esophageal diverticulum. (n=1). Peri-esophageal abscess, pneumothorax, pleural effusion and respiratory arrest was observed in one dog each. They concluded that the endoscopy assisted removal of foreign bodies had low rate of complications except in cases of bony foreign bodies which were proved to be a big risk factor for these complications.

Weil (2009) documented the different specification of general anaesthesia for different endoscopic procedure in dogs and cats requiring general anaesthesia. It was reported that the anaesthetic considerations according to type of endoscopy was an important step to avoid unnecessary complications during procedure. Air insufflation during an endoscopy and various body positions during the procedure also had profound effects on the cardiovascular and respiratory systems. It was opined that the opioids must be avoided during gastroscopy as they cause pyloric spasms or vomiting. Whereas, opioids must be used during rhinoscopy as it required proper analgesia during procedure and the procedure also required infraorbital nerve block. Doxapram was utilized during laryngoscopy to decrease the chance of false positive results. The trans nasal approach of laryngoscopy under sedation was more accurate for evaluation of laryngeal function than general anaesthesia like propofol.

Foy and Bach (2010) examined three dogs and one cat presented with history of haematochezia and chronic vomiting with gastrointestinal endoscopy. It was observed that the intestinal polyp was present in dog with history of haematochezia and gastric polyp was present in another dog with history of chronic vomiting. Both dogs underwent endoscopic guided polypectomy and recovered uneventfully after the procedure. It was concluded that the endoscopy was an efficient double action modality for both diagnosis and treatment.

Juvet et al. (2010) reported that the esophageal foreign bodies were common in dogs and the most frequent site being the region caudal to the base of heart. The foreign bodies were retrieved in 44 dogs by two techniques *i.e.* endoscopically and surgically. The study concluded that there was prolonged hospitalization time and more complication like esophagus stricture in surgical method.

Lee (2011) classified the gastritis endoscopically into several type *i.e.* (a) superficial, (b) haemorrhagic, (c) erosive, (d) verrucous, (e) atrophic, (f) metaplastic and (g) hypertrophic. In erosive gastritis, endoscopy revealed small elevations with central umbilication. It was defined as a flat or minimally depressed white spot surrounded by a reddish area. If the erosion was elevated, it was generally defined as verrucous gastritis. Whitish patches, whitish plaques and homogeneous whitish discoloration on the endoscopic findings suggested metaplastic gastritis. Nodular gastritis diagnosed by endoscopy as micronodules measuring 2–5 mm in diameter and also known as chicken skin appearing gastritis due to its appearance.

Tams and Rawlings (2011) postulated that the megaesophagus was caused by diffuse hypomotility of esophageal muscles leading to flaccid dilatation of esophagus. The primary clinical symptom of megaesophagus was regurgitation of food after the meal. Impaired transport of food from the esophagus lead to aspiration pneumonia and weight loss. Esophagoscopy revealed generalized distension of esophagus along with secondary esophagitis characterized by erythema, superficial erosions and friability of esophageal mucosa.

Dogra et al. (2013) evaluated 23 healthy adult medium sized mongrel dogs for the presence of dexamethasone induced gastric ulcer and erosions. Dogs were treated with 5 different medicinal protocols *i.e.,* lansoprazole @ 1.5mg/kg body weight,

sucralfate @ 1 g/ animal, misoprostol @ 10microgram/kg, famotidine @ 1mg/kg body weight and seabuckthorn seed oil @ 5ml/animal twice a day. The study concluded that the gastroscopy provided a clinically relevant information about gastric bleeding lesions which could be missed by the clinician, if one relies only upon the clinical signs, complete blood count and blood biochemistry. The follow-up clinical reappraisals proved that the seabuckthorn oil was the best therapeutic agent for dexamethasone-induced GUE in dogs.

Slovak et al. (2014) performed duodenoscopy on dogs suffering from inflammatory bowel disease (IBD) and images of duodenal lesions from these dogs were recorded. A set of thirty-five images were shown to expert endoscopist and trainee endoscopist for interpretation of these lesions and the results were compared with kappa coefficient. Successive trials were performed after a gap of one month to analyse the interpretation of lesions by two groups. It was observed that the Interobserver agreement improved in the second trial and there was an improved overall score of trainees endoscopist to that of expert in the second trial. Interobserver agreement of IBD mucosal appearance from endoscopic findings benefitted from operator experience.

Terragni et al. (2014) observed that diagnostic imaging modalities were very important for diagnosis of various gastrointestinal diseases in feline patients. Gastric tumours were quite common in cats and plain radiography did not give the proper diagnostic clue so, contrast radiography had been used to locate the lesion but it is time consuming procedure with complications. Ultrasonography and endoscopy are the most appropriate modalities for diagnosing gastric tumours. Endoscopy especially useful when obtaining samples for cytologic or histopathologic examination, because the imaging modalities did not always differentiate between inflammatory or infectious conditions and neoplastic disorders. Endoscopy was highly sensitive and specific for identification of lesion and location of gastric tumour in cats.

Marolf et al. (2015) performed the gastroscopy and sonography in 17 dogs and 5 cats having histopathological confirmed gastric neoplasia. The sonographic and endoscopic findings were compared in a group of dogs and cats. They concluded that the sonography could diagnose only 50 per cent of cases because of intraluminal gas

and fluid which hindered the image and also create multiple artifacts that leads to misdiagnosis of condition. Whereas, the endoscopy could efficiently diagnose 95 per cent of cases and provided feasibility for histopathological examination by endoscopy assisted tissue collection.

Hong et al. (2015) compared the results of three different diagnostic methods for identification of helicobacter i.e. polymerase chain reaction (PCR), Helicobacter stool antigen kit (HpSA), and rapid urease test (RUT) for the identification of Helicobacter spp. in eight dogs suffering from gastritis. The gastroscopic guided biopsy specimens were evaluated using RUT and PCR, while stool specimens were evaluated using both HpSA and PCR. It was concluded that the Helicobacter spp. were detected in 62% of the dogs, while *H. heilmannii* and *H. felis* were identified in 37.5% and 25% of the dogs and cats, respectively. The HpSA did not efficiently detected the Helicobacter spp. in the stool samples as compared to the RUT and PCR assays, both of which successfully detected Helicobacter spp.

Davis and Williamson (2016) reported that the gastritis and gastric ulcers were an important cause of morbidity and mortality in canine athletes. The cause was unknown, but the study postulated a link between exercise-induced hyperthermia and loss of gastric mucosal barrier function as an early event in the pathogenesis. Endoscopy remains the gold standard for the diagnosis of exercise induced gastric disease (EIGD) in dogs due to the lack of consistent clinical signs or laboratory changes. The grading of lesions varied from a few submucosal petechia to multiple actively bleeding lesion. An endoscopic severity scoring (ESS) system had made in which a stomach completely free of visible lesions was graded as 0; a stomach with a few submucosal petechia but no visible defects in the mucosa was graded as 1, a stomach with extensive areas of erosions or a single bleeding ulcer was graded as 2, and a stomach with multiple bleeding ulcers was graded as 3.

Yoon et al. (2017) treated a 9-year-old Pomeranian dog with history of regurgitation from last three days. Radiographic and fluoroscopic examination followed by an non -ionic iodinated contrast swallow reveals a soft tissue opacity of around 14 mm near caudal mediastinal region and a bean-shaped filling defect and circumferential narrowing of the lower esophageal sphincter caudal to filling defect. The

impaction causing foreign body was found out to be a bean which was later on removed using endoscopic polypectomy snare. Moreover, endoscopic evaluation shown a collapsed lower esophageal sphincter, having a narrow diameter that allowed passage of the tip of the endoscope into the stomach. After distension of stomach with gas, the lower esophageal ring of approx. 1 mm thickness and 5 mm diameter became gradually visible at the ventral aspect of caudal end of the esophagus. It was concluded that esophageal rings were often misdiagnosed in dogs as this procedure requires proper distension of both the esophagus and stomach. Lower esophageal ring should be considered as a differential diagnosis in cases in which dogs exhibit thin, circumferential narrowing of the gastroesophageal junction on fluoroscopic and radiographic images.

Suryawanshi et al. (2018) carried out the endoscopic assisted diagnosis and management of gastrointestinal disorders in 42 dogs. The animals were presented with chronic history of vomiting, regurgitation, retching and shrunken abdomen. It was observed that the 31 dogs suffered from esophagus disorders like megaesophagus, esophageal diverticulum, esophagitis, esophageal nodule and foreign bodies and remaining dogs had gastric diseases. Endoscope guided foreign body retrieval procedure were successful in 9 dogs. However, some lodged foreign bodies of esophagus were pushed into stomach with push technique.

Singh et al. (2018) performed the upper gastrointestinal endoscopy in 12 dogs who were not responding to treatment for symptoms like regurgitation, chronic vomiting and loss of appetite. Endoscopy was found to be minimally invasive and efficient diagnostic modality to visualize the exact location of the lesion in different conditions including gastric foreign body obstruction, esophagitis, megaesophagus, esophageal diverticulum, extramural esophageal mass, gastric ulcer, haemorrhagic gastritis and gastric adenocarcinoma. Radiography and ultrasonographic finding along with endoscopy facilitated better diagnosis and management of different disorders.

Mohanambal et al. (2018) retrieved the radio opaque gastric foreign body (metal cap) using endoscopic basket under general anaesthesia and dog recovered uneventfully.

Seim-Wikse et al. (2019) identified the minimally invasive biomarkers to differentiate dogs with gastric carcinoma and chronic gastritis. The study was done in 15 dogs with gastric carcinoma, 29 dogs with chronic gastritis and 7 healthy dogs. Dogs with clinical signs of upper gastrointestinal tract disease for more than 14 days that underwent gastroscopy or necropsy for collection of gastric biopsy specimens for histologic evaluation were prospectively enrolled. Gastric carcinoma and chronic gastritis were diagnosed on the basis of histologic findings. All dogs underwent a physical examination and a blood sample was collected for quantification of select serum biomarker concentrations. Histologic findings, body condition score (BCS) and serum biomarker concentrations were compared among the 3 groups. They concluded that the dogs with gastric carcinoma were significantly older and had a significantly lower BCS, lower serum folate concentration and greater serum C-reactive protein (CRP) concentration compared with dogs with chronic gastritis and control dogs.

Kumar et al. (2019) diagnosed a dog presented with vague clinical signs like difficulty in swallowing solid diet and vomiting immediately after feeding since over a month as esophageal obstruction. The definitive diagnosis was only possible after an endoscopy was performed. The same obstructive foreign body was retrieved endoscopically after repeated attempts and the animal recovered uneventfully.

Randhawa (2020) conducted a study in 30 cases in which 7 were healthy animals and 23 were diseased cases suffering from gastrointestinal affections with symptoms like of vomiting, reduced appetite, anorexia and weight loss. The clinical cases included esophageal foreign body, mega-esophagus, gastroesophageal intussusception, esophageal neoplasia, inflammatory bowel disease, gastric and intestinal foreign bodies and intestinal masses. Endoscopic procedures included esophagogastroduodenoscopy, which comprised of examination of esophageal, gastric and duodenal mucosal examination, biopsy collection of intraluminal masses or abnormal mucosa, foreign body retrieval using foreign body basket or polypectomy snare. It was concluded that endoscopy is most sensitive minimally invasive modality for esophageal affections followed by gastric and intestinal affections.

Poggiani et al. (2020) performed the endoscopy in 88 dogs to determine the physical aspects, location of esophageal and gastric foreign bodies (FB), success rate and complications associated with the procedures as well. It was observed that according to the breed of the animals, small-breed dogs represented the large number of cases with Shihtzu and Yorkshires being most commonly affected breeds. The distribution of cases in male dogs were higher as compared to female dogs and the most affected age was between 1 and 5 years (66 per cent cases). It was concluded that gastric FB cases as compared to esophageal FB were more in number, which might be related to the interval between ingestion of the object and veterinary care. According to the type of foreign body, pieces of cloth were the most frequently found FBs, representing (20%) of cases, followed by animal bones (19%) and fruit pits (10%). As for location, (78%) of the FBs were located in the stomach and only (22%) in the esophagus. The efficacy of endoscopic FB removal was found to be (83%) with no complications in majority of cases due to the location of FB. The most common complications encountered were esophageal ulcerations, inability to move the FB and adherences. The study indicated that the endoscopy was efficient procedure to diagnose and to retrieve FBs from the gastrointestinal tract.

2.3 Upper respiratory tract including trachea endoscopy:

Roudebush (1990) reported that the flexible fiberoptic endoscope worked as an efficient tool for proper visualization of torturous anatomy of lower respiratory tract. It was proved to be safe and worthful technique for the diagnosis and management of a wide spectrum of respiratory tract diseases. It was further documented that the knowledge of normal tracheobronchial anatomy and the recently developed canine endobronchial nomenclature system might enhance the localization of lesion.

Noone (2001) used the rhinoscopy, pharyngoscopy and laryngoscopy techniques and documented the equipment needed, indications, and common visual findings of specific disorders and diseased conditions. It was reported that rhinoscopy was an efficient diagnostic approach with 83 per cent success rate in animals with symptoms like nasal discharge, sneeze, stertor, or facial distortion. The technique was also used in conditions like nasal foreign body retrieval, nasal parasite detection and

evaluation of conditions like acute epistaxis. Moreover, the technique was indicated for placement of tubes to administer antifungal agents into the frontal sinuses of dogs. The indication of pharyngoscopy which includes inappetence, dysphagia, retching, gagging, dyspnoea, coughing after swallowing, oronasal reflux of food or liquids, oral breathing, or stertorous respiration were also documented. It was opined that the laryngoscopy could be performed on patients with stridor or phonation changes, noisy breathing and cough etc.

Hunt et al. (2002) evaluated 38 dogs and 24 cats presented with symptoms like stertor or difficult breathing. Physical examination (particularly of local lymph nodes) was initially done, then animal was anesthetized for digital palpation of the soft palate, visualization of nasopharynx using retraction of the soft palate or flexible retrograde endoscopy. It was concluded that the nasopharynx could be approached surgically by incision of the soft palate when manipulation of catheters, nasal flushing, or endoscopic biopsy failed to dislodge obstructing material or yield a diagnostic sample.

Radlinsky et al. (2004) performed the trans nasal laryngoscopy in seven dogs. Four dogs were presented with symptoms of laryngeal paralysis. Trans-nasal laryngoscopy was performed by intubation of scope into nasal cavity then via nasopharynx to visualize larynx. It was observed that four dogs had laryngeal paralysis. Normal motion of the arytenoid cartilages was present in three dogs. However, two dogs required mechanical stimulation of the laryngeal mucosa for full evaluation. It was concluded that the trans nasal laryngoscopy provided a means for diagnosing laryngeal paralysis in dogs without general anaesthesia.

Tobias et al. (2004) performed the laryngoscopy in two groups of animals. First group was administered with doxopram and second group was the control group. Doxopram was injected to detect changes in glottic size and arytenoid motion in dogs with laryngeal paralysis. It was concluded that the doxopram only increases the depth of respiration and had no appreciable effect on arytenoid motility. No arytenoid mobility was detected in dogs with laryngeal paralysis at baseline; however, (Normalized glottal gap area) NGGA of Rima glottides in dogs with laryngeal paralysis was greater at inspiration and expiration than normal dogs. The use of doxopram during laryngeal

examination was useful to differentiate normal dogs from the dogs with laryngeal paralysis.

Brown (2006) examined the dogs presented with chronic unilateral and bilateral nasal discharge through radiography, computed tomography (CT) and magnetic resonance imaging (MRI). It was reported that the initial changes in nasal cavity might be missed with radiography and CT scan or MRI due to lack of accessibility and affordability. However, the rhinoscopy allowed the clinician to examine the nasal cavity directly and obtain diagnostic samples of tissue. It could also be executed to assess the prognosis of treatment.

Johnson et al. (2006) documented that the nasal aspergillosis was one of the serious fungal affection of nose in canines. The pathognomic lesion include presence of plaques on nasal mucosa and frontal sinus. The rhinoscopies were conducted in 46 dogs with lesions of nasal aspergillosis. The fungal plaques on nasal mucosa in rhinoscopic examination as well as in frontal sinus and in sinuscopy or frontal sinus trephination. The other major alteration was destruction of conchae anatomy and destructive rhinitis. It was concluded that the fungal plaques were present in both nasal cavity and frontal sinus in 38 dogs and plaques were only present in frontal sinus in 8 dogs.

Creevy (2009) documented that the flexible endoscopy was an excellent tool for visualization and sampling from upper and lower respiratory tract. The structure and function of the larynx could be detected by laryngoscopy. Endoscopy provide minimally invasive diagnostic procedures like tracheal washing efficiently in minimum time as a screening test, before more invasive airway diagnostics. Sampling methods like bronchial brushing, biopsy and bronchoalveolar lavage (BAL) require trachea-bronchoscopy for proper visualization and trachea-bronchoscopy also may became a therapeutic intervention.

Lobetti (2009) attempted to find the etiological agent in 75 dogs with chronic nasal disease undergoing radiographical examination, antegrade and retrograde rhinoscopy, bacterial or fungal culture and histopathology. Most frequently diagnosed condition was nasal neoplasia followed by lympho-plasmocytic rhinitis and fungal

rhinitis. Other miscellaneous conditions such as nasal foreign body, primary bacterial rhinitis (6.7%) was also diagnosed. Some rare conditions were also found like nasal polyps, granulomatous rhinitis, oro-nasal fistula and naso-pharyngeal stenosis. This study concluded that utilization of rhinoscopy with other complementary modalities made a good diagnosis of chronic nasal disorder.

Pietra et al. (2010) performed rhinoscopy in 54 dogs with symptoms like chronic nasal discharge, epistaxis, sneezing and stertor. Rhinoscopy was performed in both retrograde and anterograde fashion and biopsy samples were also procured for histopathology test. The degree of resemblance in results were also compared. The comparison between endoscopy and histology was tested by application of Cohen's kappa coefficient as 0.73 and it required constant cooperation between the clinician and the pathologist.

Cantatore et al. (2012) used the laryngoscopy technique for diagnosis of laryngeal saccule eversion which was one of the important components of brachycephalic airway obstructive syndrome (BAOS). In 10 dogs after diagnosis, sacculectomy was also performed for its correction and the pictures were captured in succeeding follow ups for evaluation of efficiency or any reoccurrence after surgery. In one dog, after sacculectomy, proliferation of a soft tissue lesion endoscopically similar to a newly formed saccule occurred. It was concluded that the second intention healing might occasionally result in the recurrence of the obstruction.

Sobel (2013) documented that the first signs of nasal or paranasal disease were nasal discharge and sneezing in feline patients. Discharge could be unilateral or bilateral. Other alarming complaint was an acute or chronic epistaxis which arise suspicion for nasal disease of primary origin. It was observed that the most problematic feature of the anatomy in feline patient was the relatively compressed space as compared to the dog nasal cavity which make rhinoscopy procedure difficult as well as require miniaturization of the endoscopes. The most commonly encountered affection in feline rhinoscopy was nasal adenocarcinoma, nasopharyngeal polyp, lymphocytic plasmocytic rhinitis and nasal lymphosarcoma.

Harris et al. (2014) compared the accuracy of nasal biopsies collected via rhinoscopy for diagnosing neoplasia and the biopsies taken blindly or using advanced imaging for guidance. A retrospective study was carried out in 117 dogs with nasal mass lesions. Animals were divided into three groups and biopsies were collected through advanced imaging-guided technique, rhinoscopy-guided and blind biopsy. Signalment, imaging, rhinoscopy findings and histopathological findings were compared among groups. It was observed that there was no statistically significant difference in the proportion of biopsies that confirmed neoplasia obtained by three methods. It was concluded that in dogs with high index of suspicion of nasal neoplasia, rhinoscopy-guided biopsy procedure proved to be safe and provided superior diagnosis of neoplasia.

Adaszek et al. (2014) documented that the dogs between 8 and 11 years of age, showing symptoms of epistaxis commonly suffered from nasal tumours and rhinoscopy was very important tool for visualization of the gross image of these tumours. Rhinoscopy also aided in collecting biopsies under visual control for histopathological examination. It was concluded that the rhinoscopy was the better alternate than other modalities like CT scan.

Hawley et al. (2015) examined a 1.5-year-old spayed female Bernese Mountain Dog presented with history of intermittent vomiting, regurgitation, wheezing, and coughing for 6 months. Initially, a diagnosis of gastroesophageal reflux disease with secondary aspiration pneumonitis was made but clinical signs did not resolve with treatment. There was no appreciable lesion even under CT scan. The tracheoscopy revealed a firm, irregularly margin mass apparently originating from the ventral aspect of the trachea, occluding approximately one-half of the tracheal lumen and located 2 cm cranial to the carina. Cytologic and histopathologic examination of fine-needle aspirate and biopsy samples suggested a tumour from benign origin. Therefore, endoscopy in this case cleared the opaqueness and provided the confirmatory diagnosis.

Johnson et al. (2015) evaluated 42 dogs with signs of chronic cough by three different modalities i.e. radiography, fluoroscopy and tracheo-bronchoscopy. The

interpretation by bronchoscopy along with sensitivity and specificity of other imaging modalities was compared. Sensitivity for the detection of bronchoscopically identified collapse was highest for radiography at the trachea. Detection of airway collapse increases when fluoroscopy was performed after induction of cough compared to during tidal respiration. It was concluded that the bronchoscopy gave the good result in diagnosis of bronchial collapse whereas, radiography and fluoroscopy were complementary imaging techniques.

Ostrzeszewicz and Sapierzynski (2015) executed the rhinoscopy in 43 dogs with signs of chronic nasal discharge. The dogs were suspected for fungal rhinitis and sinusitis. Prior to rhinoscopy all dogs had undergone screening tests like clinical examination, haematology and serum biochemistry profiles, nasal and frontal sinus radiographs. Moreover, computed tomography in one dog was performed. In 9 dogs rhinoscopy guided biopsy samples were collected for histopathological conformation and in 8 dog's samples for cytology were collected by blind nasal swab technique. In 9 dogs fungal rhinitis was diagnosed. In 2 cases a diagnosis of fungal rhinitis was obtained solely on cytopathology, while in 7 cases, mycosis of nasal mucosa was confirmed by histopathology of biopsy sample. The study revealed that cytopathological examination of nasal swabs had a low diagnostic value in the case of fungal rhinitis in dogs and histopathology of rhinoscopy biopsy was the gold standard in such cases.

Tappin (2016) observed that the most commonly predisposed group to tracheal collapse was middle aged and small breed dogs. Clinical symptoms vary from mild airway irritation and paroxysmal coughing to respiratory distress and dyspnea. Radiographs, tracheo-bronchoscopy or fluoroscopy like diagnostic tools were preferred for diagnosis of tracheal collapse. Tracheoscopy classified severity of tracheal collapse as grade I collapse, where loss of 25% of the tracheal lumen. Loss of (50 %) lumen diameter was graded as second, 75% as grade III collapse and complete loss of tracheal lumen as grade IV tracheal collapse.

Vedrine and Blanc (2018) performed rhinoscopy in 10 dogs with sino-nasal aspergillosis (SNA) having signs of rhinitis and sinusitis. The facial deformity, epiphora and seizures were also identified in severe cases. The rhinoscopy guided debridement

of fungal plagues and instillation of one percent clotrimazole into sinuses via oxygen catheter, passed through sino-nasal ostium was done. The study showed the good prognosis of the therapy in five cured in first clinical reappraisal and four by second follow up and one dog in third follow-up rhinoscopy.

Sezer et al. (2018) documented that the rhinoscopy could be used as dual-purpose tool for diagnosis as well as therapeutic purpose in dogs suffering from epistaxis. It was reported that the rhinoscopy was the minimal invasive procedure which avoids invasive procedures like rhinotomy.

Sumner et al. (2018) carried the rhinoscopy in a 12-year-old female dog with history of progressive paroxysmal sneezing, stertorous breathing and intermittent epistaxis with some mass protruded from the right nostril occasionally. CT scan and rhinoscopy was performed for confirmation of lesion. The rhinoscopy assisted biopsy was taken for histopathological examination. It was observed that there was presence of nasal polyposis which might be due to chronic inflammation. It was opined that these potential complications should be considered and the clinician should be vigilant for evidence of malignant transformation

Dias et al. (2020) diagnosed the nasal foreign body in 42 dogs using rhinoscopy. It was observed that most of the dogs had signs like sneezing and nasal discharge either mucoid or mucopurulent. Grass awns were found to be the most frequent foreign body present in nasal cavity during rhinoscopy and these were successfully retrieved by rhinoscopy guided grasping forceps via 14.5fr operating sheath.

Parker et al. (2021) performed rhinoscopy in 2-year-old male neutered mixed breed dog presented with symptoms like left sided unilateral epistaxis, mucoid discharge, sneezing from 2 months. Computed tomography (CT) showed soft tissue that occupy the entire left nasal passage with mild turbinate loss. The rhinoscopy revealed multi-focal patches of discrete, white, wispy, vascularized abnormal tissue in the left nasal cavity. Rhinoscopy guided cytobrush and biopsy were collected for cytology and histopathology. Later on, the confirmation of a TVT was made with polymerase chain reaction for the long-interspersed element inserted upstream of the c-myc gene. The dog showed the complete and sustained resolution of clinical signs after the third cycle of treatment.

2.4 Urethroscopy and cystoscopy:

Biewenga and Oosterom (1985) documented the complete urological examination with cold light cystoscopes in diagnosis and surgical procedures. The fast and minimal invasive property of the procedure limits the inconvenience to the patient. However, the use of rigid telescope was limited to female dogs only.

McCarthy (1996) carried out two different types of cystoscopy i.e. first one by transurethral access done in most cats and other prepubic percutaneous cystoscopy allowing evaluation when transurethral cystoscopy could not be utilized. Cystoscopy could be indicated for assessment of chronic cystitis, haematuria, tenesmus, increased frequency of urination, urinary incontinence, alteration of urinary stream, trauma and cystic and urethral calculi. The vagina, urethral opening, urethra, bladder and ureteral openings could be properly analysed and samples could be collected for histopathology, cultures, and stone analysis. Cystoscopy provides an easy access to diagnostic information that can be difficult to obtain with any other technique.

Chew et al. (1996) documented that the cystoscopy was an important part of diagnosis of various disease condition related to lower urinary tract disease in cats with perineal urethrostomy. It provided high quality images for proper diagnosis and had very less chance of complications. It was estimated that urethroscopy might became a popular diagnostic method in male cat in future clinical practice. It might be possible because of expertise in utilization of smaller scopes, and as scope technology advances. Retrograde cystoscopy of male cats was not yet routine because of visual limitations of present-generation small fiberoptic scopes.

Messer et al. (2005) used the rigid Hopkin type endoscope with 30-degree proximal angled tip for the visualization of female urethra, urinary bladder, ureter opening in bladder and in males only penile urethra. Cystoscopy was used for familiarization with normal anatomy and disease conditions of lower urinary tract along with calculi removal and submucosal injection into urethra.

Liberman et al. (2011) treated nine dogs with partial or complete urethral obstruction due to urinary calculi using minimally invasive transabdominal urethroscopy

after attempting pre-operative stabilization protocol i.e., cystocentesis and retro-hydro propulsion. The study reported that in contrast to other techniques like cystocentesis or retro-hydro propulsion that increases the risk of uroabdomen and iatrogenic injury, transabdominal cystoscopy efficiently removes calculi with minimum damage. Magnification of endoscope also aids in identification and removal of smaller size stones.

Morgan et al. (2015) used cystourethroscopy technique to gain access to the lower genitourinary tract (urethra, urinary bladder, ureteral orifices and vagina). In most cases, cystourethroscopy was used as a diagnostic tool to visually assess the lower urinary tract if routine diagnostic evaluation (blood work, urinalysis, urine culture, radiography and ultrasonography) does not yield a definitive diagnosis for the cause of a patient's lower urinary tract disease. In addition, some treatment modalities could be administered with cystoscopy guidance. It was considered a minimally invasive procedure but does require general anaesthesia in order to minimize patient movement and secondary iatrogenic injury to the lower urinary tract.

Llido et al. (2020) documented that the recurrent urinary tract infection was common in female spayed dog and required urethro-cystoscopy for precise diagnosis of disease. Dogs with recurrent UTI had symptoms of pyuria, positive urine culture or reoccurrence of UTI symptoms at least twice in the six-month duration. Transurethral cystoscopy revealed various kinds of anomalies such as mucosal edema, vestibulo-vaginal septal remnant, lymphoid follicles, short urethra and ectopic ureter. Bladder wall edema and ulceration were the most common findings on histopathology (25/39).

CHAPTER 3

MATERIALS AND METHODS

A total of 124 endoscopies were performed under the study of "Endoscopic assisted diagnosis of various disease conditions in small animals" from January 2020 to July 2021 in dogs. The study was further divided into four subsections and these sections were selected based upon the endoscopic infrastructure available in department as follow:

3.1 Video-otoscopy

3.2 Gastro-intestinal tract endoscopy

3.3 Upper respiratory tract including trachea

3.4 Urethroscopy and cystoscopy

The technical programme of work was divided into two phases:

- Standardization of different endoscopic procedures in small animals
- Clinical application of endoscopy in small animals

3.1. Video-otoscopy

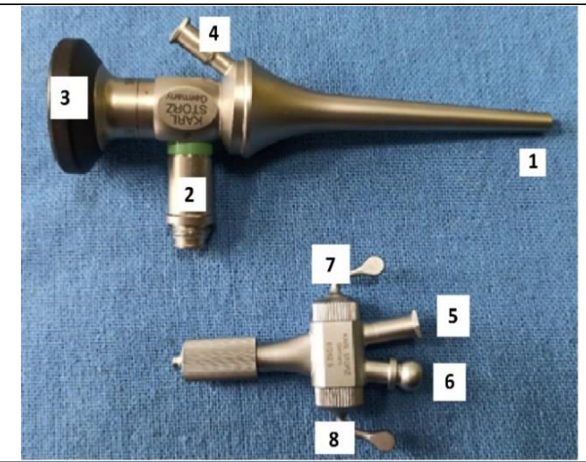
3.1.1 Standardization protocol for performing video-otoscopy

Standardization trials were carried out in five dog cadavers and five dogs who were brought for routine check-up including ear. These canine ears were examined for understanding normal anatomical detail of ear canal.

3.1.1.1 Instrumentation for the video-otoscopy procedure

I. Video-otoscope

Video- otoscopy was performed using an autoclavable rigid video-otoscope (Karl storz 67260 OSA Veterinary otoscope) having diameter of 5 mm and length of 8.5 cm. The diameter of working channel of the otoscope was 5 Fr which was used for the passage of different types of accessories such as grasping forceps, biopsy forceps, ear curette and Otex cytobrush (Plate 3.4). The working channel also provided the attachment to Luer-Lock adaptor (Plate 3.1), which made it convenient for irrigation and suction of the fluids into and out of ear canal.

Plate 3.1: Video-otoscope and Luer-lock adaptor	
	1.Distal tip with Zero-degree angle 2. Light guide post 3. Eyepiece 4. Accessory channel 5. Suction valve of Luer-lock 6. Irrigation valve of Luer-lock 7. Suction regulating lever 8. Irrigation regulating lever

II.Supporting Instruments for image processing and visualization:

- **Monitor:** Tele pack Vet X monitor (Karl Storz) was utilized, which was compatible with both rigid and flexible endoscopies set up (Plate 3.2). It was a fifteen-inch LCD TFT monitor having high resolution (1024 X 768) with LED backlight that enhances image display quality. It was integrated with every component necessary for endoscopic imaging such as camera, LED light source, image capturing unit and port for USB attachment for storage of captured images.
- **Light transmitting cable:** It was a long flexible fiberoptic cable that transmits light from a light source placed within the monitor to the light guide post of a rigid telescope, which illuminated the orifice for the proper visualization of mucosal linings (Plate 3.2).

Plate 3.2: Supporting Instruments for image processing and visualization	
Monitor	Light transmitting cable

- **Camera**: Single chip veterinary video camera 3 with PAL/NTSC colour system was utilized during rigid endoscopy procedure. At proximal end of the camera head, C-mount lens was present (Plate 3.3). Camera head also contains two freely programmable camera head buttons which were used for taking images and videos by operator. The camera head was attached to camera control unit via BNC video cable, which was 180 cm in the length.
- **Suction and air insufflator assembly**: Vet Suction pump along with presence of air insufflator was utilized for suction of fluids (Plate 3.3). There working powers were adjustable. Suction was done for removal of excessive fluids or secretions present on intraluminal lining for proper visualization of mucosal surface of the hollow organs. The suction out fluid was collected into suction jar (1.5 ltr capacity) through the suction pipe attached with the endoscope assembly.

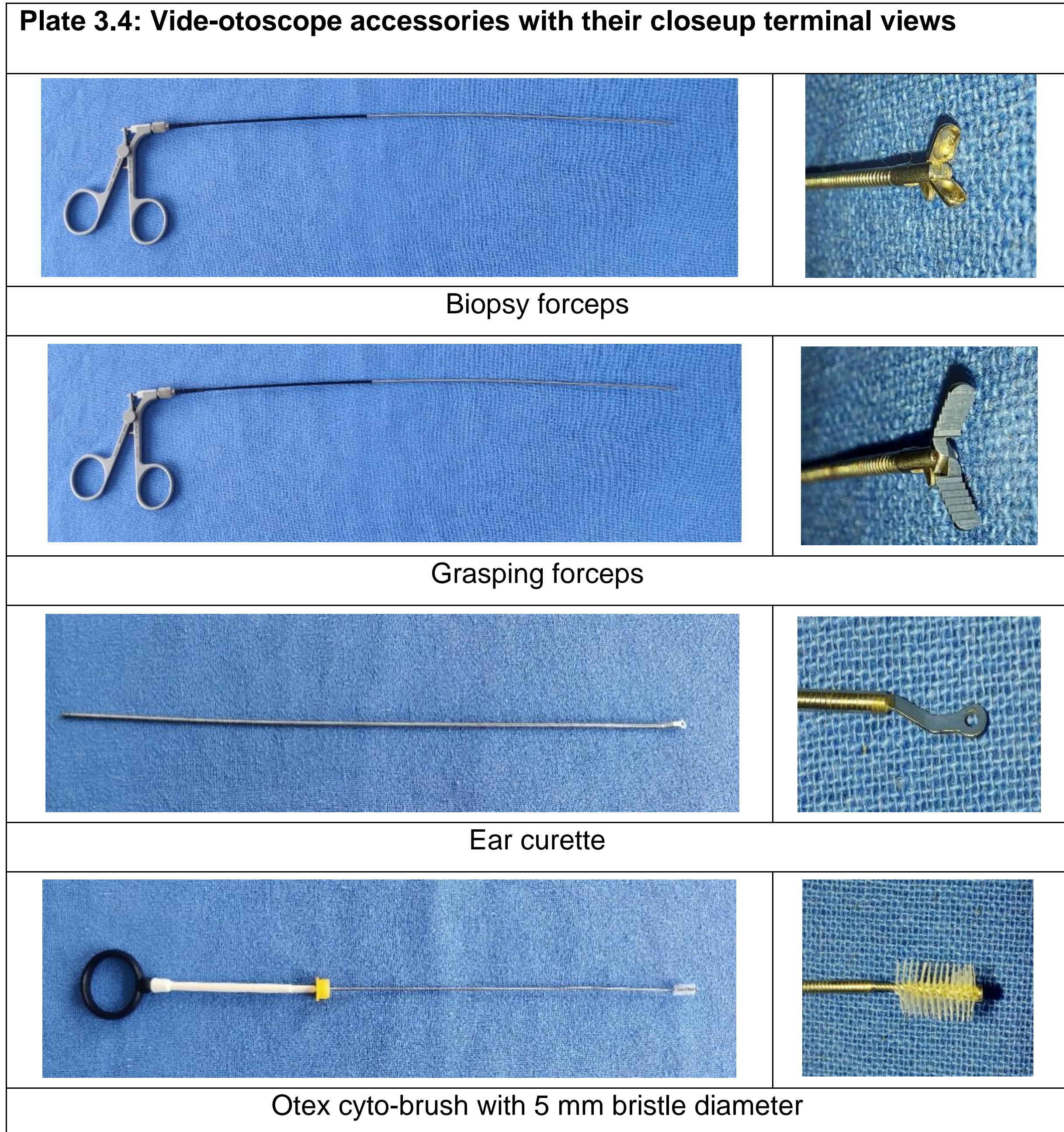
Plate 3.3: Camera and air/ suction assembly for rigid endoscopy		
Single chip Camera with BNC cable	Camera Head	Air insufflation and suction assembly

III.Accessories of video-otoscope:

- **Biopsy forceps (34 cm X 5 Fr):** These forceps were used to collect the video otoscopic guided tissue samples for histopathological examination. These were flexible, oval and having double action jaws. (Plate 3.4).
- **Grasping forceps (34 cm X 5 Fr):** These forceps were used to grasp and retrieve foreign bodies, removal of inspissated ear wax and maggots etc from ear canal. It had flexible and double action jaws (Plate 3.4).

- **Ear curette (30 cm X 5 Fr):** It was used to clean ear canal filled with cerumen (earwax) (Plate 3.4).
- **Otex cyto-brush (19 cm X 5 Fr):** It was long flexible brush (5mm bristle diameter) with ring shaped handle and was utilized for taking otoscopic guided cytology sample from specific lesion (Plate3.4).

Plate 3.4: Vide-otoscope accessories with their closeup terminal views



Biopsy forceps

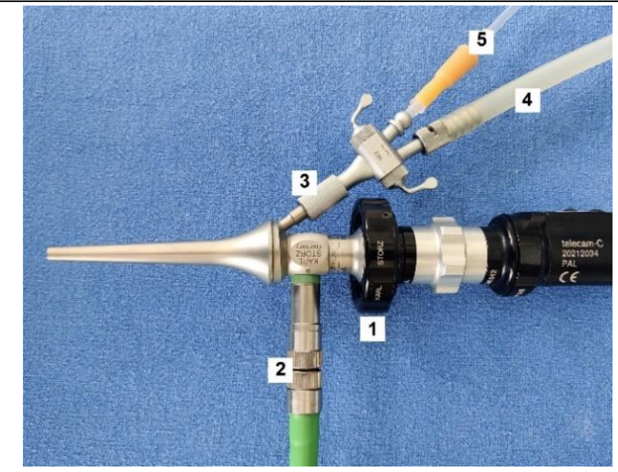
Grasping forceps

Ear curette

Otex cyto-brush with 5 mm bristle diameter

IV. Video-otoscopic Assembly:

The C-mount camera head was fixed on the eyepiece of video-otoscope and light transmitting cable was attached to the light guide post of otoscope, the other end of the both camera and light cable were attached to their respective ports on the telepack X monitor. Further the Luer-lock adaptor was connected to accessory channel of scope, which provided attachment for irrigation and suction pipes through their respective valves (Plate 3.5).

<table>
<tr><th colspan="2">Plate 3.5: Ready to use video-otoscopy assembly</th></tr>
<tr><td>
</td><td>1.Attachment of eyepiece within C mount of Camera head
2. Fiberoptic light cable attached to lightguide post of scope
3. Luer-Lock adaptor attached to scope
4. Suction pipe
5. Irrigation pipe</td></tr>
</table>

V. Sterilization of instruments

The sterilization of otoscope and accessories was accomplished by autoclaving (121^0C and 15 lbs for 30 minutes) or by cold sterilization with Glutaraldehyde dip (2%) for 2 hours followed by rinsing of instruments with distilled water before their usage (Plate 3.6).

Plate 3.6: Cold sterilization of instruments	
	Glutaraldehyde dip (2%) for 2 hours

3.1.1.2: Patient preparation:

The routine general examination of dogs was done to ensure their compatibility for anaesthesia or sedation. The dogs were kept off fed for 12 hours and off water for 6 hours prior to procedure.

3.1.1.3: Restraining of patient:

Restraining of dogs was done with either of three methods i.e. general anaesthesia in 28 dogs (28/35), sedation in 3 dogs (3/35) and without any chemical restraining in 4 dogs (4/35).

For sedation: injection butorphanol, atropine and acepromazine cocktail was used as follows:

- Inj. Atropine @ 0.02 -0.04 mg/kg body weight (I/M).
- Inj. Butorphanol @ 0.2 mg/kg body weight (I/M).
- Inj. Acepromazine @ 0.03mg/kg body weight (I/M).

Whereas General anaesthesia (GA) protocol used in study included:

- Inj. Atropine @ 0.02 -0.04 mg/kg body weight (I/M or S/C)
- Inj. Butorphanol @ 0.2 mg/kg body weight (I/M or S/C)
- Inj. Diazepam @ 0.5 mg/kg body weight (I/V)
- Inj. Propofol to effect (I/V), then followed by endotracheal intubation and maintained on gaseous anaesthetic agent isoflurane along with oxygen.

Some video-otoscopies were performed without GA and sedation had been included in drug free group.

3.1.1.4: Position and Recumbency:

Animal undergoing video-otoscopy were kept in either right or left lateral recumbency with affected ear upside (Plate 3.7). The standing ergonomic of endoscopist was done in either by standing behind the convex surface of ear pinna or to stand in front of concave surface of ear pinna (Plate 3.7).

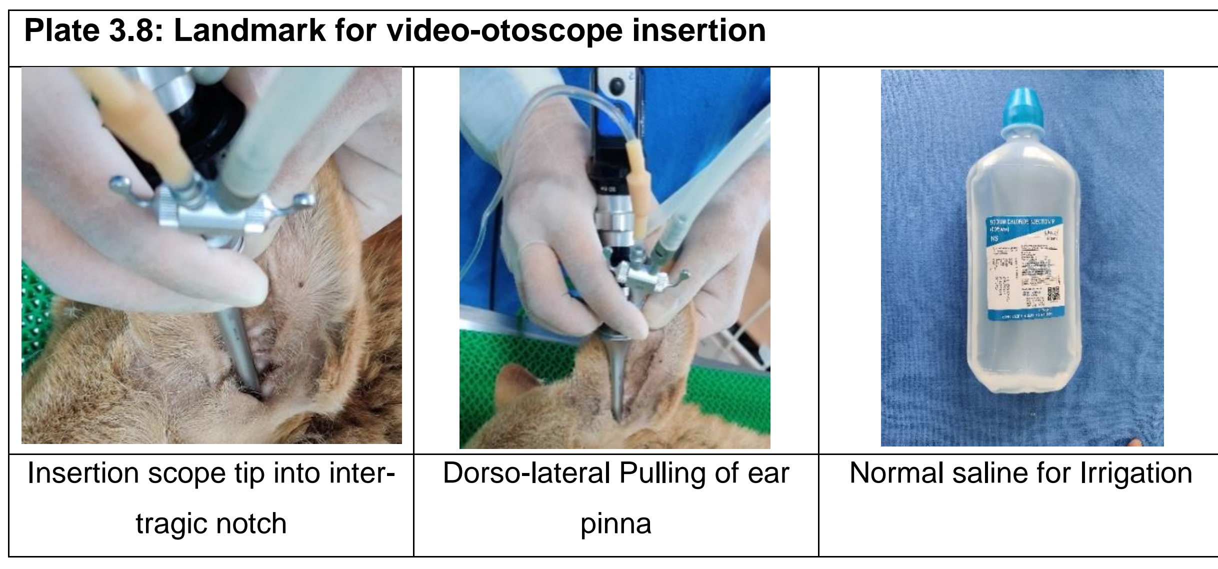
Plate 3.7: Position and recumbency

3.1.1.5: Technique of performing Video-otoscopy:

The standard protocols for technique of video-otoscopy was based upon the methods given by (Tams and Rawlings 2011; McCarthy 2005)**.**

Once the desired position was achieved the operator stand behind the convex surface of the ear and hold the ear pinna with non-dominant hand pulling it dorso-lateral away from the skull. The video-otoscope assembly was held in dominant hand; it was inserted into the ear canal at the level of inter-tragic notch (i.e. in between the two tragic’s scope was gently passed) (Plate 3.8).

Plate 3.8: Landmark for video-otoscope insertion



Insertion scope tip into inter-tragic notch	Dorso-lateral Pulling of ear pinna	Normal saline for Irrigation

At this level images of tragic and pinna were captured. Then the scope was advanced into central lumen of vertical ear canal slowly, facilitating the visualization of

the vertical ear canal (VEC) mucosa. Once the scope reached at the cartilaginous ridge, which marked the entry of horizontal ear canal was also visualized. Further advancement of scope through horizontal ear canal (HEC) provided the visualization of tympanic membrane.

Throughout the procedure, alternate irrigation and suction of fluids were required to remove the wax and other debris for visualization of ear canal mucosa. The irrigation was performed with normal saline solution via infusion set attached to irrigation valve of Luer-lock adaptor and suction by suction apparatus attached to the suction bottle.

- **Deep ear cleaning:**

In cases requiring deep ear cleaning, again 0.9 per cent normal saline solution (Plate 3.8) was most commonly used along with other cleaning solutions such as Salicylic acid 0.2 % w/v (Epiotic ®; Virbac, India) and Chlorhexidine gluconate solution 0.15% + Propylene glycol 10% w/v + Tris EDTA (Ambifush ®; Intas, India).

- **Technique of biopsy:**

Biopsy was taken with the flexible biopsy forceps. The forceps were inserted through accessory channel of endoscope. Then after selecting the site of interest scope was steadily placed at one field. The jaws of biopsy forceps were opened and the forceps were retrieved back after closing the jaws containing desired tissue sample. Afterwards forceps were pulled and biopsied tissue was put into formalin containing sample vial.

3.1.2: Clinical application phase of Video-otoscopy:

The standardized video-otoscopy technique was applied on total of 30 dogs presented for different ear affections, out of which 6 dogs underwent unilateral otoscopy and in remaining 24 cases it was performed in both ears. So, in total the video-otoscopy was done in 54 ear canals.

3.1.2.1: History and Signalment:

History of ear shaking, head tilt, ear scratching, ear discharge, otodynia, duration of ear problem, affected ears (bilateral or unilateral) was recorded on the day of presentation. Further, anamnesis included information related to feed and water intake, urination, defecation status, general status of animal and any other previous

medication. Signalment comprised of information related to the age, species, breed, body weight, body score and gender.

3.1.2.2: Basic clinical examination:

The parameters such as rectal temperature (^{0}F), color of conjunctival mucous membrane, heart rate (bpm), pulse rate (bpm), respiration rate (breaths per minute), lymph node status and hydration status were also recorded.

3.1.2.3: Endoscopic examination:

During video-otoscopy, different parameters were recorded. For the evaluation and interpretation of video-otoscopy results, a modified scoring system based on otitis index scoring (OTIS3) (Ettinger et al 2017) was used. Erythema, exudate, inflammatory changes, ceruminous alterations and stenosis were all noted, with zero indicating normal, one being mild, and two being moderate and three being severe based on the video-otoscopy examination (Table 3.1). The video-otoscopy findings were recorded from pinna/tragic up to the tympanic membrane. The location of the lesions was also noted (Table 3.2).

A customized Performa was prepared for recording the various lesions and their severity as shown in the table below:

Table 3.1: Customized Performa for video-otoscopy based on lesion severity

	Lesion/Parameters	Code		Comments/ location	
		R	L	Right ear	Left ear
1.	Erythema				
2.	Exudate				
3.	Inflammatory changes				
4.	Ceruminous changes				
5.	Ear canal stenosis				
6.	Hemorrhage				
7.	Other				

Code: normal - 0, Mild - 1, Moderate - 2, Severe – 3
R- Right ear, L- Left ear

Similarly, a customized Performa was also prepared for localization of various lesions in ear canal as shown in the table below:

Table 3.2: Customized Performa for video-otoscopy based on location					
	Location	Code		Comments	
		R	L	Right Ear	Left Ear
1.	Pinna and tragic				
2.	Vertical ear canal				
3.	Horizontal ear canal				
4.	Tympanic membrane				
5.	Comments and interpretation				
R- Right ear, L- Left ear					

3.1.2.4: Additional data recording:

- **Haemato-biochemistry:**

Complete blood count was done by using the blood collected from cephalic or saphenous veins in an EDTA vial. The biochemical test was done on heparinized venous blood. As most of animal undergoing video-otoscopy required chemical restraining so, complete haematology, serum biochemistry and urine analysis was done to achieve a safe and effective anaesthesia, but these findings are not included in result and discussions. The urine analysis was done in selected cases as per the need of the individual case.

- **Cytological examination:**

In sedated or anaesthetized dogs, a sample for cytological investigation was obtained from the intersection of the vertical and horizontal ear canals by one of the following methods:

- Direct ear swab with sterile swab (without video-otoscope) (Plate 3.9).
- Video-otoscopic guided sample with Otex Cytobrush (Plate 3.9).

The swab or cyto-brush when reached at level of intersection between horizontal ear canal and vertical ear canal, they were gently rolled in an anti-clockwise direction and removed with little contact with the vertical ear canal. After that, the sample was

rolled on a clean glass slide to evenly distribute the thin layer of material (Plate 3.9). Each slide was labelled to ensure that it was appropriately identified.

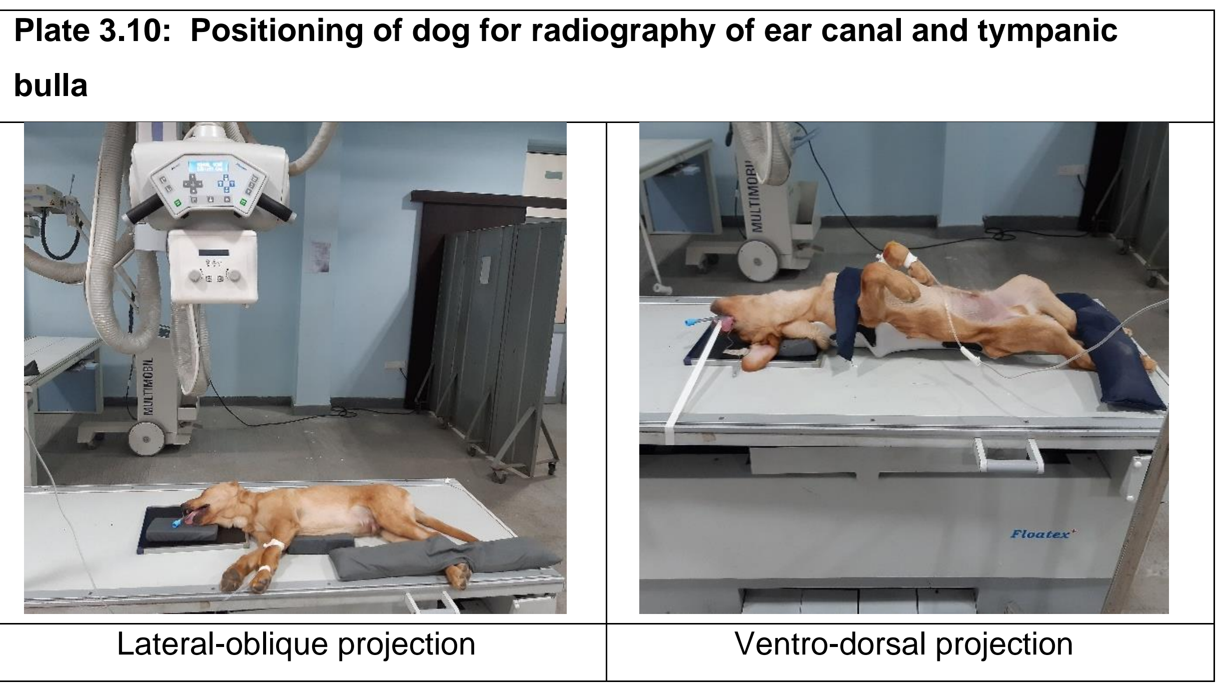
Plate 3.9: Sterile swabs for cytology and culture sensitivity test

Direct Ear swab	Otex cytobrush	Sampling from ear canal	Distribution of sample on the glass slide

- **Radiological examination:**

Radiological examination was carried out in cases with history of chronic otitis externa or media as per the need of case. Standard orthogonal projections, *i.e.* lateral-oblique projection and the ventro-dorsal projection were taken (Plate 3.10).

Plate 3.10: Positioning of dog for radiography of ear canal and tympanic bulla



Lateral-oblique projection	Ventro-dorsal projection

3.2: Gastrointestinal tract endoscopy (Gastroscopy and colonoscopy)

3.2.1: Standardization protocol for performing gastroscopy and colonoscopy

Standardization phase was undertaken by utilizing eight dogs suspected for GIT disturbance without history of weight loss, six for gastroscopy and two dogs for colonoscopy. These dogs were examined for understanding normal anatomical detail of gastro-intestinal tract.

3.2.1.1: Instrumentation:

I. **Flexible Video-endoscope:** Flexible video-endoscope had working length of 140 cm and diameter 9.7 mm along (Plate 3.11) with working channel of 2.8 mm diameter which was utilized for passage of different types of accessories such as biopsy forceps, alligator grasping forceps, cleaning brush and stone basket. (Plate 3.13). The basic structure of video-endoscope has been divided into following sections: Insertion tube, hand piece, umbilical cord, monitor and light source.

Plate 3.11: Flexible video-endoscope along with its part

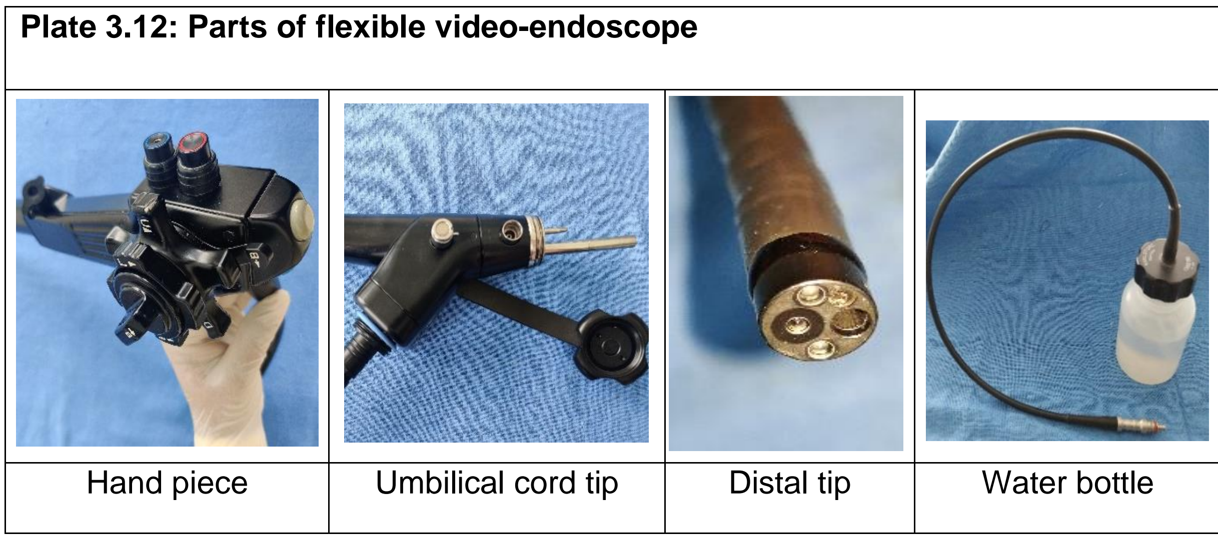
1. Hand piece
2. Umbilical cord
3. Insertion tube

- **Insertion tube:** It was the proximal tubing of endoscope which was intubated into mouth of animal and had graduations showing its length of insertion (Plate 3.11). Distal tip comprised of working channel for inserting instruments, fiberoptic light guide, camera, an air insufflation nozzle and flushing system attached to its tip for clearing debris from proximal lens during the procedure. Tip deflection occurred by the angulation wires attach to the control knobs and act as a pulley system at the distal tip.

The tip had an ability to bend in different directions i.e. up, down, left and right direction for performing different manoeuvers during complete GIT examination.

- **Handpiece:** It consisted of two types of control knobs which helped to move the deflection tip and manoeuvring it in all four directions i.e. left and right, up and down. One control knob for right and left direction, other for up and down along with their brakes. The two valves one for suction (red colour) and other for air insufflation or water irrigation were also present on handpiece. Moreover, it had two caudally placed control buttons for recording of images and videos by operator's own hand (Plate 3.12).
- **Umbilical Cord:** The umbilical cord had the fiber bundles for the transmission of light to the distal tip of the endoscope. It also contained the channels for air insufflation, lens-washing water and suction (Plate 3.12).
- **Light guide connector:** The tip of the umbilical cord had the light guide connector, which plugged into the light source. This connector also had the ports for connections of the water bottle, suction tube, air pump, and pressure compensation (Plate 3.12).

Plate 3.12: Parts of flexible video-endoscope



Hand piece	Umbilical cord tip	Distal tip	Water bottle

- **Water bottle:** The water bottle had capacity of 250 ml and utilized for removal debris stuck on proximal lens of flexible endoscope (Plate 3.12). The water bottle attachment was present on the umbilicus of flexible endoscope (Plate 3.12).

II. Other supporting instruments: The other instruments used for these procedures such as monitor, image storage device (Plate 3.2) and suction jar (Plate 3.3) were already discussed in the video-otoscopy section (3.1.1).

III. Flexible Video-endoscope accessories:

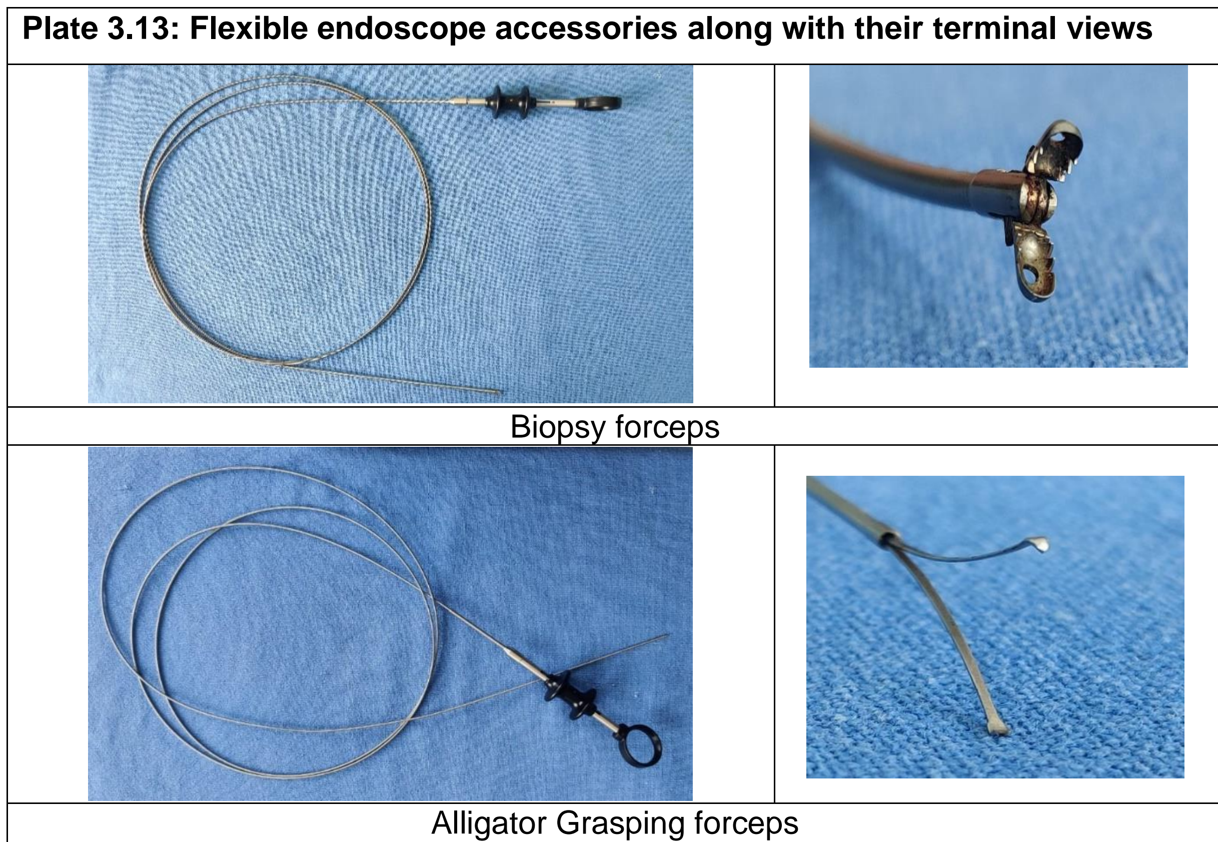
Biopsy forceps (230 cm X 2.4 Fr): It had oval jaws with working length of 230 cm. It was used for collection of biopsy sample (Plate 3.13).

Alligator rat-tooth grasping forceps (210 cm X 2.4 Fr): It was used for the retrieval of any foreign body/object (Plate 3.13).

Foreign body retrieval basket (230 cm X 2.4 mm): The four wired stone basket was used for the retrieval of any foreign body/object. It had opening width of 30 mm (Plate 3.13).

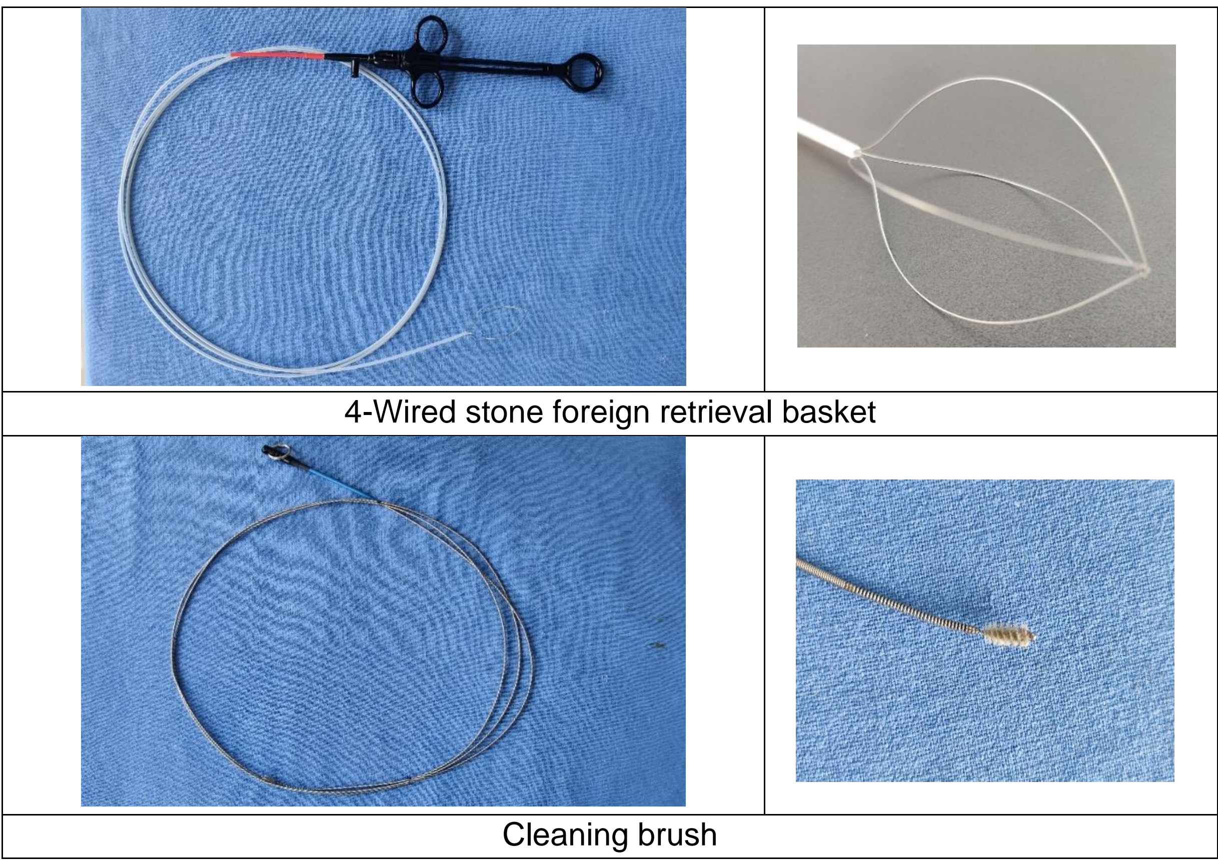
Cleaning brush (230 cm X 2.4 mm): It was used for cleaning of accessory channel of endoscope (Plate 3.13).

Plate 3.13: Flexible endoscope accessories along with their terminal views



Biopsy forceps

Alligator Grasping forceps



4-Wired stone foreign retrieval basket

Cleaning brush

IV. Flexible endoscopy assembly:

The tip of umbilical cord and the camera cable of scope had plugged into their respective ports on the tele pack X monitor. Then the water bottle line and suction line were attached on their respective connectors present on the umbilicus of the endoscope (Plate 3.14).

Plate 3.14: Ready to use assembly of flexible endoscope

1. Connection of umbilical cord tip into monitor
2. Attachment of suction tube
3. Water bottle connection
4. Attachment camera cable into monitor

V. Sterilization of instruments:

It was done with glutaraldehyde dip (2%) for 2 hours. Afterwards the scope was rinsed with distilled water and air dried.

3.1.2.2: Patient preparation:

The routine general examination of dogs was done to ensure their compatibility for anaesthesia or sedation. The dogs were kept off fed for 12 hours for Upper GIT endoscopy and 12-24 hours for colonoscopy.

For the colonoscopy, the dogs were prepared with three different methods:

- Given a laxative solution (Sol. Cremaffin ® @ 10 ml, tid) three times a day, starting three days before the endoscopy along with multiple enema on day of endoscopy in three patients (3/7).
- Colonic lavage solution PEGWASH (polyethylene glycol with electrolytes for oral solution) along with multiple enemas were also utilized in two cases (2/7).
- Only Multiple enemas were performed on the day of the colonoscopy in two dogs (2/7).

3.1.2.3: Anaesthesia:

General anaesthesia was utilized for performing gastroscopy and colonoscopy. The protocol for general anaesthesia was the same as discussed in the video-otoscopy section (3.1.1.3), except Atropine, a pre-anaesthetic drug was not used in this protocol.

3.1.2.4: Position and Recumbency:

For upper GIT endoscopy, the dogs were kept in right lateral recumbency but for visualization of every important part of stomach, the recumbency was first change to ventro-dorsal and later to left lateral (discussed in results and discussion section 4.2.1.2).

For colonoscopy, the dog was kept in left lateral recumbency (Willard 2001).

3.1.2.5: Technique of Gastro-intestinal tract endoscopy:

Specific steps which were set as standard recommended protocols in the endoscopic procedure by Tams and Rawlings (2011) were followed.

Upper gastro-intestinal tract endoscopy:

Upper gastrointestinal endoscopy procedure included esophagoscopy, gastroscopy and duodenoscopy. The animals undergoing upper GIT endoscopy were anesthetized and intubated with appropriate size of endotracheal tube and kept animal in a right lateral recumbency. The mouth gag was applied to keep the mouth wide open throughout the procedure. The standard protocol for holding the scope by the left hand and simultaneously regulating the control knobs with the right hand of operator was followed. Then assistant inserted the endoscope tip into mouth of dog and directed it dorsal to the endotracheal tube and larynx so as to pass the cricopharyngeal sphincter (Plate 3.15). The collapsed cervical esophagus was dilated by air insufflation for proper visualization of mucosal lining.

Plate 3.15: Set up and approach for GIT endoscopy		
Handling of endoscope	Insertion of endoscope	Measurement technique

Four basic Principles for performing GIT endoscopy were followed:

1. Air insufflate the cavity for visualization of proper lumen of GIT.
2. Made central tunnel view by manoeuvring of tip.
3. Advancement of scope (after insufflation and centralization, scope was gradually advanced for further examination).
4. Stop advancing when view was lost, pull back and again centralize the scope tip (never advanced the scope when view was lost).

These principles were repeated throughout the procedure for performing efficient GIT endoscopy.

The insertion tube was inserted into the esophagus along with air insufflation to visualize the entire length of the esophagus. The distance of gastroesophageal sphincter (cardiac sphincter), thoracic esophagus (where heart beat appears) and cricopharyngeal sphincter from canine tooth of maxilla were measured and recorded in the dogs with variable body weights (Plate 3.15) (discussed in results and discussion).

After crossing the cardiac sphincter, the distal tip entered into the stomach, the tip was positioned to provide a view of the gastric lumen. Different manoeuvres were performed for examination of every portion of stomach i.e. cardia, fundus, body, pyloric antrum and angulus incisura by changing the recumbency of the animal during the procedure (discussed in results and discussion). After complete examination and recording of gastric mucosa, the tip was passed through pyloric sphincter into the duodenum.

- **Measurements of different landmarks according to body weight for upper gastro-intestinal tract:**

Standardization trials for gastroscopy was performed on dogs having different body weight and different landmark measurements were taken. The croup rump length was also measured in every dog.

A customized Performa for standardization trials:

Table 3.3: Performa for gastroscopy standardization trials

<table>
<tr><td>Patient ID –</td><td>Species-</td><td>Age-</td><td>Sex-</td><td>Body weight</td></tr>
<tr><td colspan="2">CRL-</td><td colspan="3">Position of animal-</td></tr>
<tr><td colspan="2">Different landmarks</td><td colspan="3">Distance from canine tooth (cm)</td></tr>
<tr><td colspan="2">Crico-pharyngeal sphincter</td><td colspan="3"></td></tr>
<tr><td colspan="2">Thoracic esophagus (heart beat appears)</td><td colspan="3"></td></tr>
<tr><td colspan="2">Cardiac sphincter</td><td colspan="3"></td></tr>
<tr><td colspan="5">Abnormal findings (if any) –</td></tr>
</table>

Colonoscopy procedure:

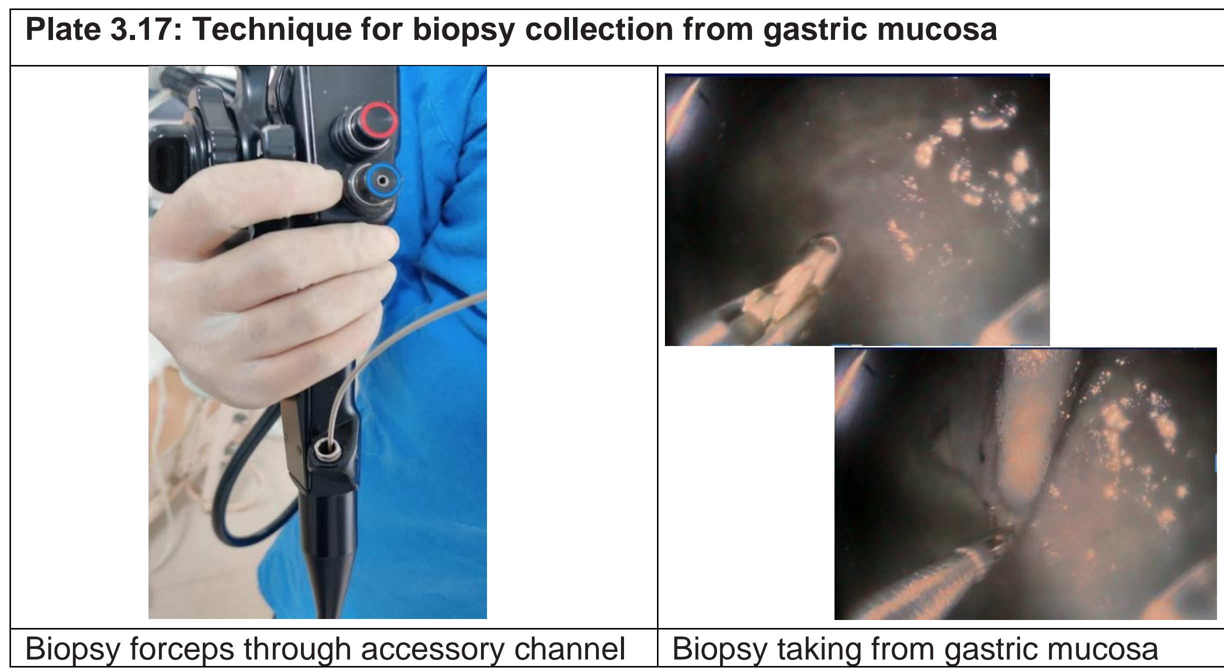
The insertion tube was lubricated with lignocaine jelly (2%). The scope tip was inserted into the rectum and the peri-anal opening around the scope was closed tightly to avoid air leakage during air insufflation (Plate 3.16). The scope was advanced into central tunnel pathway with simultaneous air insufflation to maintain the patency of field view. The three-part philosophy of safe and effective colonoscopy, “centralize, insufflate, and advance,” was repeated as the endoscope is advanced toward the cecum (Tams and Rawlings 2011). After visualization of rectum, various junctions and structures were examined during colonoscopy like sigmoid flexure, descending colon, splenic flexure, transverse colon, hepatic flexure, ascending colon, ileocolic junction and caecum opening were seen.

Plate 3.16: Colonoscopy position and set-up	
Grip around endoscope	Left recumbency for colonoscopy

- **Technique for taking biopsy sample:**

Biopsy was done with help of oval cup flexible biopsy forceps. The forceps were inserted through accessory channel of endoscope (Plate 3.17). Then after selecting the site of interest scope was steadily placed at one field. The jaws of biopsy forceps were opened and desired tissue was grasped and after closing the jaws of forceps were retrieved along with tissue obtained within the jaws of forceps. (Plate 3.17). Afterwards forceps were pulled and biopsied tissue was put into formalin containing sample vial.

Plate 3.17: Technique for biopsy collection from gastric mucosa



Biopsy forceps through accessory channel	Biopsy taking from gastric mucosa

3.2.2: Clinical application of Gastro-intestinal tract endoscopy:

The standardized technique was applied on 23 clinical cases.

3.2.2.1: History and signalment:

History regarding anorexia, vomiting (frequency and duration), diarrhoea (frequency, colour, consistency) weight loss, feeding habit, general status, deworming and vaccination status and any previous medication were recorded at day of presentation. Signalment includes information about breed, general body condition of the animal, body weight, age, sex and duration of illness in animal.

3.2.1.2: Basic Clinical examination: same as supra (section 3.1.2.2)

3.2.1.3: Specific clinical examination:

The symptoms related to gastro-intestinal tract affections such as hypersalivation, nausea, head raise, frequent retching and gagging, oral examination, vomiting, melena, stance of animal, body condition score, diarrhea and haematochezia were recorded on the presentation of the case. Abdomen palpation was done for any evidence of turgid, enlarged, bloat, presence of foreign body and presence of any mass

occupying lesion. Anal and Rectal examination could also be done for detecting any mass, fistula and perianal disorder.

3.2.1.4: Endoscopy severity scores for Gastric ulceration and erosions:

Endoscopic severity scores (ESS) was utilized for scoring the severity level of GU&E on gastric mucosa. The stomach mucosa free from any visible lesion was scored as 0, and score 1 was given to stomach with few submucosal petechia with no visible abnormality. The gastric mucosa with extensive areas of erosions or a single bleeding ulcer was scored as 2. A dog with multiple bleeding ulcers was scored as 3.

3.2.1.5: Customized Performa for evaluation of clinical cases for GIT endoscopy:

Performa for gastroscopy and colonoscopy was made for proper documentation of clinical cases. This Performa mainly based on type of lesions, their severity and location of lesion.

Table 3.4: Performa for upper and lower gastrointestinal tract endoscopy

Esophagus ☐ Stomach ☐ Duodenum ☐ Colon ☐

Lesions/ Parameters	Code	Observation and location
Hyperaemia/ Vascularity		
Hemorrhage		
Erosion/ Ulcer		
Inflammation		
Presence of contents		
Others		
Comments and interpretation:		

(ESS) Code: Normal = 0 Mild = 1 Moderate = 2 Severe = 3

Anesthesia:

Recumbency of animal:

Forceps/retrieval device(s) used (if any):

Sampling:

Biopsy☐ Brush cytology ☐ Foreign body retrieved ☐ None ☐

Problems/Complications:

None ☐ Perforation ☐ Excessive bleeding ☐ Anaesthetic complications ☐

Excessive time ☐ Other ☐

☐ Unable to complete full examination:

☐ Unable to obtain adequate biopsies:

☐ Unable to retrieve foreign object:

☐ Visualization obscured:

3.2.1.6: Additional data recording:

- **Haemato-biochemistry:**

  Same as discussed in video-otoscopy section (3.1.2.4)

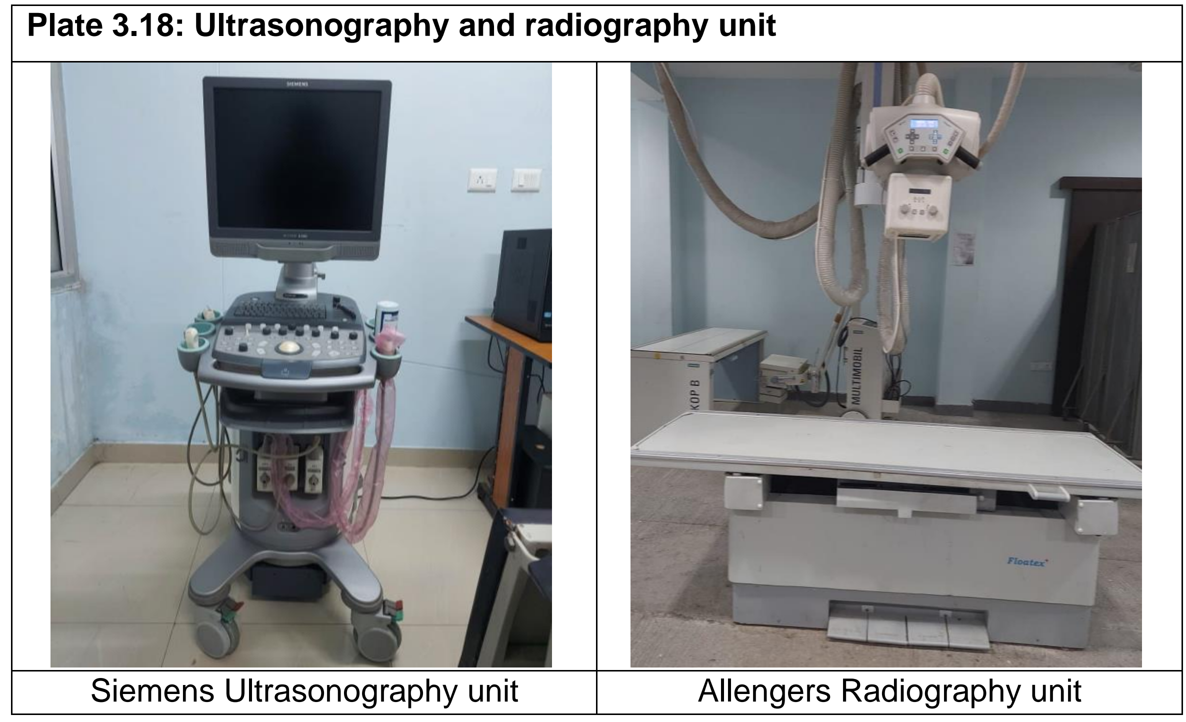
- **Radiographic examination:**

Survey radiographic examination on the day of presentation for identification of any abnormality was done wherever needed. Standard orthogonal lateral and ventro-dorsal abdomen projections were taken. Contrast radiography was done with barium sulphate as per the need of the case. Simple chest radiographs and contrast radiography with barium swallows were taken for evaluation of various affections of esophagus. The results were then correlate with the findings of endoscopy and radiography.

- **Ultrasonographic examination:**

Ultrasonographic examination was performed with Siemens ACUSON X300 premium edition ultrasound machine, with a 5-10 MHz linear and 3-7 MHz convex transducers as per the need of the case (Plate 3.18).

Plate 3.18: Ultrasonography and radiography unit



Siemens Ultrasonography unit	Allengers Radiography unit

3.3: Upper respiratory tract including trachea:

3.3.1: Standardization protocol for performing upper respiratory tract endoscopy and tracheoscopy:

Standardization trials were done in four dogs suspected for mild respiratory disease without history of epistaxis or respiratory distress. The upper respiratory tract and trachea were examined for understanding normal mucosal and anatomical detail.

3.3.1.1: Instrumentation for upper respiratory tract and tracheoscopy:

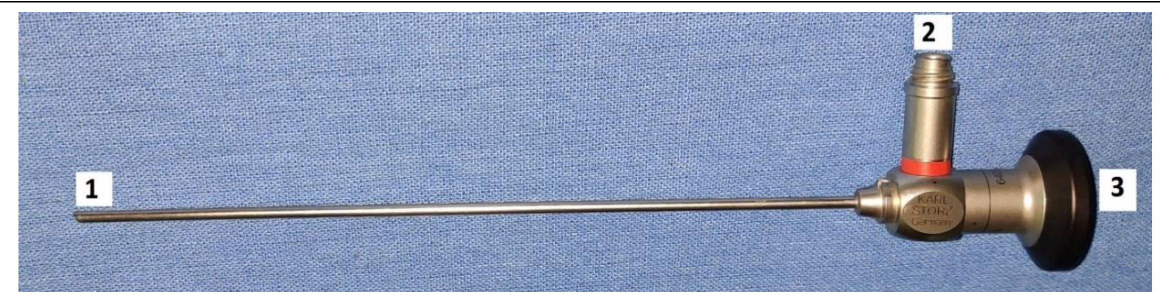
I. Rigid and flexible endoscopes:

Rigid 2.7 mm multi-purpose endoscope was utilized for upper respiratory tract and 9.7 mm flexible video-endoscope was used for tracheal endoscopy.

Rigid endoscope: The nasal meatus, conchae (turbinate), and nasopharynx were visualized using a 2.7 mm multipurpose rigid endoscope with working length of 18 cm (Plate 3.19). It had a 30-degree angled forward tip. The body of scope was protected by a protective sleeve having a diameter of 3.5 mm (Plate 3.19). The laryngoscopy was performed with 5 mm rigid endoscope with working length of 30 cm. It also had a 30-

degree angled tip (Plate 3.19). The video-otoscope (section 3.1.1) was also utilized for performing rhinoscopies in some dogs.

Plate 3.19: Instrumentation for rhinoscopy



2.7 mm multi-purpose Rigid endoscope
1. 30 degree angled distal tip 2. Light guide post (for attachment of fiber optic light cable) 3. Eyepiece (for attachment of single chip endoscope camera)

3.5 mm protective sleeve for 2.7 mm rigid endoscope
1.Angled distal tip 2. Attachment for suction and irrigation 3. Regulating lever for suction and irrigation 4. Lock of sleeve

Rigid endoscope with 5 mm diameter and 30-degree distal tip angle

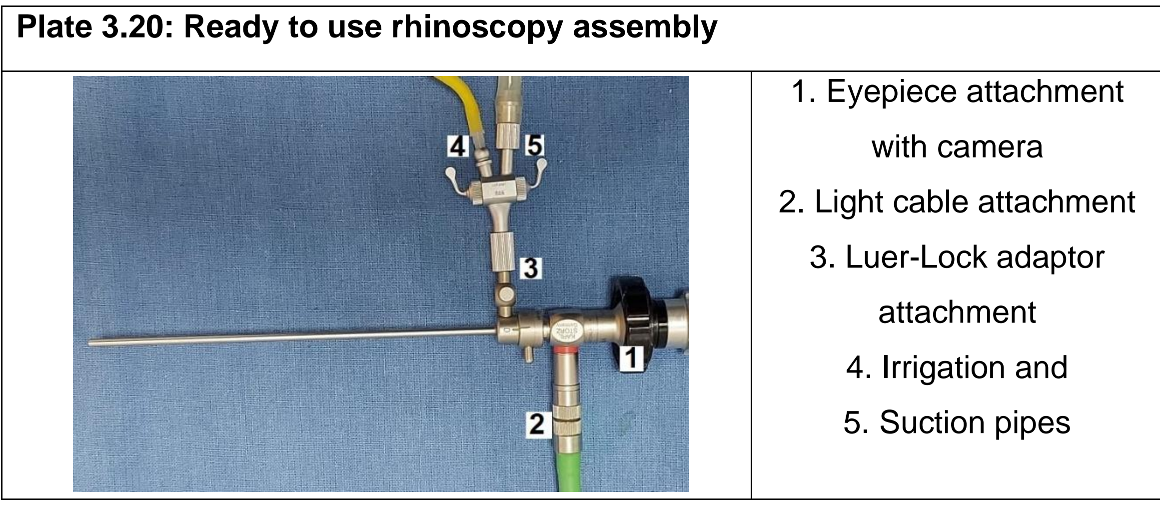
- **Flexible endoscope:** The flexible video-endoscope with diameter of 9.7 mm and length of 140 cm was utilized for visualization of trachea and larynx (discussed in section 3.2.1.1, shown in Plate 3.10).

    I. **Supporting Instruments for image processing and visualization:** same as discussed above in video-otoscopy section (3.1.1).

    II. **Instrument accessories:** same as discussed in video-otoscopy (section 3.1.1.1 and shown in Plate 3.3).

    III. **Rhinoscopy assembly:** The C-mount camera head was fixed on the eyepiece of telescope and light transmitting cable was attached to the light guide post of otoscope, the other end of the both camera and light cable were attached to their respective ports on the tele pack X monitor. Further the Luer-lock adaptor was connected to working channel port of protective sleeve, which provided attachment for irrigation and suction pipes through their respective valves (Plate 3.20).

    IV. **Sterilization of instruments:** same as discussed above in video-otoscopy (section 3.1.1.2).

<table>
<tr><th colspan="2">Plate 3.20: Ready to use rhinoscopy assembly</th></tr>
<tr><td>
</td><td>1. Eyepiece attachment with camera
2. Light cable attachment
3. Luer-Lock adaptor attachment
4. Irrigation and
5. Suction pipes</td></tr>
</table>

3.3.1.2: Patient Preparation: Same as discussed in video-otoscopy (section 3.1.1.2).

3.3.1.3: Anaesthesia:

The similar general anaesthesia protocol was followed as discussed in video-otoscopy section, but endo-tracheal tube was removed for intubation of flexible

endoscope into trachea during tracheoscopy. Prior to general anaesthesia animals were oxygenated to prevent hypoxemia at the time of endoscopy (laryngoscopy and tracheoscopy). Whereas for rhinoscopy, snuggly fit cuffed endo-tracheal tube was utilized for preventing aspiration of fluids used for irrigation.

3.3.1.3: Position and recumbency:

Rhinoscopy was done in either lateral or sternal recumbency along with Trendelenburg position of table. The positioning aid was placed under the neck of dog for easier passage of scope (Plate 3.21). It could be done in lateral recumbency in unilateral cases with affected nostril on lower side.

Laryngoscopy was done in either sternal or lateral recumbency and tracheoscopy in lateral recumbency.

Plate 3.21: Position for rhinoscopy procedure in dog

Dorso-ventral position with positioning aid under the neck and Trendelenburg position of table

3.3.1.4: Technique of upper respiratory tract endoscopy and tracheoscopy:

The upper respiratory tract endoscopy was performed for visualization of nasal cavity, nasal sinuses, nasopharynx, oropharynx and larynx.

Rhinoscopy: Rhinoscopy was done in anterograde fashion from external nares to posterior internal nares. Once the desired position was achieved the operator sits in front of the head of a dog and hold the scope assembly with the dominant hand and

raise the tip of the nasal planum with thumb of non-dominant hand for easier passage of scope into nares. Initially, rhinoscope was oriented ventro-medially into the nasal cavity to avoid unnecessary obstruction of scope into the alar fold. After entry into the nasal cavity, the three different passes were performed in rhinoscopy for proper visualization and examination of different structures of nasal cavity such as nasal meatuses, nasal conchae and nasopharynx. The complete rhinoscopy procedure included the examination of nasal cavity in three passes (discussed later in results and discussion section).

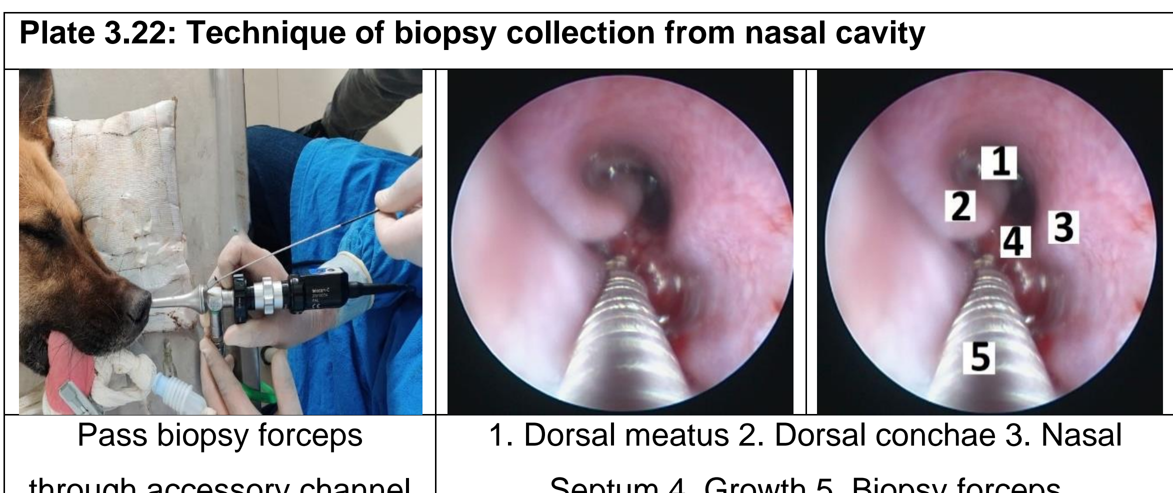
Laryngoscopy: Laryngoscopy was performed in either lateral or sternal recumbency with flexible video-endoscope or with 5 mm rigid endoscope (Plate 3.19). The endotracheal tube was removed, then the scope was inserted into mouth and pass dorsally to epiglottis for visualization of various structures of larynx. The laryngoscopy was usually performed by oral approach, but in one dog it was also performed by trans nasal approach.

Tracheoscopy: Tracheoscopy was performed with flexible endoscope in lateral recumbency. The scope tip was introduced into tracheal lumen via laryngeal opening after removal of the endo-tracheal tube. Gradual advancement of scope up to carina (where the trachea divided into left and right primary bronchus) was done. The trachea was first evaluated for colour, vascularity, rigidity, size, position and movement of the dorsal tracheal membrane. The whole procedure was done in a quick manner to avoid hypoxemia and awakening of animal.

3.3.1.5: Technique for taking biopsy:

Biopsy collection was done by two methods in rhinoscopy. In rhinoscopy, there were two ways for taking tissue sample. Either the biopsy forceps were inserted sideways to the multipurpose 2.7 mm telescope or video-otoscope was utilized for taking biopsies through its accessory channel (Plate 3.22). The technique for taking tissue sample was same as discussed in video-otoscopy section (3.1.1.5). The biopsy sample from larynx and trachea did not taken during the study.

Plate 3.22: Technique of biopsy collection from nasal cavity



Pass biopsy forceps through accessory channel	1. Dorsal meatus 2. Dorsal conchae 3. Nasal Septum 4. Growth 5. Biopsy forceps

3.3.3: Clinical application phase for upper respiratory tract and tracheoscopy:

The standardized technique was applied on 20 clinical cases. Out of which 12 dogs were presented for rhinoscopy, 2 for pharyngoscopy and 3 cases of laryngoscopy and tracheoscopy each.

3.3.3.1: History and Signalment:

History of epistaxis (unilateral or bilateral), sneezing, snoring, reverse sneezing, stridor, exercise intolerance, respiratory distress and change in voice were considered for upper respiratory tract on the day of presentation. Whereas acute and chronic cough along with abnormal breathing pattern were considered for trachea affections on the day of presentation. General history and signalment were same as discussed in video-otoscopy section (3.1.2.1).

3.3.3.2: Basic clinical examination: Same as discussed above in video-otoscopy section**.**

3.3.3.3: Performa for upper respiratory tract and trachea endoscopy:

During upper respiratory tract and trachea endoscopy, different parameters were recorded for the evaluation and interpretation of different clinical conditions in dogs.

- A customized Performa for rhinoscopy (Table 3.5):

Table 3.5: Performa for rhinoscopy examination			
S no.	Parameters	Right nasal cavity	Left nasal cavity
1	Haemorrhage		
2	Hyperaemia		
3	Ulcer/erosion		
4	Inflammatory changes		
5	Growth/ mass		
6	Exudate		
7	Hypertrophy of turbinate's		
8	Nasopharynx		

- A customized Performa for laryngoscopy (Table 3.6):

Table 3.6: Performa for larynx examination			
S no.	Parameters	Right side	Left side
1	Movement of vocal folds		
2	Hyperaemia and vascularity		
3	Edema		
4	Status of laryngeal saccules		

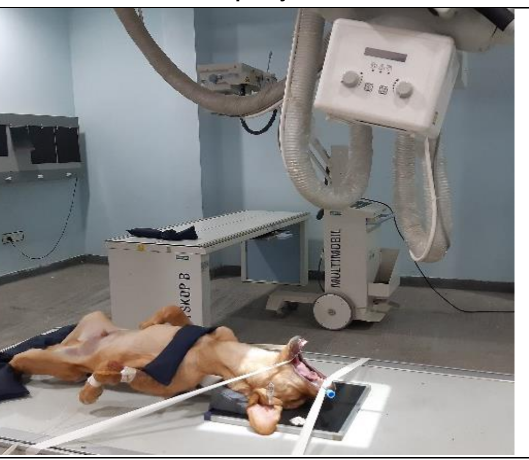
- A customized Performa for tracheoscopy (Table 3.7):

Table 3.7: Performa for tracheal examination		
S no.	Parameters	
1	Colour	
2	Vascularity	
3	Rigidity	
4	Tracheal stenosis	

3.3.3.4: Additional data recordings:

- **Haemato-Biochemistry:** Same as discussed in video-otoscopy section (3.1.2.4)**.**
- **Radiography:**

Specific radiographs for nasal cavity, nasal sinuses, larynx and trachea were taken as per the need of the case under GA with different positioning aids. Open mouth ventro-dorsal and lateral projections were taken for nasal meatus and conchae whereas rostro-caudal or caudo-rostral projections were taken for frontal sinus (Plate 3.23). For larynx and trachea, ventro-dorsal and lateral projections of neck and chest were taken as per the need of the case.

<table>
<tr><th colspan="2">Plate 3.23: Radiographic positioning for nasal affections</th></tr>
<tr><td> </td><td>
</td></tr>
<tr><td>Lateral projection</td><td>Caudo-rostral projection</td></tr>
<tr><td>
</td><td> </td></tr>
<tr><td colspan="2">Open mouth ventro-dorsal projection</td></tr>
</table>

- **Cytological sampling:**

It was done for nasal diseases by either**:**

I. Direct swab method (without endoscope assistance)
II. Endoscope guided otex cyto-brush (with endoscope assistance):

The video-otoscope was utilized for taking endoscope guided cytology sample from nasal cavity. After the identification of the lesion within the nasal cavity, the otex ctyo-brush was passed through accessory channel of video-otoscope. Then under the endoscope guidance, cyto-brush was rolled in anti-clockwise direction over the desired tissue. Afterwards, cyto-brush along with scope was pulled out from nasal cavity and the sample material was evenly distribute on the clear glass slide.

3.4: Urethroscopy and Cystoscopy:

3.4.1: Standardization protocol for performing Urethroscopy and Cystoscopy:

Standardization trials were done on 2 male and 3 female dogs who were suspected for lower urinary tract affections.

3.4.1.1: Instrumentation:

Rigid 2.7 mm multipurpose scope along with protective sleeve was utilized for urethro-cystoscopy (discussed in rhinoscopy section 3.3.1.1).

Note: the other instruments for image processing, instrument accessories were same as discussed in video-otoscopy section (3.1.1). The ready to use rigid endoscope assembly was same as discussed in rhinoscopy section (3.3.1.1).

3.4.1.2: Patient Preparation:

The routine general examination of dogs was done to ensure their compatibility for anaesthesia or sedation. The dogs were kept off fed for 12 hours and off water for 6 hours prior to procedure. The dogs in which urinary bladder was severely distended, transcutaneous cystocentesis was performed prior to urethro-cystoscopy. The Injection hyoscine bromide @ 0.1-0.3 mg/ kg body wt. was given prior to procedure.

3.4.1.3: Anaesthesia:

In female dogs either general anaesthesia or sedation was utilized for performing urethro-cystoscopy. In male dogs, urethroscopy was performed without GA.

3.4.1.4: Position and recumbency:

Male dogs were kept in lateral recumbency for performing urethroscopy, whereas female dogs were kept in either lateral or ventro-dorsal recumbency for performing urethroscopy and cystoscopy.

3.4.1.5: Technique of performing urethroscopy and cystoscopy:

- In male dogs, initially lignocaine (2%) jelly was applied on the scope. The penis was exteriorized and scope tip was inserted into urethral orifice. Then scope along with sleeve was gently advanced within urethra along with intermittent bouts of air insufflation to avoid collapsing of urethra mucosa. Examination of urethra was performed up to caudal point of OS penis.
- In female dogs, the two types of techniques were utilized for performing urethro-cystoscopy:

First technique was performed with the help of irrigation of fluids for distension of urogenital tract for intubation of scope into it. The vulvar lips were tightly griped around the body of telescope for making an optical space within urogenital tract and avoided spillage of irrigated fluids. The scope was passed into the urethral orifice for visualization and examination of urethra and urinary bladder mucosa.

The second technique was performed with help of intermittent bouts of air insufflation and using the infant feeding tube as guide for easier intubation of scope into urethra and urinary bladder. A 6-Fr infant feeding tube was initially inserted into the urethra to serve as a guide. To avoid the scope tip becoming trapped in the false diverticulum, the vulvar lips were separated and lignocaine jelly coated scope was passed in a dorsal orientation. After reaching urethral opening, the baby feeding tube was visualized. The scope was also passed through the same orifice. When the scope was introduced into the urethra, the scope tip was gently advanced while simultaneous

pulling of infant feeding tube. Eventually, the baby feeding tube was extracted completely from urethral orifice. The mucosa of the urethra was thoroughly examined. Then the scope was inserted into the urinary bladder and mucosal lining was examined. Final examination of mucosa was done after suction out the urine from urinary bladder in both the techniques.

3.4.2: Clinical application of urethroscopy and cystoscopy:

The standardized technique was applied in 5 clinical cases.

3.4.2.1: History and Signalment:

History regarding urine dribbling, urinary obstruction, stranguria and haematuria was recorded on the day of presentation. The general history and signalment was same as discussed in the video-otoscopy section (3.1.2.1).

3.4.2.2: Basic clinical examination: same as discussed in video-otoscopy section (3.1.2.2).

3.4.2.5: Specific clinical examination:

Posture while urination and pattern of urination were examined. Then exteriorize the penis in male dog, it was examined to rule conditions such as transmissible venereal tumour (TVT), neoplasia and penile laceration etc. In female dogs, vulvar region was also examined to rule out the conditions such as TVT, neoplasia, vaginal fibroids and vaginal laceration etc. Caudal abdomen palpation was done for examination the extent of urinary bladder distension.

3.4.2.6: Customized Performa for recording of urethroscopy and cystoscopy findings:

During urethro-cystoscopy, different parameters were recorded for the evaluation and interpretation of different clinical conditions in dogs. The different Performa’s were designed for documentation of various clinical cases related to urethra and urinary bladder.

- A customized Performa for urethroscopy and cystoscopy Table 3.8.

Table 3.8: Performa for urethroscopy and cystoscopy

S no.	Parameters	Findings
1	Hyperaemia	
2	Haemorrhage	
3	Inflammatory changes	
4	Calculi and sludge	
5	Others	

3.4.2.7: Additional data recordings:

These tests aided for making the diagnosis and were performed as per the need of the case.

- **Haemato-biochemistry:**

Same as discussed above in video-otoscopy section (3.1.2.4).

- **Urine analysis:**

Urinalysis was performed in every case related to lower urinary tract. The various assay's such as urine pH, specific gravity, glucose, protein, WBC and RBC were evaluated.

- **Cytology and isolation:**

The urine sample was collected by transcutaneous cystocentesis for cytology and isolation.

- **Radiographic examination:**

The standardized orthogonal lateral and ventro-dorsal projections of caudal abdomen were taken as per the need of the case. The hindlimbs were pulled caudally during positioning for radiography of lower urinary tract.

- **Ultrasonography:**

Abdomen ultrasonography was performed as per the need of the case.

CHAPTER 4

Results and discussion

The results are being discussed in following parts:

4.1. Video-otoscopy

4.2. Gastro-intestinal tract endoscopy

4.3. Upper respiratory tract including trachea endoscopy

4.4. Urethroscopy and cystoscopy

4.1: Video-otoscopy

4.1.1: Standardization of video-otoscopy procedure in small animals:

4.1.1.1: Restraining of dog:

In the beginning, video-otoscopy was done under sedation only by BAA *i.e.* (Inj. Butorphanol @ 0.2-0.4 mg/ kg, Inj. Atropine @ 0.02-0.04 mg/kg and Inj. Acepromazine @ 0.02-0.04 mg/kg body wt.). The procedure under sedation was carried out in three dogs (3/35). However, the dogs used to jerk their heads and did not cooperate with the procedure, especially during irrigation and suction. So, further video-otoscopies were done under general anaesthesia (28/35). Griffin (2006) also observed that video-otoscopy was not adequately done under sedation.

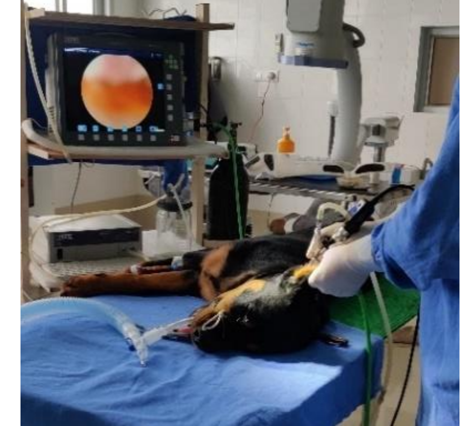
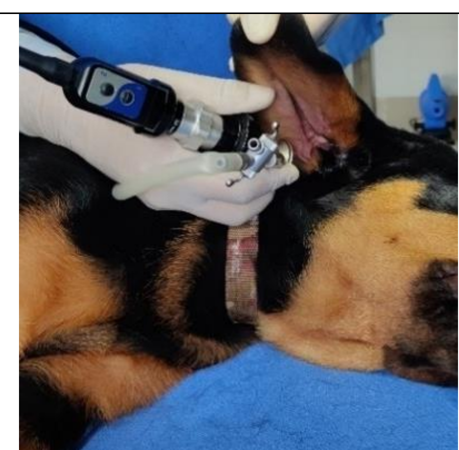
Out of twenty-eight video-otoscopies (28/35) done under general anaesthesia, fifteen dogs (15/28) moved their heads in the light plane of anaesthesia during deep ear canal examination. However, this did not happen in the surgical plane of anaesthesia. As per Gupta (2017), general anaesthesia was likewise the preferred approach for video-otoscopy.

The four video-otoscopic procedures (4/35) were performed without any chemical substance (drug free group) in dogs with good temperament. These animals allowed examination of vertical ear canal but posed a difficulty while examination of the horizontal ear canal and tympanic membrane, further deep ear cleaning with video-otoscope was not possible in these dogs.

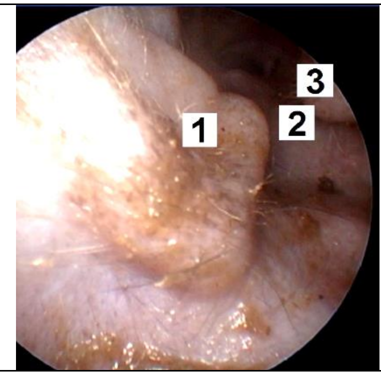
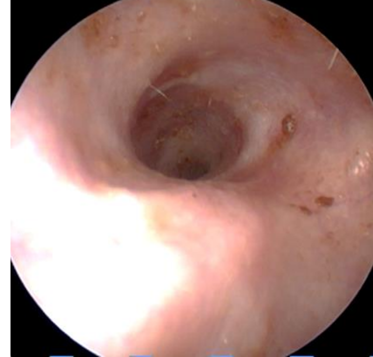
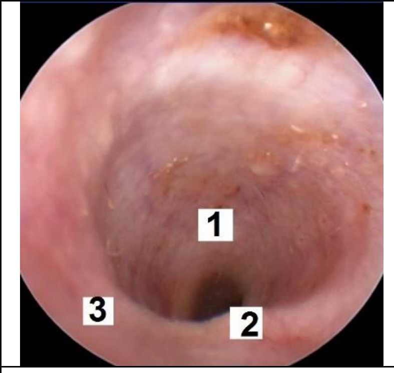
So, it can be safely said that the surgical plane of general anaesthesia was the optimum option for video-otoscopy for deep ear canal examination which is almost invariably needed for complete and thorough examination of ear canal.

4.1.1.2: Technique of Video-otoscopy:

After general anaesthesia, dogs were kept in lateral recumbency with the ear to be examined upside. The otoscopy procedure was performed while standing behind the convex surface of ear pinna had made the pulling of ear pinna dorso-laterally (Plate 4.1) easy and insertion of scope into inter-tragic notch in better manner in this orientation. The ear pinna was pulled ventro-laterally (Plate 4.1) at the time of insertion of scope into horizontal ear canal (HEC) after the complete examination of vertical ear canal (VEC).

Plate 4.1: Pulling of ear pinna for visualization of VEC and HEC	
	
Dorso-lateral pulling of ear pinna for insertion and VEC visualization	Ventro-lateral pulling of ear pinna during HEC visualization

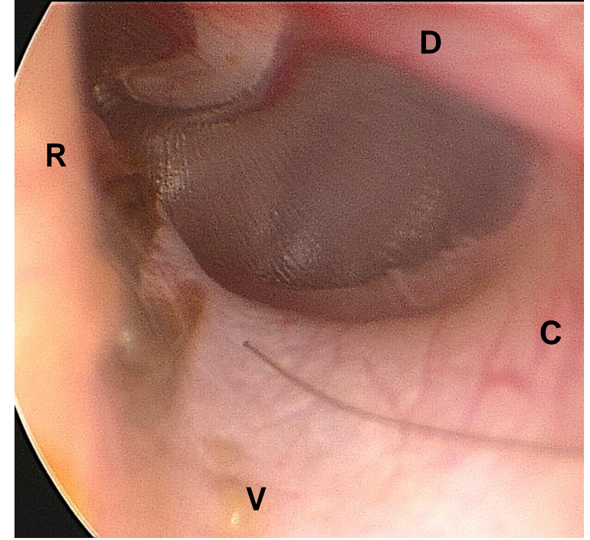
Initially changes in pinna like hypertrophy of tragic, swelling of pinna, acantholysis etc. were carefully observed. Afterwards scope was introduced into vertical ear canal with central tunnel view (Plate 4.2). In VEC, mucosal layer was visualized for any alteration such as inflammation, follicular hyperplasia, stenosis, erosions, foreign body or proliferative ear canal etc. The mucosa of the external ear canal was normally smooth, pale in colour with a little amount of wax (Plate 4.2). After crossing the cartilaginous ridge i.e. present between vertical ear canal and horizontal ear canal (Plate 4.2).

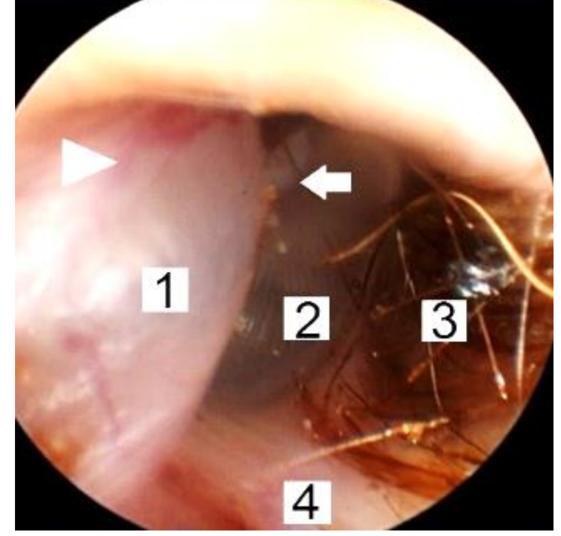
<table>
<tr><th colspan="3">Plate 4.2: Visualization of ear canal at different levels during video-otoscopy</th></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>1.Tragus 2. Inter-tragic notch 3. Medial process of anti-tragus</td><td>Vertical ear canal</td><td>1. Horizontal ear canal
2. Cartilaginous ridge
3. Vertical ear canal</td></tr>
</table>

The ear pinna was pulled ventro-laterally and gradual advancement of scope tip was done for proper visualization of horizontal ear canal (HEC). Hair shafts was occasionally be found in the horizontal ear canal also reported by Harvey et al (2001).

The scope was finally placed in external tympanic concavity for visualization of tympanic membrane (also known as Ear drum). At this stage, the ear pinna was pulled ventro-laterally with non-dominant hand and the scope assembly was slightly rotated clockwise with dominant hands. The normal ear drum presented two distinct sections the Pars flaccida and Pars tensa. The pars flaccida was a loose, opaque, pink triangular area of the eardrum that contained small branching blood vessels (vascular strip) (Plate 4.3). Whereas the pars tensa was a semi-transparent, tough sheet-like structure with the malleus bone's manubrium visible beneath it (Plate 4.3). The same visualization of tympanic membrane was also reported by Tams and Rawlings (2011). The C shaped malleus' bone manubrium that was visible beneath the pars tensa differentiate the tympanic cavity from the tympanic bulla and its end was pointing toward the rostral side of head (Griffin 2006). The tympanum was 30 to 45 degrees angle in relation to central axis of horizontal ear canal. When the ventral portion of the tympanic membrane met the ventral floor of the horizontal canal forms a groove. This area had numerous hairs along with small accumulation of wax in normal dogs (Plate 4.3), it was also observed by Griffin (2006).

Plate 4.3: Structures of Tympanic membrane (Ear drum)





1. Pars flaccida 2. Pars tensa 3. Hair and wax present in horizontal canal 4. External tympanic concavity, Arrow head- Vascular Strip, Arrow- Malleus bone manubrium, D-dorsal, R-rostral, C-caudal, V-ventral

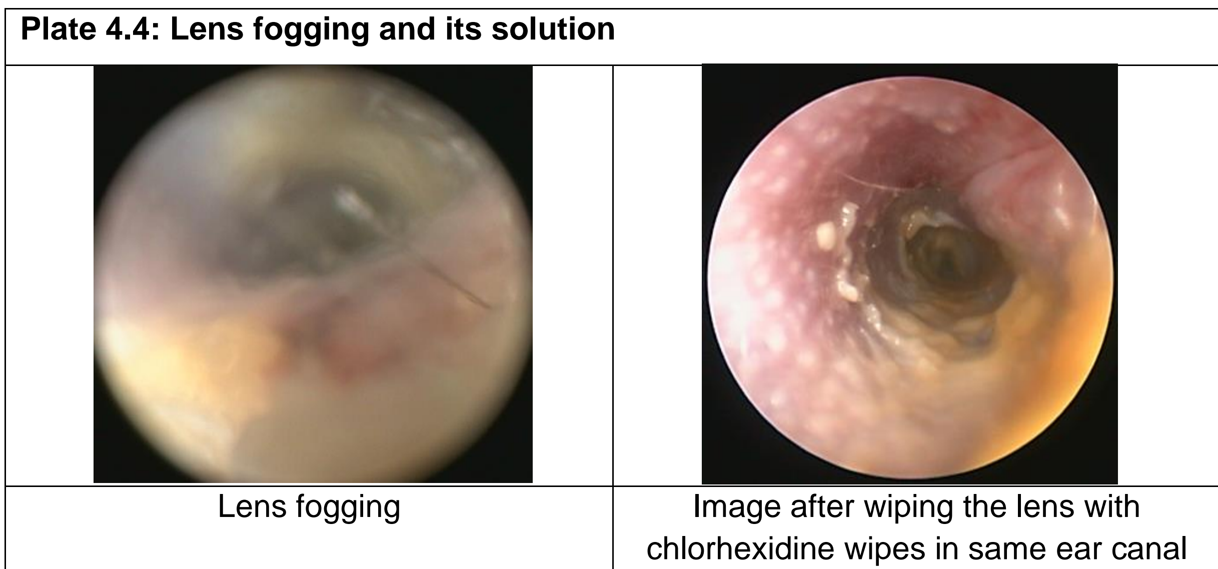
Any alteration from this normal visualization of tympanum was keenly observed and any abnormalities such as bulging, opaqueness of ear drum or any perforation of tympanic membrane was recorded. Both the mucosal surface of the external auditory canal and the lateral surface of the tympanic membrane were composed of a stratified squamous, keratinizing epithelium (Tabacca 2011)

Karl Storz video-otoscope also had Luer-Lock adaptor that facilitated alternate irrigation and suction for removal of debris and excessive cerumen from the ear canal. It was proved to be very beneficial for better visualization of mucosal lining. It also avoided hindrance in field of view created by cerumen. Sometimes, wax adheres to the proximal lens of endoscope so, the scope was pulled back out of ear canal and cleaned with sterile gauze piece. This process needs to be repeated number of times while performing video-otoscopy.

The normal total length of the ear canal of an adult dog of different breeds varied from 5cm to 10cm and the otoscope total length up to the eyepiece was 8.5cm, so the complete examination of ear canals in some large sized breeds with long ear canals such as golden retriever was not possible with the video-otoscope. In golden retriever adult dogs, the total length of scope was inserted into the ear canal but the distal tip

was reached up to the level of cartilaginous ridge of ear canal. So, in these kinds of dogs, if deep ear examination was required, then it was done with 2.7mm the multi-purpose telescope (instrument discussed later in rhinoscopy section). Lens fogging was a frustrating problem encountered frequently while performing video-otoscopy (Plate 4.4). It caused blurring of image during the procedure. This problem was mainly due to temperature differential between a cold video-otoscope and a warm ear (McCarthy 2005). To circumvent this problem, the proximal tip was dipped in warm normal saline solution for 15 minutes prior to procedure. This helped in decreasing the temperature differential between scope and the ear canal. The intermittent wiping of distal tip lens with chlorhexidine solution (Plate 4.4) during otoscopy procedure had also decreased this problem, but again it had to be repeated.

Plate 4.4: Lens fogging and its solution



Lens fogging	Image after wiping the lens with chlorhexidine wipes in same ear canal

4.1.2: Clinical application:

A total of 30 dogs were presented for otoscopy, out of which 6 dogs underwent unilateral otoscopy and in remaining 24 cases it was performed in both the ears. The video-otoscopy was done in 54 ears in total. Males were over presented with distribution of (80%) 24/30 in comparison to female dogs with (20%) 6/30 cases.

The Labrador retriever was the most commonly encountered breed in this study, with a total of 10 cases and 17 ear canals, followed by German Shepherd and mongrel dogs, each with 5 cases and 9 ear canals.

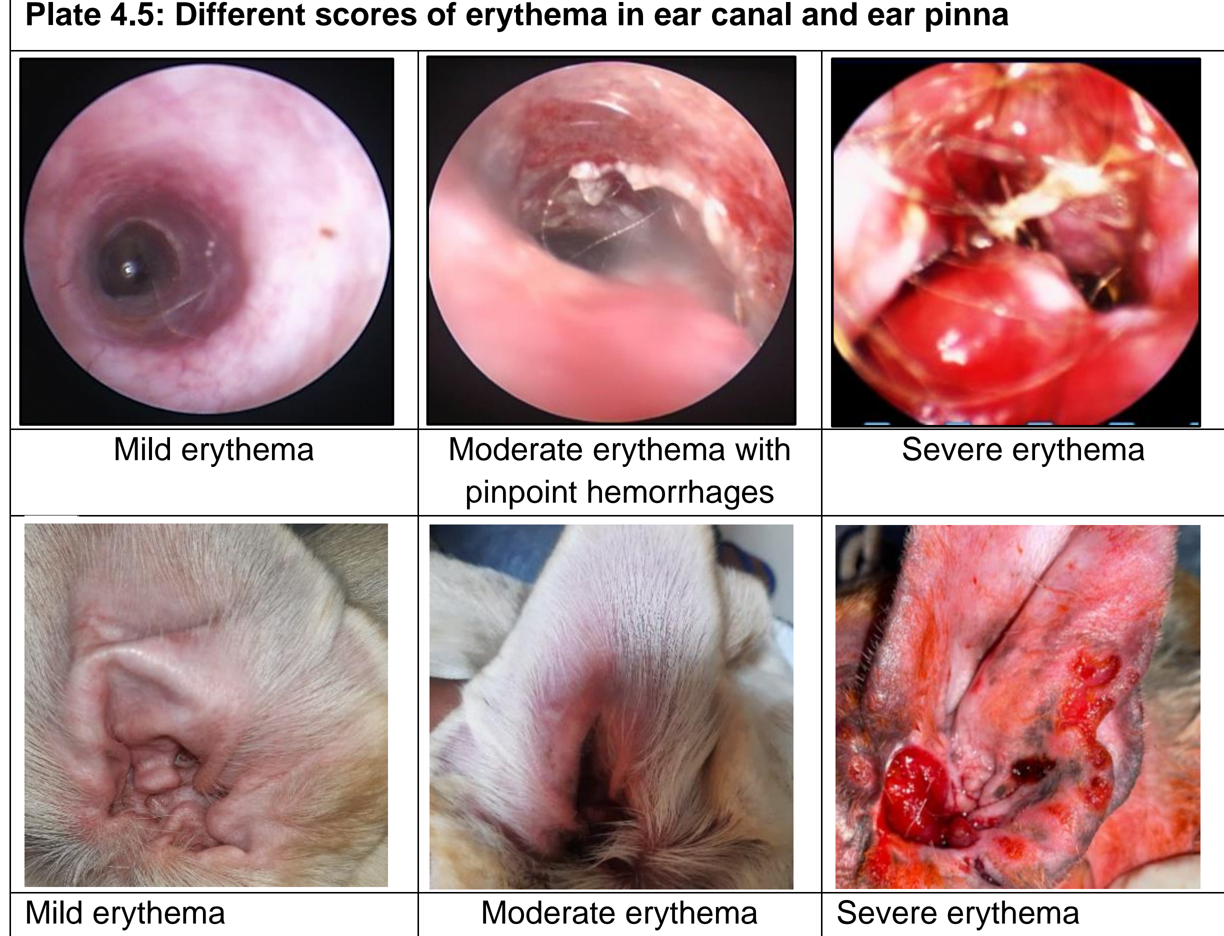
4.1.2.1: Video-otoscopy finding:

- **Erythema**

Erythema was observed in 47 ear canals out of total 54 canals examined (47/54). Erythema scoring was done from 0 to 3 as per the OTIS3 scoring system of otitis externa (Plate 4.5). Mild erythema (score1) was present in twelve ear canals (12/47). The moderate erythema (score 2) was found in twenty ear canals (20/47) and fifteen ear canals (15/47) had severe erythema (score 3) (Plate 4.5).

As per location, the erythema was present in 47 vertical ear canals and in 25 horizontal ear canals. The erythema was also present in ear pinna of twelve (12/47) dogs. The three dogs had mild erythema (Plate 4.5), five had moderate (Plate 4.5) and remaining 4 had severe erythema (Plate 4.5) at ear pinna.

Plate 4.5: Different scores of erythema in ear canal and ear pinna



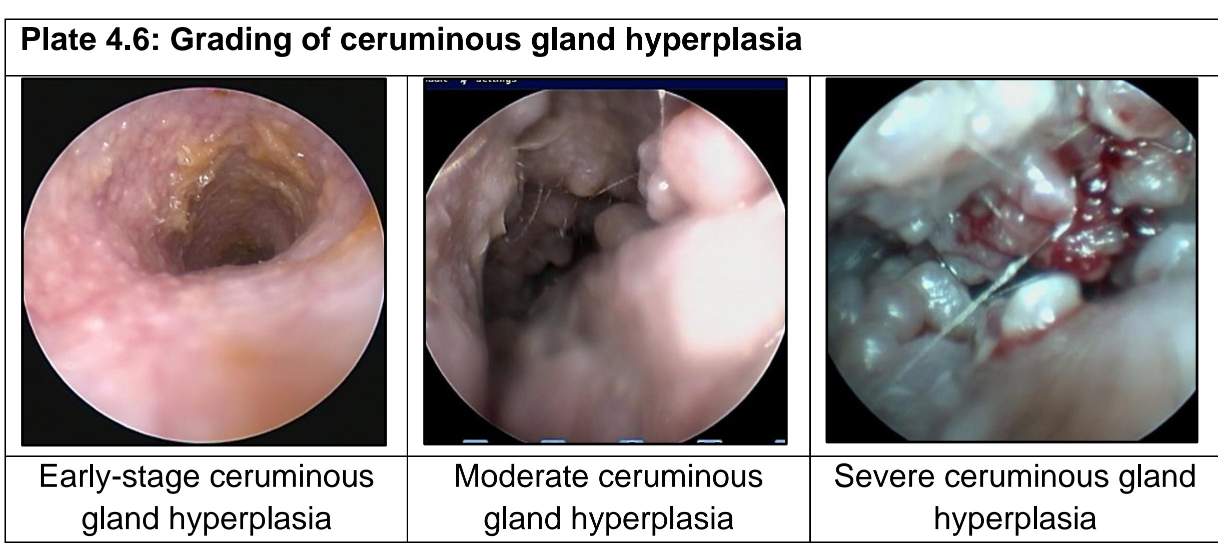
Mild erythema	Moderate erythema with pinpoint hemorrhages	Severe erythema
Mild erythema	Moderate erythema	Severe erythema

Erythema is redness of the skin or mucous membranes caused by hyperaemia (increased blood flow in superficial capillaries). This phase is known as erythematous phase and was mostly due to primary causes which directly irritate the mucosal lining of ear canal like parasites, foreign body, hypothyroidism and autoimmune diseases (Rosser 2004). The mild presence of erythema in ear canal indicated early changes in otitis externa (erythematous phase) (Ettinger et al 2017).

- **Ceruminous gland hyperplasia:**

Out of 54 ears examined, the ceruminous gland hyperplasia (CGH) was evident in 15 ear canals. The early-stage ceruminous gland hyperplasia (score 1) was found in seven ear canals (7/15) and appeared like white polka dots on video-otoscopy examination (Plate 4.6), aural hematoma was also present in one ear out of these seven-ear canal having mild CGH (Plate 4.6). Moderate ceruminous gland hyperplasia (score 2) was found in five ear canals (5/15) having cobblestone appearance (Plate 4.6) and the severe CGH was found in three cases (3/15) there were cystic dilatation filled with bluish colour secretions (Plate 4.6). In present study, one dog out of three dogs (1/3) having CGH score 3 also had otitis externa induced ear hematoma due to frequent ear scratching by dog.

Plate 4.6: Grading of ceruminous gland hyperplasia



Early-stage ceruminous gland hyperplasia	Moderate ceruminous gland hyperplasia	Severe ceruminous gland hyperplasia

The epithelium of the external auditory meatus is composed of stratum corneum (Miller 2016). The outermost glands are the sebaceous glands especially abundant in

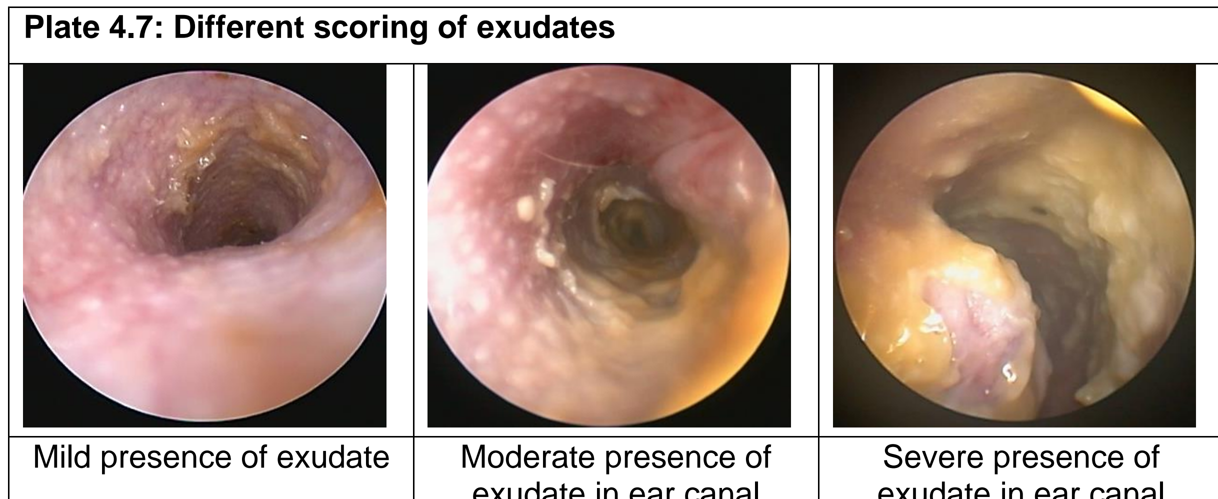
deeper parts of the auditory meatus that secretes sebum. The ceruminous glands lie beneath the sebaceous glands, with ducts that exit directly into hair follicles or onto the surface of the ear canal help in production of cerumen. The secretions of these simple, coiled, tubular apocrine glands provide a protective coating over the mucosa of the ear canal, functioning as bactericidal and bacteriostatic agents as well as preventing the mucosa from drying up (Cragg 2008).

Ear wax is composed of cerumen, sebum and epidermal debris under normal physiological condition. The sebaceous glands became hyperactive and hyperplastic during inflammatory reactions, whereas ceruminous glands became dilated thickened and loaded with secretions. Chronic irritation of ceruminous and sebaceous glands leads to hyperplasia and increased activity of the overlying sebaceous glands and cystic dilation of ceruminous glands. The mild ceruminous gland hyperplasia was characterized by polka dots which indicated the presence of gland with their openings on ear canal lining (Weithers 2005). (Angus and Campbell 2001) observed the cobblestone like appearance of ear canal mucosa in CGH. Inflammatory alterations within external ear canal like glandular hyperplasia and dilation leads to rise in production of cerumen which in turn increased the humidity and shift the pH which activates the secondary infection (Bajwa 2019). In the present study, all the ear canals (15) with ceruminous gland hyperplasia had secondary infection such as bacterial, fungal and mixed (bacterial and fungal) identified by cytological and microbiological examination. Five ear canals out of 15 (5/15) had bacterial and fungal mixed secondary infection, 8 had bacterial alone and remaining 2 ear canals had fungal colonies only.

- **Exudate**

The variable amount of exudate was observed during the otoscopic examination in 25 ear canals (25/54). The mild amount of exudate (score 1) was evident in 12 ear canals (Plate 4.7), moderate exudate (Plate 4.7) in five ear canals and severe (Plate 4.7) in eight ear canals (8/25). The exudate was present in vertical ear canal of 10 animals and both vertical and horizontal ear canal in 15 animals. Exudate colour and amount was carefully noted.

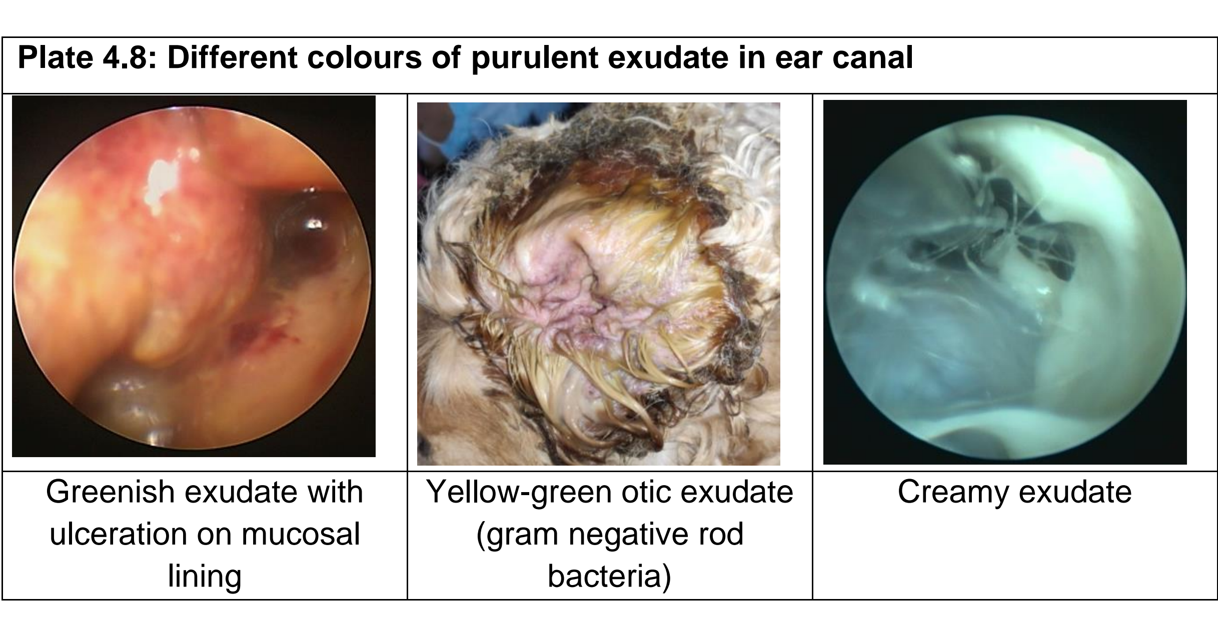
Plate 4.7: Different scoring of exudates



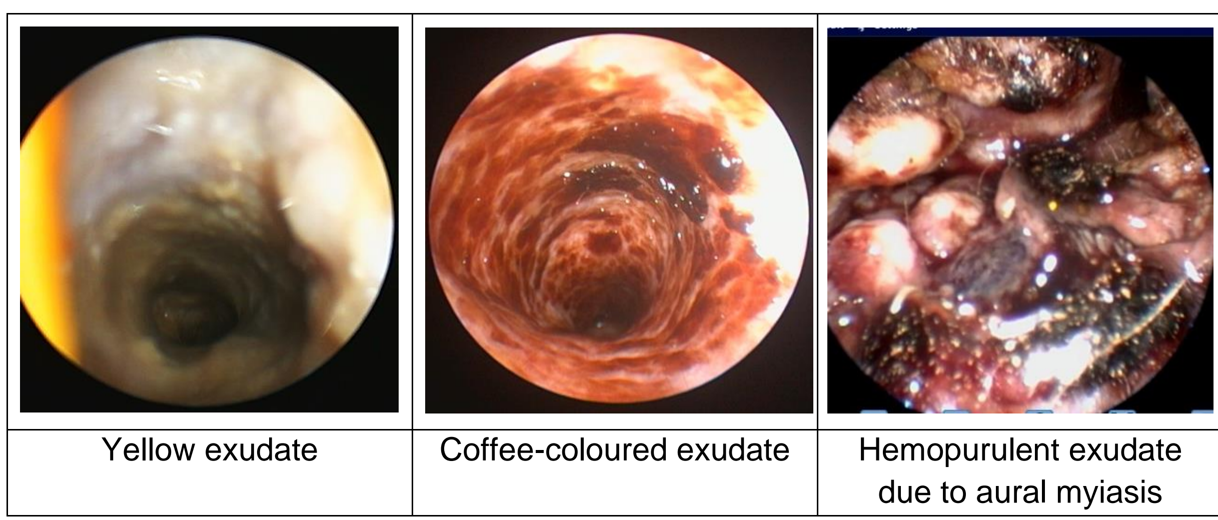
Mild presence of exudate	Moderate presence of exudate in ear canal	Severe presence of exudate in ear canal

Out of 25, the purulent exudate was found in 11 ear canals (11/25) based upon the cytology and isolation. Creamy greenish exudate (Plate 4.8) was evident in two ear canals (2/11) having gram negative rod and cocci in cytology. These dogs had erythematous, ulcerated ear canal lining along with the presence of exudate (Plate 4.8). Three ear canals (3/11) which were positive for cocci and fungal infections had creamy purulent exudate (Plate 4.8). The thick coffee-colored discharge was present in one ear canal (1/11) which was positive for Malassezia alone (Plate 4.8). In four dogs (4/11) yellow purulent exudate was visible (Plate 4.8) and had gram positive cocci in cytology examination. One dog (1/11) with the auditory myiasis had haemopurulent discharge (Plate 4.8).

Plate 4.8: Different colours of purulent exudate in ear canal



Greenish exudate with ulceration on mucosal lining	Yellow-green otic exudate (gram negative rod bacteria)	Creamy exudate

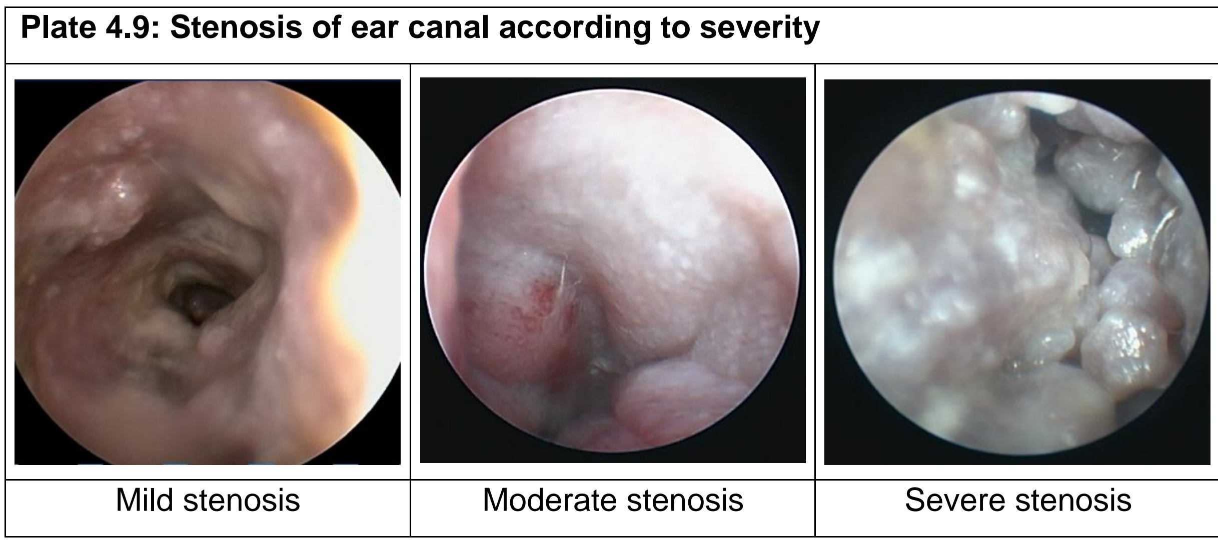


Yellow exudate	Coffee-coloured exudate	Hemopurulent exudate due to aural myiasis

The inflammatory and ceruminous phase of otitis externa together leads to formation of excess cerumen and exudate in ear canal. The colour of the exudate may provide some insight into the infective organism. The presence of organism should always be confirmed by cytological examination of exudate (Cole 2004). Pseudomonas, a gram-negative bacillus, causes ulceration and greenish otic exudate. The presence of rod-shaped bacteria in cytology should raise suspicion of Pseudomonas as the infectious agent causing otitis externa. Karlapudi (2017) reported that the erythematous ear canal with moderate edema and dark coloured ear discharge was mostly suffering from Malassezia. Gupta (2017) also observed the different colour of exudate with various kinds of infective organism in the cytological examination.

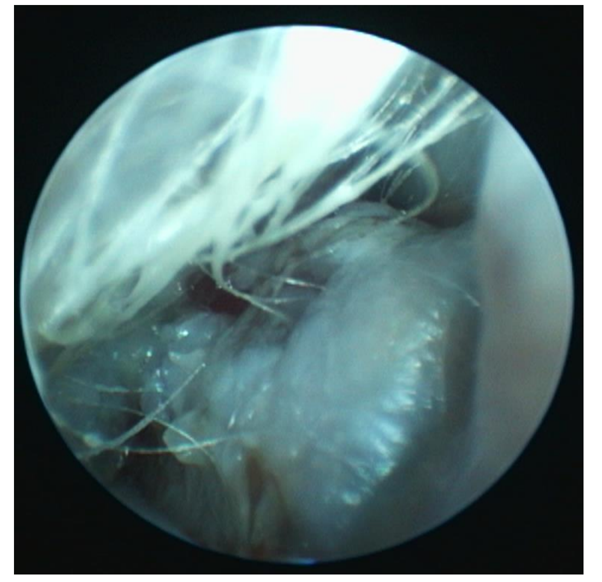
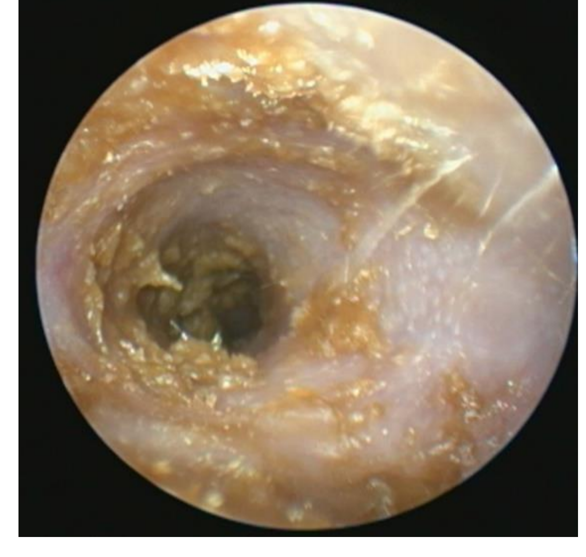
- **Ear canal stenosis**

A total of eleven ear canal were diagnosed to be stenosed. Out of the eleven-ear canal, mild stenosis (Plate 4.9) was seen in six dogs, moderate (Plate 4.9) in two dogs and severe (Plate 4.9) in three dogs. The eight ear canals were stenosed at the level of vertical ear canal and three ear canals were stenosed at the level of horizontal ear canal.

Plate 4.9: Stenosis of ear canal according to severity		
		
Mild stenosis	Moderate stenosis	Severe stenosis

The excessive production of cerumen and exudates due to CGH resulted in increase in moisture which in turn leads to secondary infections such as bacteria and fungi. These alterations further cause hyperplasia and hyperkeratosis of ear canal mucosa thus resulting into narrowing of lumen of canal (ear canal stenosis). Chronic otitis externa causes hyperkeratosis and hyperplasia of the epithelial lining as well as increase in the number and size of sebaceous and ceruminous glands also resulted in stenosis (Angus and Campbell 2001). Ear canal stenosis interfered in otoscopic examination so, both systemic and topical corticosteroids were started 7-14 days prior to reappraisal otoscopic examination for opening of ear canal. For this purpose, Tab. Prednisolone (Wysolone®) @ 1mg/kg body weight (orally) and Ear drops Prednisolone or Spray Fluticasone (apply topically, tid) for 2 weeks was prescribed in all the cases of ear canal stenosis. However, only two cases were presented after treatment of 14 days for reevaluation of ear canal by video-otoscopy. In these two cases, it was observed that there was increase in diameter of ear canal lumen and hence it was possible to pass the scope up to the horizontal ear canal. The pre and post treatment images were shown in the Plate 4.10.

Plate 4.10: Pre and post treatment images of ear canal stenosis

	
Stenosis of ear canal before treatment	Ear canal after treatment of 14 days

- **Hypertrophy of tragic and growths:**

Hypertrophy of tragic and edematous ear canal was seen in 8 ear canals (Plate 4.11). Out of eight, one ear (1/8) had ear hematoma along with hypertrophy of tragic. The two ears (2/8) had infestation of maggots within tragic of ear, lead to swelling and severe hypertrophy of tragic. Along with hypertrophy of tragic, five dogs (5/8) also had stenosed ear canal seen in cases of chronic otitis externa, it led to narrowing of inter-tragic incisure and made otoscope insertion difficult.

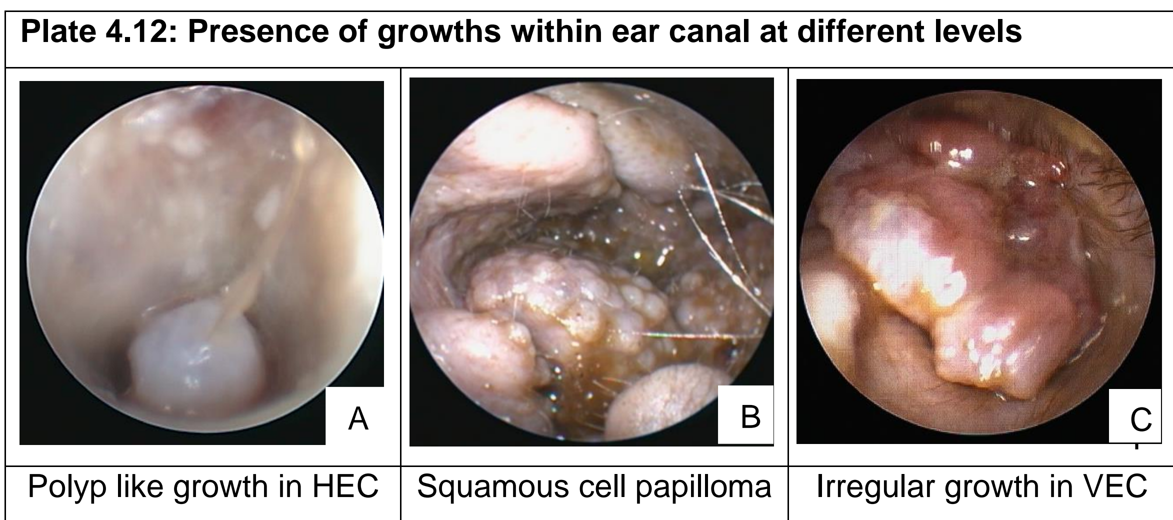
Plate 4.11: Hypertrophy of tragic and neoplasia within ear canal

Mild to moderate hypertrophy of tragic	Severe hypertrophy of tragic due to aural myiasis	Edematous ear canal lining

Growths or masses were found in 6 ear canals. Most of these dogs were suffering from chronic otitis externa or recurrent otitis externa. The 2/6 ear canals were having polyp like growth in horizontal ear canal (Plate 4.12) with presence of pleomorphic squamous cells as diagnosed by exfoliative cytology. In another four ear canals, there was presence of irregular growths in two ears and growth with multiple nodules in other two ear canals (Plate 4.12), the latter growth with raised nodules was diagnosed as squamous cell papilloma with the help of cytology and histopathology. Whereas other two growths from ear canals did not provided any conclusive result in cytology.

The similar kind of findings i.e. the clinical incidence of chronic otitis externa or recurrent otitis externa was found on higher side in the ear canal having different types of growths was also reported by Cole (2004).

Plate 4.12: Presence of growths within ear canal at different levels



Polyp like growth in HEC	Squamous cell papilloma	Irregular growth in VEC

A total of five dogs suffered from aural myiasis, 2 had unilateral and 3 had bilateral aural myiasis. Video-otoscopy revealed the presence of maggots within the ear canal along with presence of erythema, ulceration and multiple pinpoint haemorrhages on the mucosal lining (Plate 4.13). The mucosa of ear canal also became macerated along with presence of bleeding in two ear canals (2/5). The maggots were removed from ear canal with the help of grasping forceps under the guidance of video-otoscope (Plate 4.13). Maggots were present at the level of tragics and vertical ear canal in all the cases.

The maggot infestation was mostly reported in dogs with frequent ear scratching due to severe otitis externa. Aural myiasis is caused by a fly infestation on these scratched wounds. The use of video-otoscopic guided grasping forceps made it easier to remove maggots from deeper ear canals (Plate 4.13). Gupta (2017) also found the similar video-otoscopic findings in the cases of aural myiasis and also retrieved the maggots from ear canal.

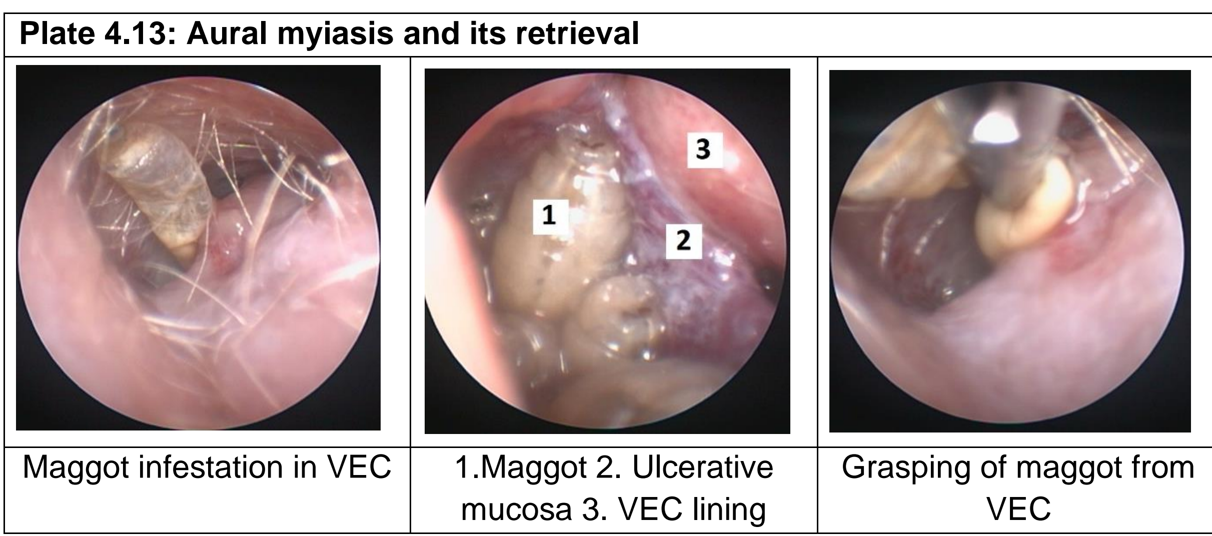


Plate 4.13: Aural myiasis and its retrieval		
Maggot infestation in VEC	1.Maggot 2. Ulcerative mucosa 3. VEC lining	Grasping of maggot from VEC

- **Miscellaneous video-otoscopic findings:**

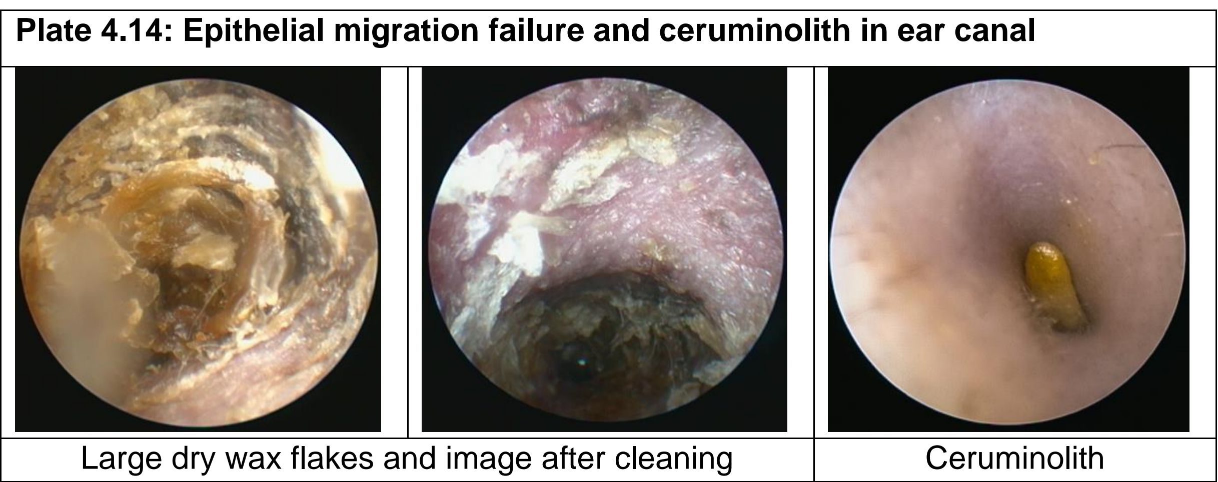


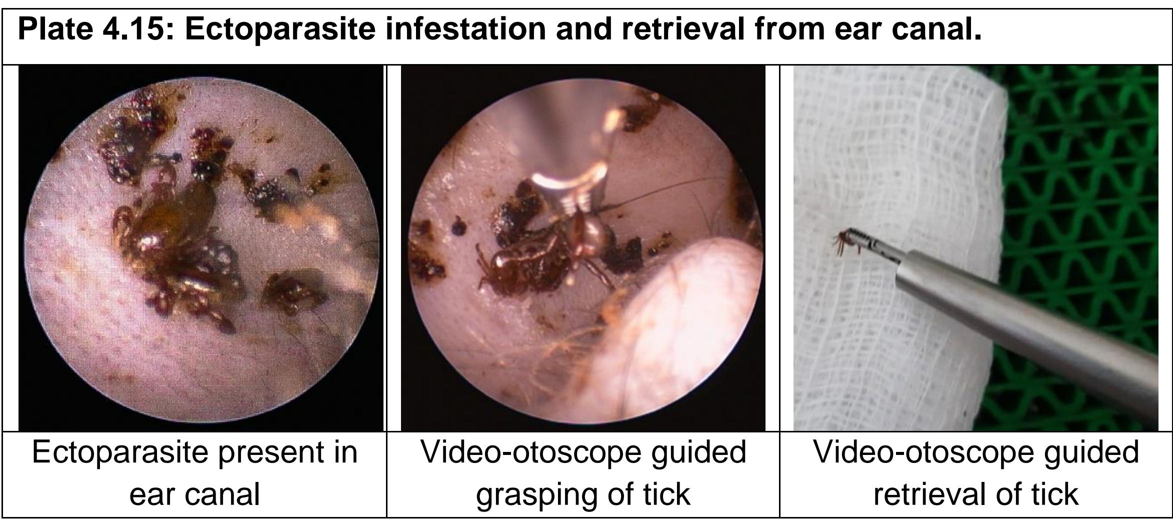
Plate 4.14: Epithelial migration failure and ceruminolith in ear canal	
Large dry wax flakes and image after cleaning	Ceruminolith

One case (1/54) of epithelial migration failure was recorded during the study in which video-otoscopy provided the final diagnosis as rough patchy mucosa with white

flakes was visualized (Plate 4.14) after removal of large quantity of medium to large sized wax flakes with deep ear cleaning and video-otoscope guided flexible grasping forceps. Epithelial migration on the ear drum and the external ear canal was must to remove the wax and debris from the external auditory canal and maintained a clear passageway for sound to travel to the tympanic membrane (Tabacca 2011). One ear canal (1/54) had presence of a ceruminolith (Plate 4.14). Failure of epithelial migration results into accumulation of keratin and wax at the base of ear drum, it may be soft wax plugs or hard concretions (Gotthelf 2005).

The ectoparasites (ticks) were present in VEC of one ear (1/54). The *Rhipicephalus sanguineous* (brown dog tick) was found and retrieved with the help grasping forceps under the video-otoscope guidance (Plate 4.15). Gupta (2017) also found some cases of *Rhipicephalus sanguineous* tick infestation within VEC. The ectoparasite is the primary cause of otitis externa and cause erythema.

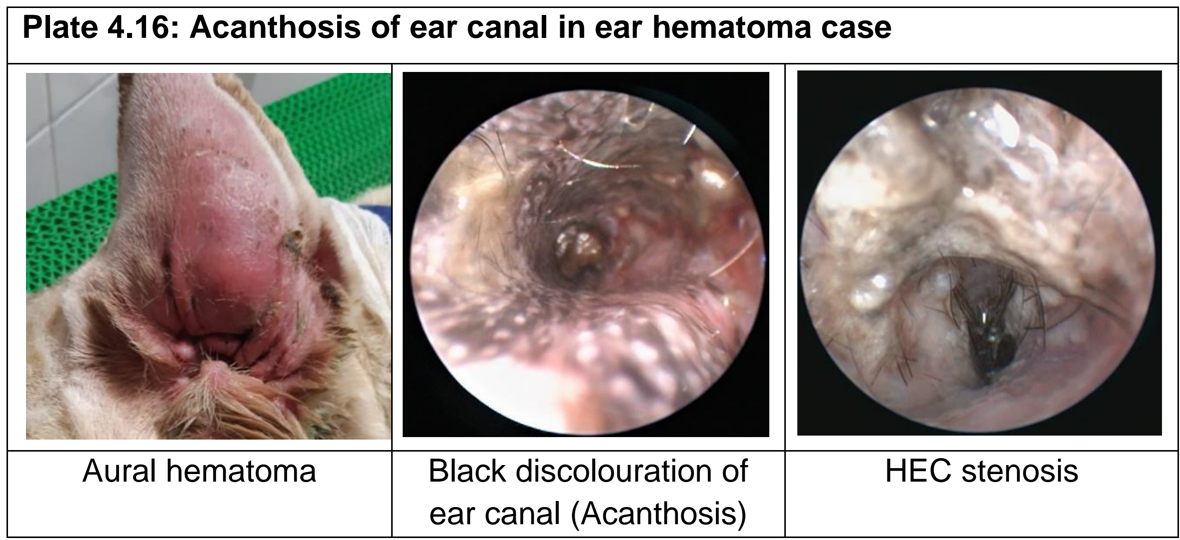
Plate 4.15: Ectoparasite infestation and retrieval from ear canal.



Ectoparasite present in ear canal	Video-otoscope guided grasping of tick	Video-otoscope guided retrieval of tick

One case (1/54) with aural hematoma under video-otoscopy examination revealed presence of black discolouration of mucosal surface (Acanthosis) along with mild ceruminous gland hyperplasia and stenosed HEC (Plate 4.16).

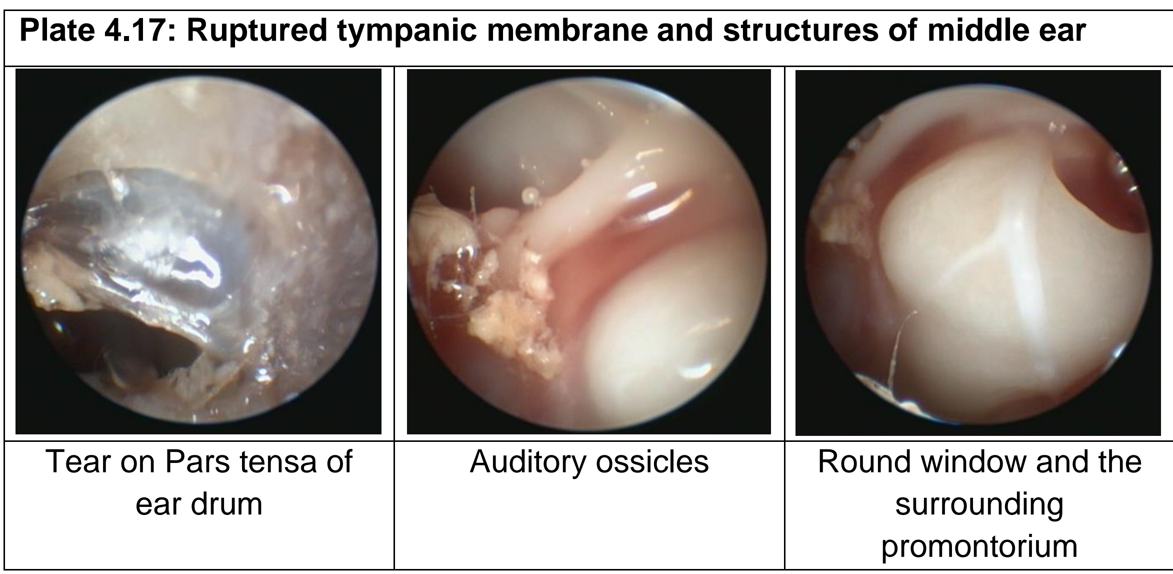
Plate 4.16: Acanthosis of ear canal in ear hematoma case



Aural hematoma	Black discolouration of ear canal (Acanthosis)	HEC stenosis

One case of tympanic membrane perforation was also recorded. On video-scopic examination, the pars tensa layer of tympanic membrane was ruptured and the structures behind the ear drum were also visualized (Plate 4.17). The deep ear cleaning was not done in this case.

Plate 4.17: Ruptured tympanic membrane and structures of middle ear



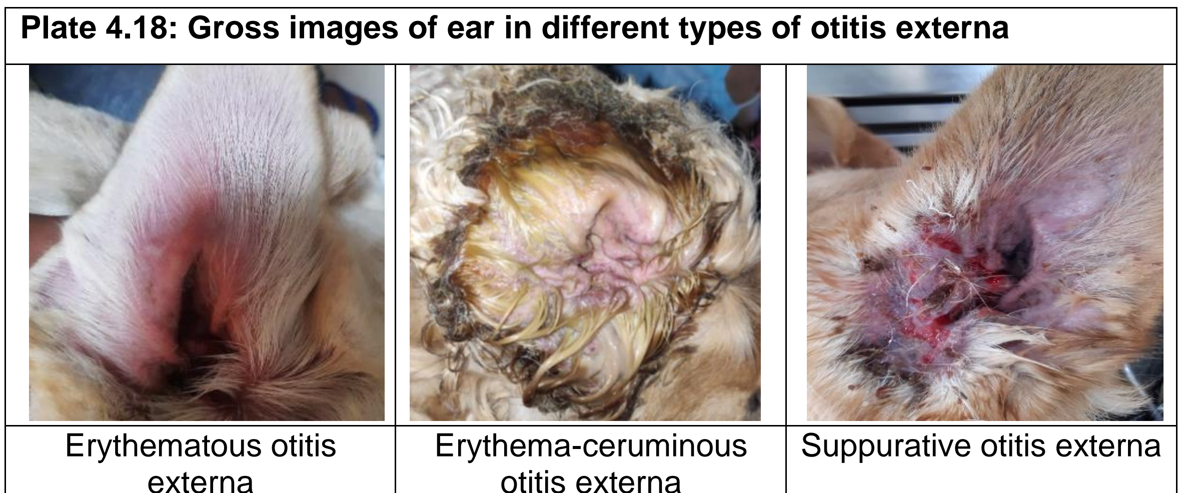
Tear on Pars tensa of ear drum	Auditory ossicles	Round window and the surrounding promontorium

4.1.2.2: Gross evaluation of ears:

There are three types of otitis externa according to the gross evaluation of ear. The inflammation of ear canal without ear discharge (erythematous otitis) was present in 12 ears (12/54). The erythema-ceruminous otitis characterized by presence of ear

canal inflammation along with ceruminous exudate was evident in 25 cases (25/54). Suppurative otitis externa was characterized by erosion and presence of purulent exudate was found in seven ears (7/54). (Plate 4.18)

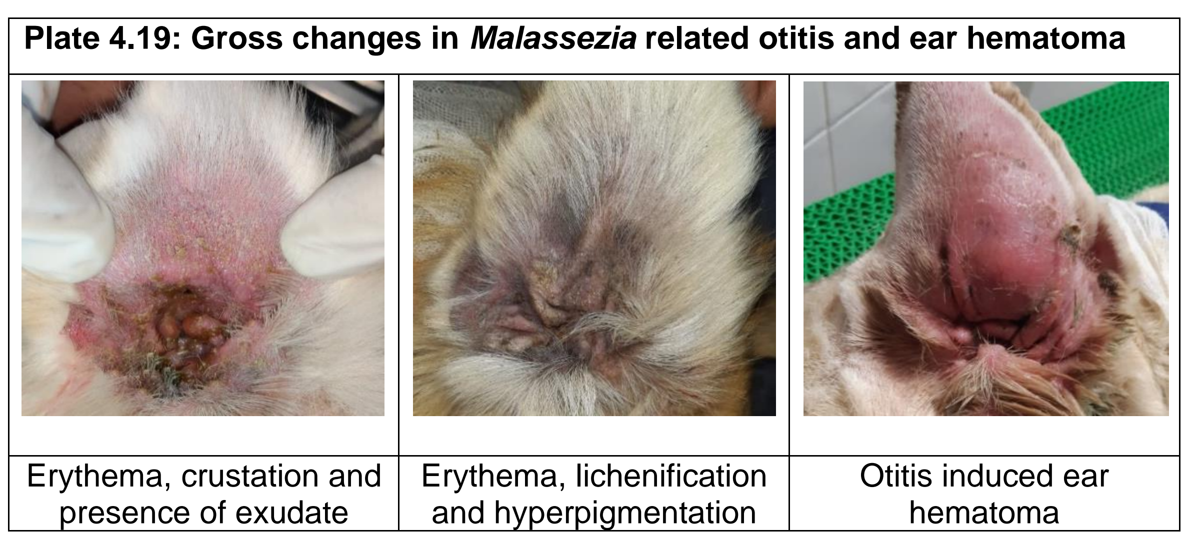
Plate 4.18: Gross images of ear in different types of otitis externa



Erythematous otitis externa	Erythema-ceruminous otitis externa	Suppurative otitis externa

The alteration such as hyperpigmentation, crustations, erythematous, lichenification along with presence of otic discharge (Plate 4.19) was evident gross findings in *Malassezia* associated otitis externa cases was evident in seven ear pinna (7/54), Kamaljyoti (2017) also found the similar gross lesion in Malassezia related otitis externa. The Ear hematoma (Plate 4.19) was soft fluctuant swelling caused due to rupture of vasculature of ear pinna by various kinds of trauma, were found in three ears with severe otitis externa (3/54). Ear hematoma was due to frequent ear scratching due to otitis externa (Patel et al. 2016).

Plate 4.19: Gross changes in *Malassezia* related otitis and ear hematoma



Erythema, crustation and presence of exudate	Erythema, lichenification and hyperpigmentation	Otitis induced ear hematoma

On the basis of video-otoscopic findings by evaluating every parameter. The otitis externa cases were graded as mild otitis externa in 15 ear canals (15/54), the moderate otitis externa cases were evident in 23 cases (23/54). The severe otitis externa was found in 16 ear canals.

4.1.2.3: Video-otoscopic interventions:

- Deep ear cleaning (DEC)
- Video-otoscope guided biopsy
- Video-otoscope guided removal of foreign body

Deep ear cleaning (DEC):

Video-otoscopic guided deep ear cleaning was done with help of alternate irrigation of fluids deep into the ear canal along with suction out of residual fluid to remove excessive debris and exudates. Deep ear cleaning was done with help of 0.9% normal saline solution. Along with it, salicylic acid 0.2 % w/v, (Epiotic ®) and Chlorhexidine gluconate solution 0.15% + propylene glycol 10% w/v + Tris EDTA (Ambifush ®) solution (Plate 4.20) were also utilized in moderate to severe otitis externa cases.

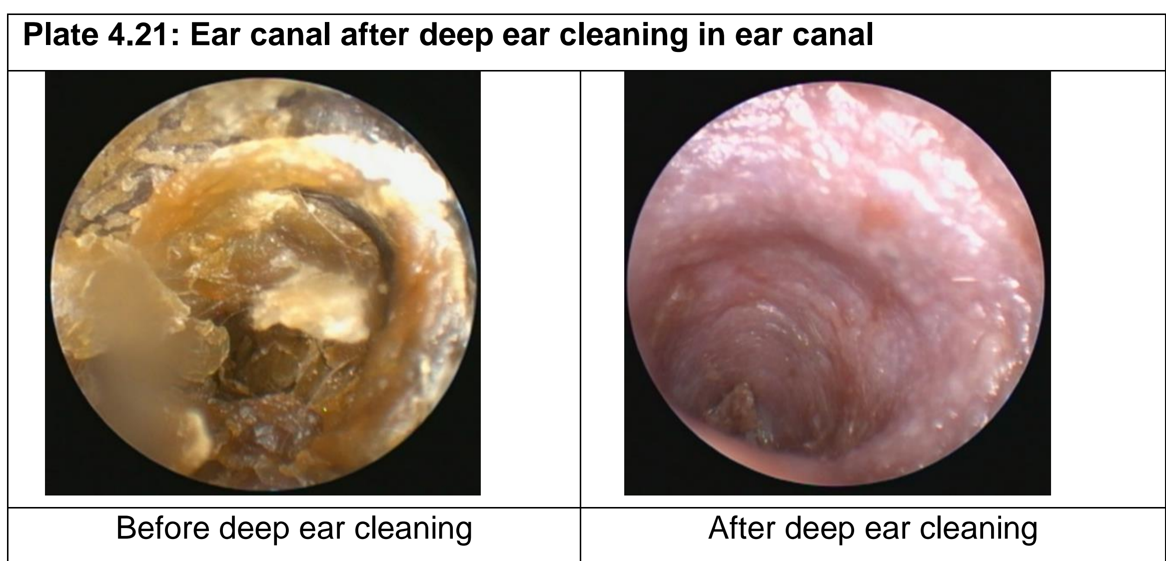
Plate 4.20: Solutions utilized for deep ear cleaning.

Normal saline solution (0.9%) | Commercial ear cleaning solution

DEC provided removal of various ear canal exudate, debris, necrotic tissue and various other kinds of biological material from ear canal along with better visualization of ear canal mucosa (Plate 4.21). Further it also provided better efficacy of treatment

by removing the biofilm which acts as barrier to the action of local medication (Angus and Campbell 2001). Bajwa (2019) reported that different bacteria in otitis externa made a biofilm over the mucosal surface of ear canal and it was very important to clear out this biofilm for proper efficacy of local medication.

Plate 4.21: Ear canal after deep ear cleaning in ear canal

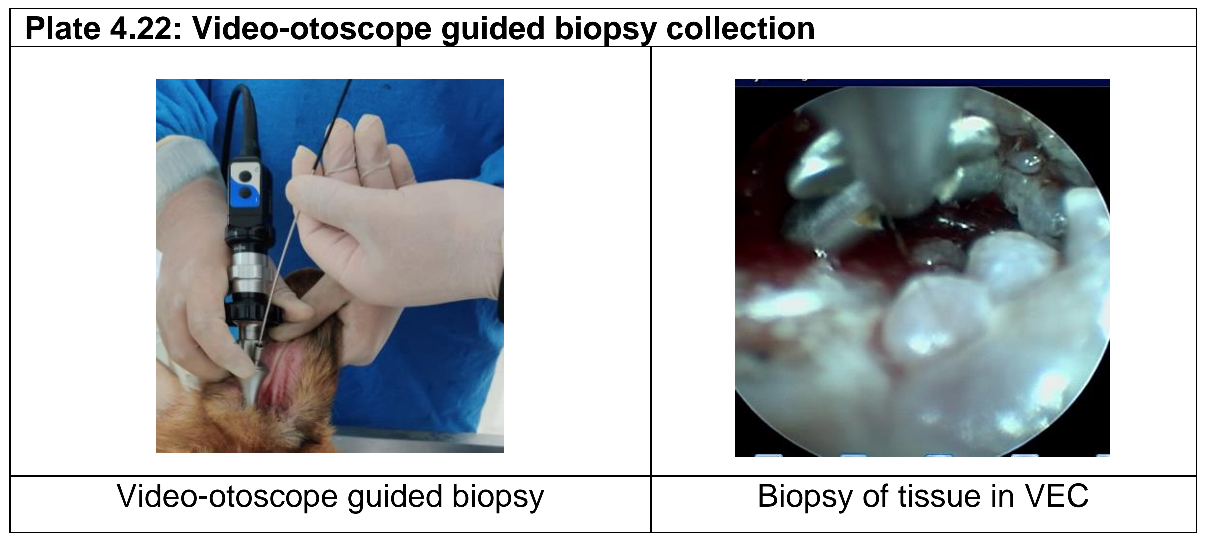


Before deep ear cleaning	After deep ear cleaning

Video-otoscope guided biopsy:

After the lesion localization by video-otoscopy the biopsies were collected under its guidance by passing the biopsy forceps through its channel (Plate 4.22). This method of biopsy collection provided precise tissue collection and avoiding unnecessary damage to the surrounding soft tissue. The biopsy sample was collected from four ear canals (4/54).

Plate 4.22: Video-otoscope guided biopsy collection

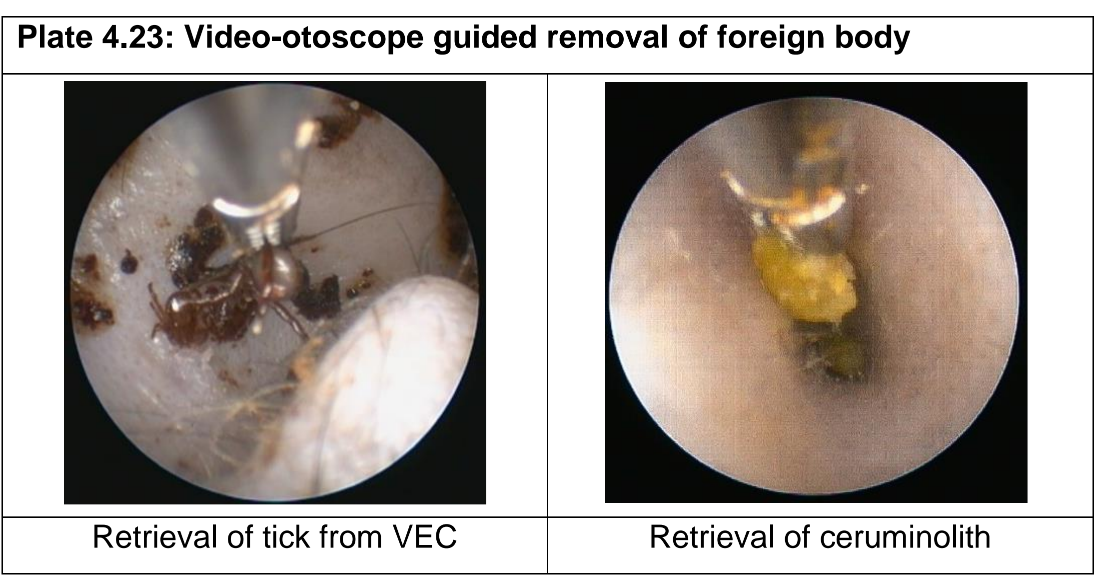


Video-otoscope guided biopsy	Biopsy of tissue in VEC

Video-otoscope guided removal of foreign body:

This method was utilized for retrieval of foreign bodies with flexible grasping forceps passed through the accessory channel after localization of the same without damaging the surrounding tissue. The method was used for the removal of various kinds of foreign bodies such as maggots, ceruminolith, wax flakes and ectoparasites etc. from 10 ear canals (10/54) (Plate 4.23). (Angus and Campbell 2001) stated that the video-otoscope guided removal of foreign body from ear canal was an ideal method as well as it also avoided iatrogenic injury to the delicate parts of the ear.

Plate 4.23: Video-otoscope guided removal of foreign body



Retrieval of tick from VEC | Retrieval of ceruminolith

4.1.2.4: Cytological examination:

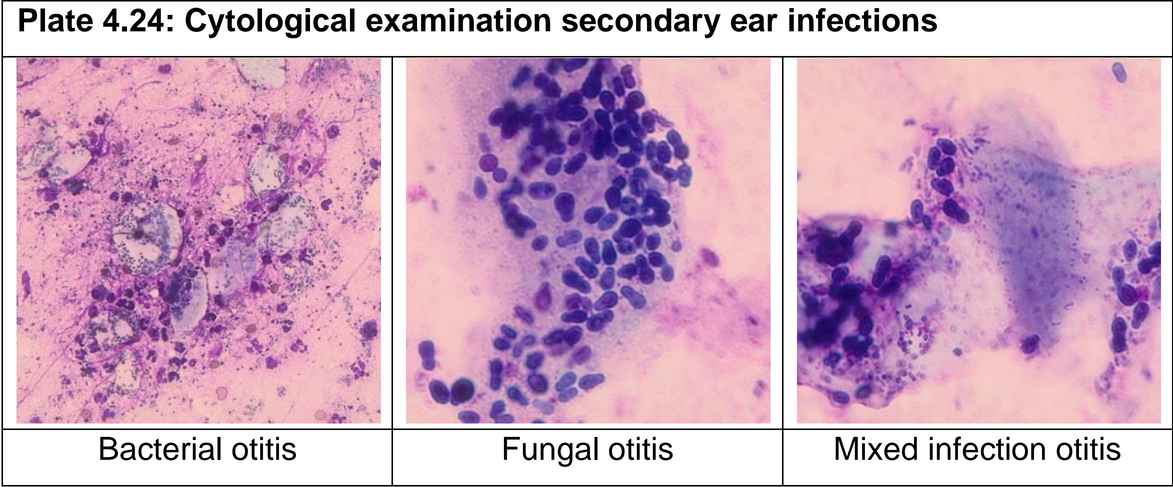
A total of 41 affected ear canals had secondary infection. Out of which 21 had bacterial alone, 14 had mixed secondary infection (bacterial plus fungal) and 6 ear canals had fungal infection alone.

The bacterial infection was present in total 35 ear canals either bacterial infection alone or mixed (bacterial and fungal) infection was recorded (Plate 4.24). Out of 35 cases, 21 cases (60%) were reported as bacterial alone and 14/35 (40%) had bacterial plus fungal mixed infection. The gram-positive cocci were isolated from 22 ear canals (63%), followed by 7 cases (20%) of gram-negative rods and 6 cases (17%) of coccobacilli. Most frequently isolated gram-positive cocci were *staphylococcus*. The

gram-negative bacteria (rods) causes the suppurative type of otitis externa with presence of ulceration and exudate in the ear canal mucosa. The *staphylococcus* was most commonly isolated bacteria in ear canal and *pseudomonas* was isolated from the chronic cases of otitis externa with presence of erosions and greenish otic exudate in the ear canal mucosa (Rosser 2004).

The fungal infection was present in total 20 ear canals. Out of which mixed mycotic otitis externa *(Malassezia, candida and Blastomycosis)* were found in 4 ear canals (4/20) (Plate 4.24) and *Malassezia* was reported in 16 ear canals in total (16/20). The *Malassezia* was the most common fungal organism evident in the study (16/54) (29%). The incidence of *Malasezzia* was higher in breeds with pendulous ear. Other research had found that the breeds with pendular ears are more predisposed (Perry et al. 2017), which was consistent with our findings. The pendulous ears obstruct the normal airflow and made them vulnerable to secondary *Malassezia* infection.

Plate 4.24: Cytological examination secondary ear infections



Bacterial otitis	Fungal otitis	Mixed infection otitis

Changes like ceruminous gland hyperplasia increased the moisture in ear canal also lead to the secondary infections in the ear canal. The fifteen ear canals with secondary infection had different scores of CGH.

4.2: Gastro-intestinal tract endoscopy:

The Gastro-intestinal tract (GIT) endoscopy was conducted in 30 dogs, utilizing upper GIT tract endoscopy in 23 dogs and lower GIT tract endoscopy in 7 animals. Out

of 23 animals undergoing upper GIT endoscopy, 17 were suffering from upper gastrointestinal tract affections and remaining 6 dogs were suspected to had GIT problem (without weight loss) utilized for visualization the mucosa of different portions of upper gastrointestinal tract in the standardization trials. Similarly, colonoscopy was carried out in 7 dogs, out of which five were suffering from lower GIT affections and remaining 2 dogs were utilized for standardization trials.

4.2.1: Standardization of Gastro-intestinal tract endoscopy in small animals:

The standardization of esophago-gastro-duodenoscopy procedure was done in 6 dogs with variable body weight. The normal colour and texture of esophagus and stomach mucosa was visualized so that differentiation could be made between normal and altered mucosal lining in the clinical phase of study.

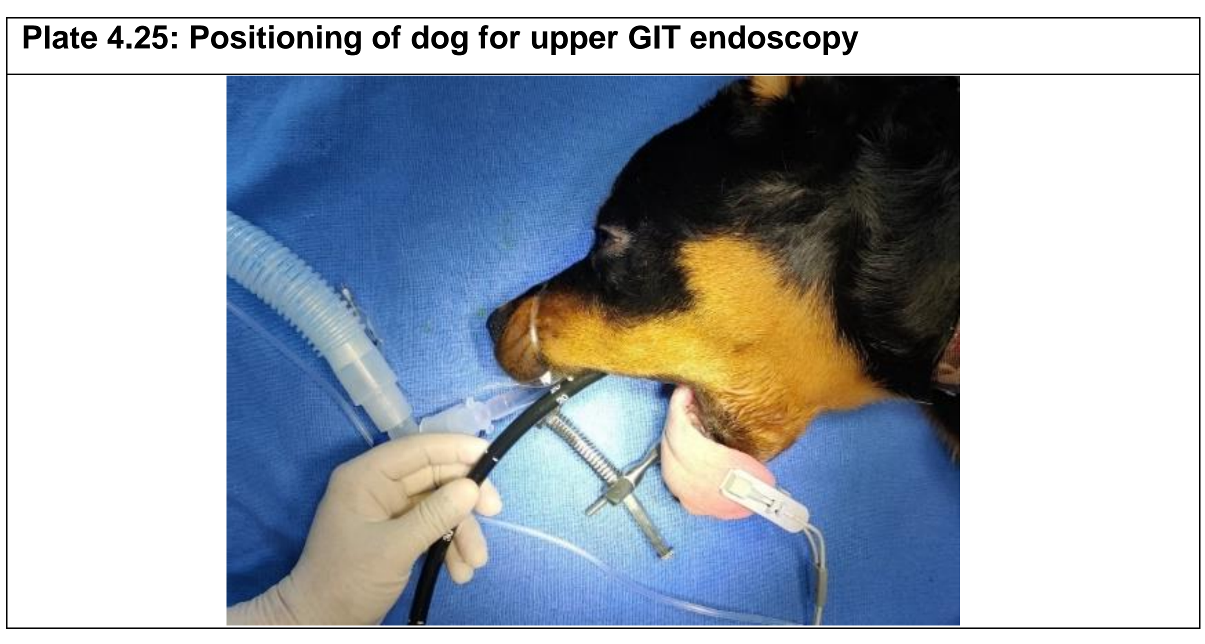
4.2.1.1: Patient preparation for upper GIT endoscopy:

The animals were fasted for 12 hours before the procedure, so that the incidence of presence of food material in the stomach can be minimized. In all the animals undergoing upper GIT endoscopy, 12 hours fasting provided complete clearing of gastric contents. Zoran (2001) reported that 12 hours off fed and 6 hours off-water in dogs were sufficient for preparation of Gastro-duodenoscopy.

4.2.1.2: Technique and normal structures of upper GIT endoscopy:

For upper GIT endoscopy, dogs were kept in right lateral recumbency under general anaesthesia. The mouth gag was applied on the right canines to avoid any hindrance to insertion tube of endoscope Plate 4.25.

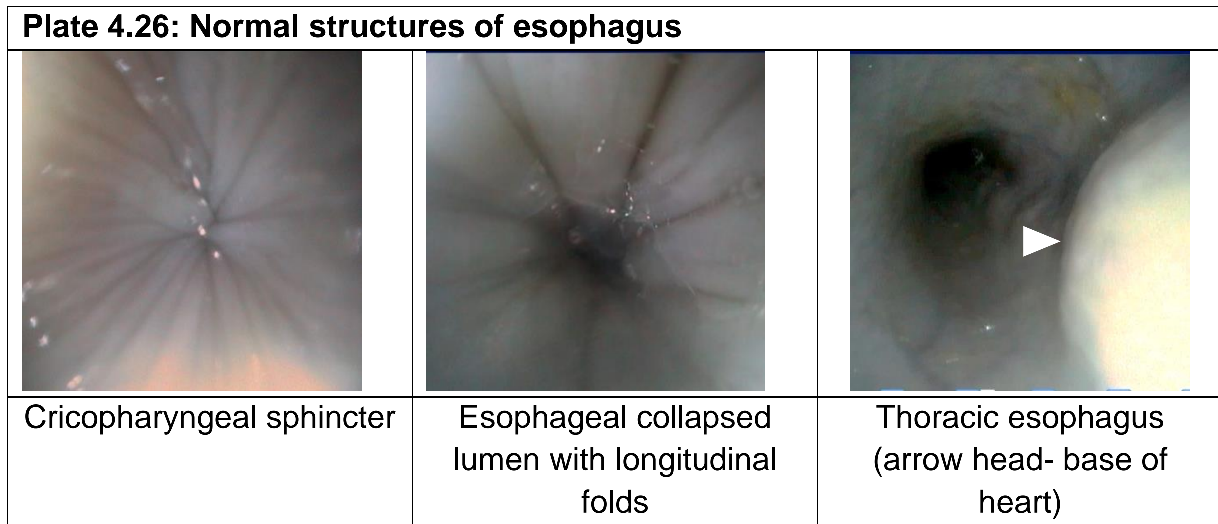
Plate 4.25: Positioning of dog for upper GIT endoscopy



The hand piece of endoscope was held with the non-dominant hand. The index finger of that hand regulated the suction by pressing first valve. The middle finger was used to switch the air/water valve. Insufflation was triggered by putting the fingertip at the top of the valve over the cavity. After lubrication of the insertion tube of endoscope with lignocaine jelly (2%), the assistant inserted the endoscope into the mouth and directed dorsally to the endotracheal tube to visualize cricopharyngeal sphincter (Plate 4.26). The sudden red out was appeared due to the contact of mucosa of cricopharyngeal sphincter. Then the endoscope entered esophagus at this point. The continuous air insufflation was performed to avoid collapsing of esophageal mucosa and it was always attempted to keep the endoscope in central tunnel of esophagus while advancing the same during esophagoscopy. The heart beat was observed at thoracic esophagus (Plate 4.26). On further advancement of scope, the gastroesophageal sphincter was visualized was remained closed in normal dogs (Plate 4.27). The esophagoscopy included the examination of esophageal mucosa between cricopharyngeal sphincter to the gastroesophageal sphincter. The normal appearance of esophagus mucosa was pale pink. It had glistening mucosa along with fine sub-mucosal blood vessels of esophagus (Plate 4.26). Under normal condition, the esophagus was found collapsed with longitudinal folds and occasional presence of little amount of clear fluid in it (Plate 4.26). Ritcher (1992) also reported the similar

endoscopic findings of the normal esophageal mucosa. Esophagus may contain the small amounts of clear fluid but, the presence of food material was abnormal (McCarthy 2005).

Plate 4.26: Normal structures of esophagus



Cricopharyngeal sphincter	Esophageal collapsed lumen with longitudinal folds	Thoracic esophagus (arrow head- base of heart)

During standardization phase, the lengths of various upper GIT landmarks were taken in dogs. The distance from canine tooth of maxilla to the cricopharyngeal sphincter, thoracic esophagus and gastroesophageal sphincter was measured in dogs with different body weights. These measurements are described in the following (Table 4.1).

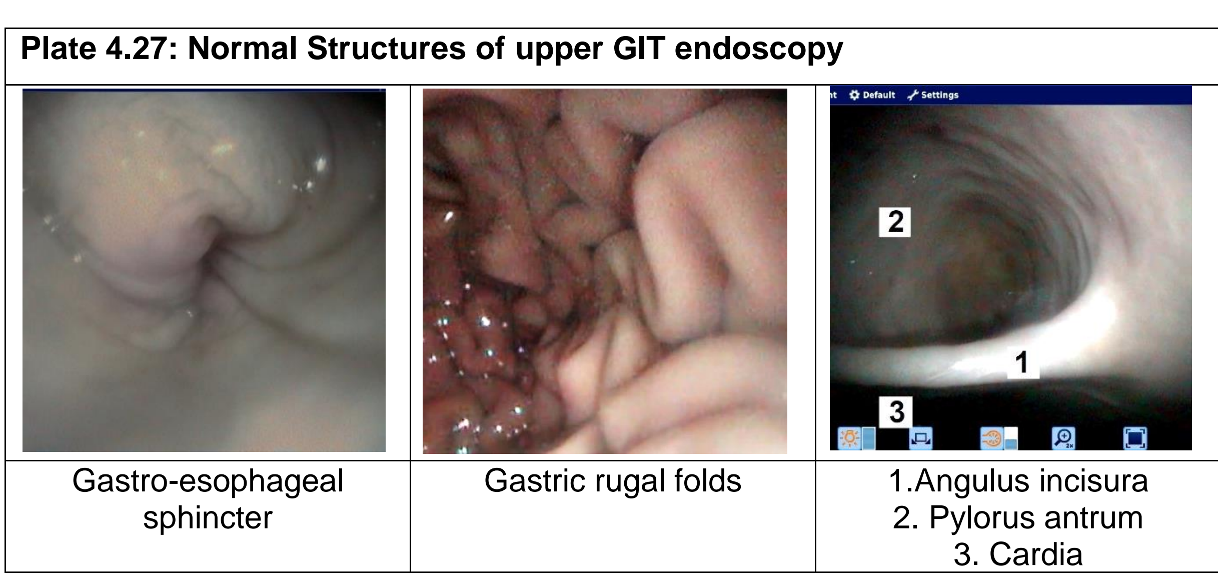
Table 4.1: Measurement of lengths of different landmarks

S.no.	Different landmarks	Distance from canines in different body weight and croup rump length (CRL) groups					
		5 kg 52 cm	10 kg 60cm	15 kg 57cm	20 kg 68cm	25 kg 73cm	30 kg 85cm
1	Cricopharyngeal sphincter	10cm	13cm	13cm	18cm	18cm	19cm
2	Thoracic esophagus (heart beat appears)	25cm	28cm	28cm	30cm	35cm	45cm
3	Gastroesophageal sphincter	35cm	39cm	44cm	46cm	48cm	60cm

After examination of esophagus, the scope tip was passed into gastro-esophageal sphincter by anticlockwise turn of inner control knob for visualization of

gastric mucosa. Initial inspection of rugal folds of gastric mucosa was done with only air insufflation created during esophagoscopy. Then complete exploration of gastric mucosal lining was performed with air insufflation to flatten the folds for thorough examination of gastric mucosa. The ultimate level of insufflation was achieved, when rugal folds became flattened and allows gross investigation of gastric mucosa. Tams and Rawlings (2011) also suggested proper air insufflation for visualizations of anomalies such as ulcer, erosions, mass or any kind of foreign body etc. The colour of normal gastric mucosa was pink and glistening whereas often appeared paler in the pyloric antrum (Plate 4.27). Simpson (1993) also observed the similar appearance of normal gastric mucosa.

Plate 4.27: Normal Structures of upper GIT endoscopy



Gastro-esophageal sphincter	Gastric rugal folds	1.Angulus incisura 2. Pylorus antrum 3. Cardia

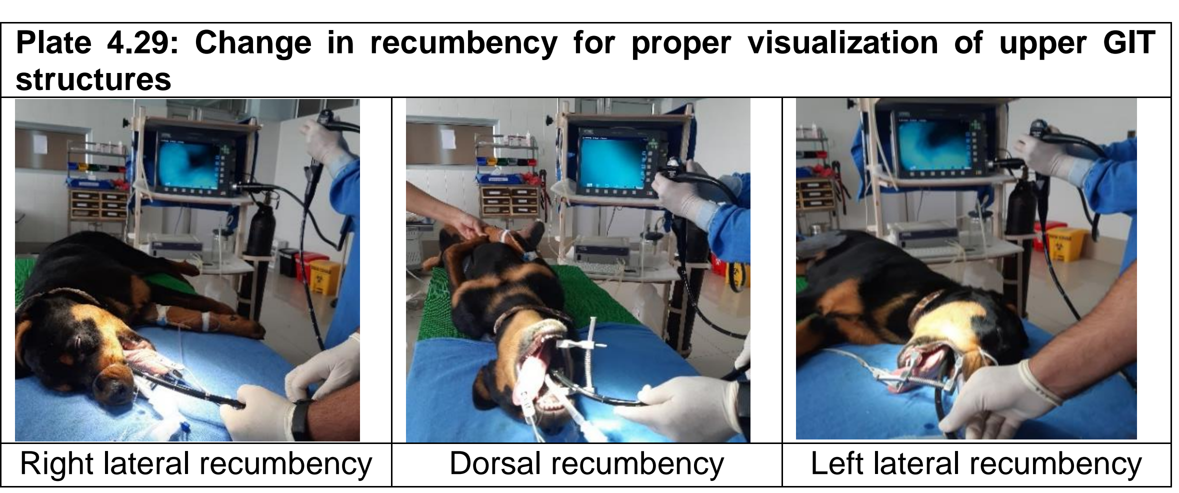
While advancing the scope further into stomach, the large intraluminal fold (Incisura angularis or Angulus notch) was observed, which distinguished the cardia and pyloric portion of stomach. It also acted as an important landmark to navigate the location of scope. It also facilitated to spot the portion of stomach being examined. Then the retroversion manoeuvre of scope tip with counter clockwise turn of inner control wheel parallel to angulus notch facilitated the complete view of fundus and cardia for thorough examination. Actually, this retroversion manoeuvre was the J manoeuvre of flexible endoscopy, which needs at least 180 degrees of tip deflection and pulling the scope back keep the tip closer to the cardia for close visualization (Plate 4.28) and these findings were in line with the study of (Tams and Rawlings 2011). During the

whole process an intermittent air insufflation was must, as the air also leaked out from GIT due to presence of insertion tube in the esophagus.

Plate 4.28: Normal structures visualized during retroversion and pyloric antrum		
J manoeuvre for fundus view	J manoeuvre for cardia view	Pyloric Antrum

After examination of fundus and cardia, the distal tip was straightening out and advanced in line with greater curvature. However, the pylorus normal location was on the right side, so it was not easy to visualise it in right recumbency. As a result, the recumbency was changed first to ventro-dorsal and then to left-lateral in a slow and gentle manner, which facilitated easier intubation of scope tip into the pyloric antrum and sphincter (Plate 4.29). Several workers had also suggested that the change in recumbency made it easier to visualise every important part of stomach (Tyagi 2006; Thakur 2011; Gupta 2012 and Thakur 2013).

Plate 4.29: Change in recumbency for proper visualization of upper GIT structures

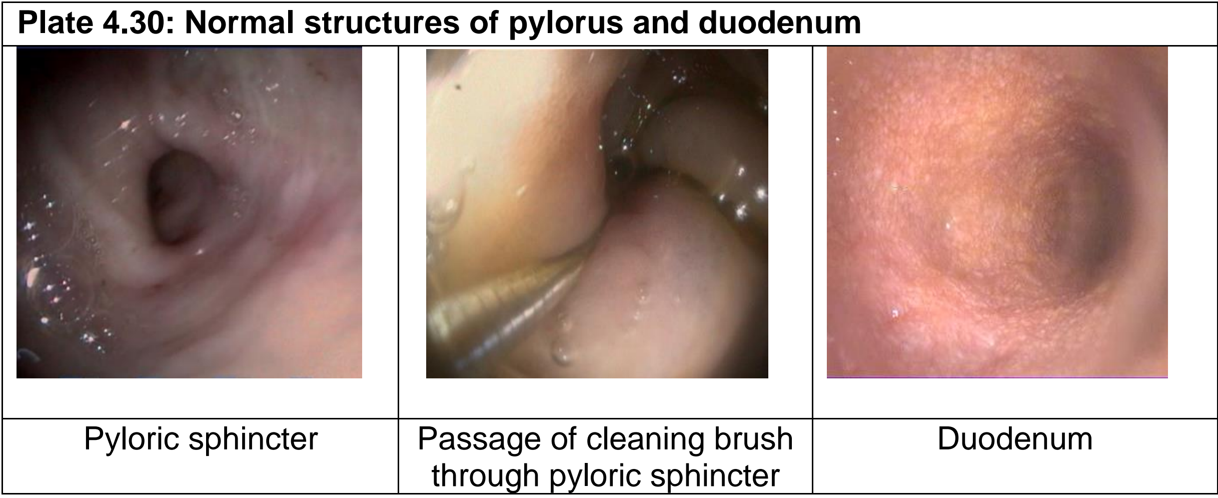


Right lateral recumbency	Dorsal recumbency	Left lateral recumbency

Minimal air insufflation was done for easier passage of scope into the pyloric antrum. The pyloric sphincter was visualized by advancing the scope tip into pyloric antrum. Gaag and Happe (1983) observed that passing the endoscope into pylorus become effortless by preventing excess air insufflation of stomach and avoiding too much angulation of the scope tip.

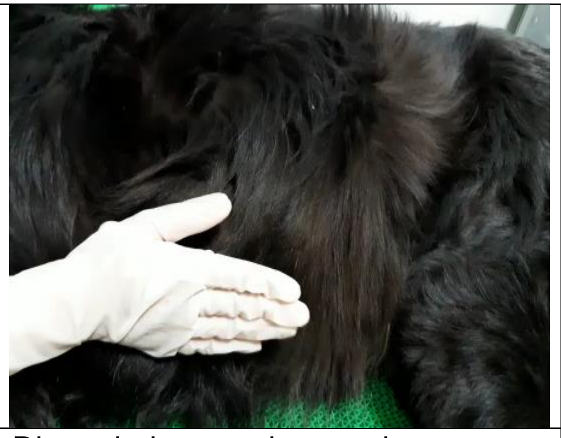
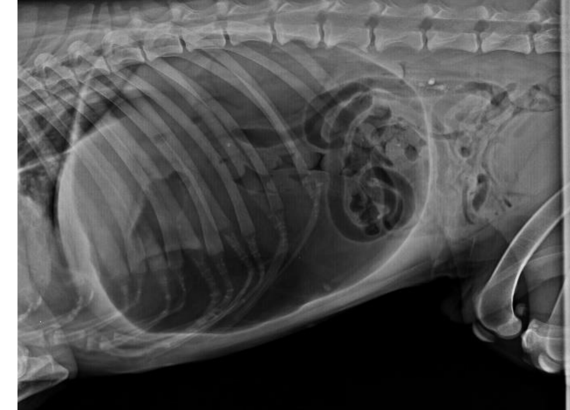
It was difficult to pass the insertion tube into pyloric sphincter so, cyto-brush was passed through the accessory channel of endoscope and it was passed into the sphincter and later utilized as a guide wire for easier passage of endoscope into pyloric sphincter (Plate 4.30). The endoscope tip was carefully transit through pyloric sphincter and proximal duodenum was reached in three dogs (3/23). Normal duodenum was slightly irregular with creamy pink to light red in colour (Plate 4.30). Randhawa (2020) also reported the similar findings in duodenum of normal dog.

Plate 4.30: Normal structures of pylorus and duodenum



Pyloric sphincter	Passage of cleaning brush through pyloric sphincter	Duodenum

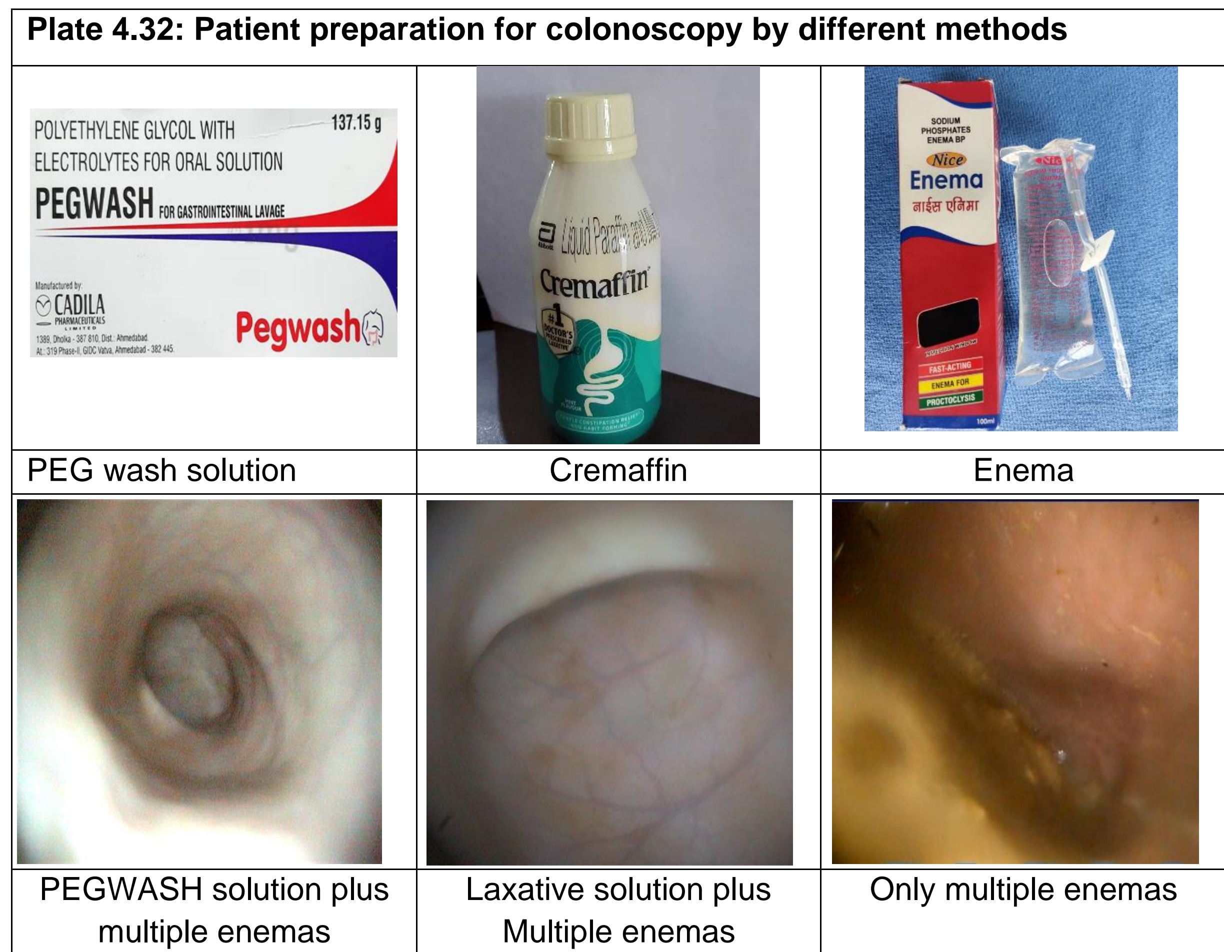
The intragastric air was suctioned out before removing the endoscope tip out of gastrum (Plate 4.31). The gastric tympany due to trapping of air inside stomach was recorded in one dog in this study. So, it was critical to suctioned out the insufflates air from the gastrum after completion of the endoscopic procedure.

Plate 4.31: Complication of upper GIT endoscopy (Gastric tympany)	
	
Distended stomach gross image	Distended stomach radiographical image

4.2.1.3: Patient preparation for colonoscopy:

The proper clearance of colon was required for efficient endoscopic examination of colon. The colonic lavage solution polyethylene glycol with electrolytes for oral solution (PEGWASH) and multiple enemas were utilized in preparation of two patient (2/7), which facilitated the excellent clearance of the colon (Plate 4.32). In the second method, only sodium phosphate multiple enemas were performed 3 hours prior to colonoscopy in two dogs (2/7) but, it was unable to clear lumen of colon except rectum (Plate 4.32). In three dogs (3/7), a laxative solution such as cremaffin (liquid paraffin and milk of magnesia) was administered for three days (three times a day) along with repeated enemas on the day of the colonoscopy, resulting in good clearance with just little faecal material stains on the mucosal wall (Plate 4.32). The residual contrast media obscured the mucosal detail of colon as seen in one dog having contrast radiographic study one day (24 hours) prior to procedure. (Richer and Cleveland, 1989) also stated that in preparing dogs for colonoscopy, an orally administered polyethylene glycol-containing electrolyte solution is better than multiple enemas. Moreover, always avoid barium contrast study of GIT prior to endoscopy.

Plate 4.32: Patient preparation for colonoscopy by different methods



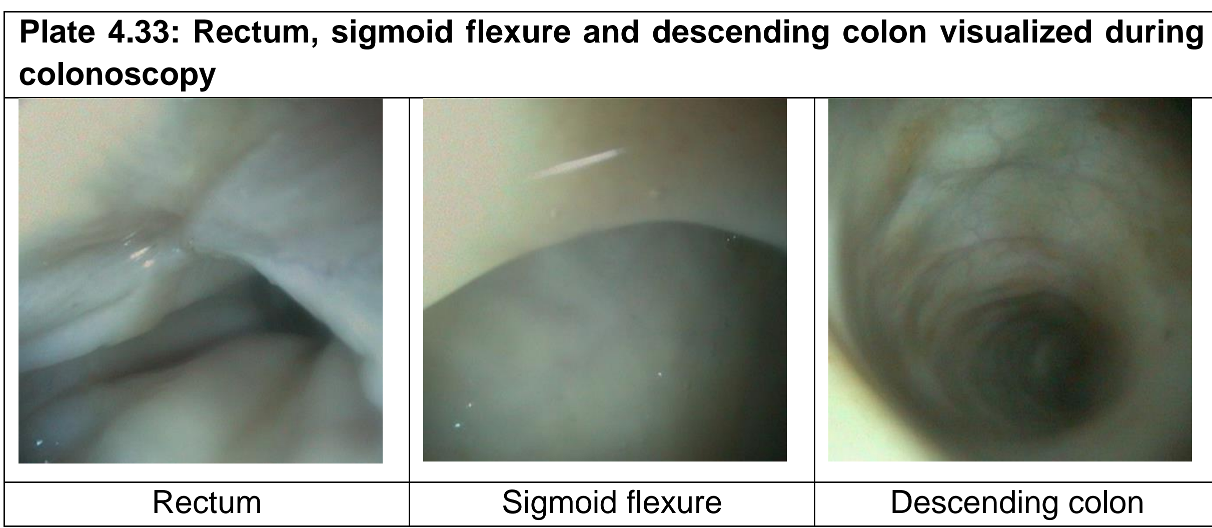
PEG wash solution	Cremaffin	Enema
PEGWASH solution plus multiple enemas	Laxative solution plus Multiple enemas	Only multiple enemas

4.2.1.4: Technique and normal structures of colonoscopy:

For colonoscopy, left lateral recumbency found to be more useful as this position prevented adjacent organs from compressing the area of the ileocolic valve (Willard 2001) and also facilitated pooling of residual fluid into descending colon, where it can be easily suctioned out and provided better visualization of ascending colon mucosa (McCarthy 2005). Digital rectal examination was done prior to colonoscopy to rule out the possibility of rectal obstruction, mass, ulceration, and any diverticulum. Leib et al (2004) also suggested that digital rectal examination should be performed before insertion of endoscope. The well-lubricated endoscope was advanced several centimetres into the rectum and air was insufflate to distend the colon. To prevent the already insufflated air from escaping the colon and to allow the rectal mucosal folds to distend, an assistant was utilized to tightly grip the perianal tissues around the endoscope. The advancement of scope into central tunnel view along with air

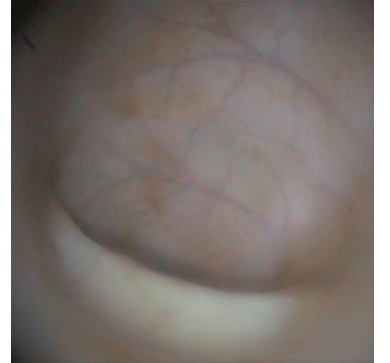
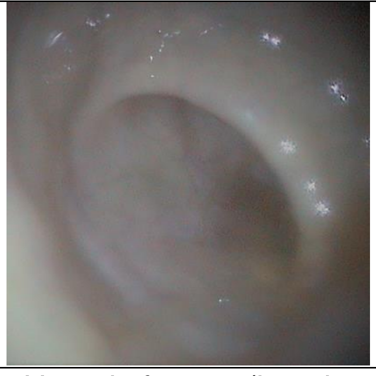
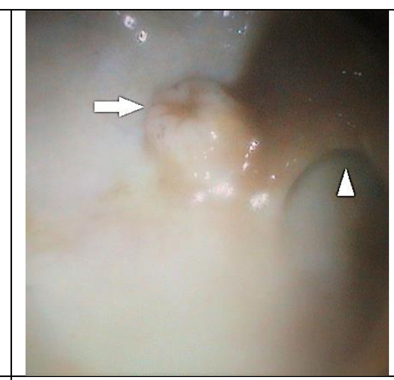
insufflation was done for smooth passage. The three principles for effective colonoscopy, “insufflate”, “centralize” and “advance,” were always kept in mind and repeated as the endoscope is advanced toward the cecum as suggested by (Tams and Rawlings 2011). After visualization of rectum scope was halted at sigmoid flexure (Plate 4.33). The sigmoid flexure was passed which required the manoeuvring of scope tip along with air insufflation to cross this flexure and advancement of scope up to the descending colon (Plate 4.33).

Plate 4.33: Rectum, sigmoid flexure and descending colon visualized during colonoscopy



Rectum	Sigmoid flexure	Descending colon

After examination of descending colon, the next junction encountered was splenic flexure, the junction between descending colon and transverse colon (Plate 4.34). It was a sharp 90-degree curve. For passing this curve, continuous air insufflation was required which decreased its angle and dorsal manoeuvring of tip by controlling both types of knob help in intubating the scope into transverse colon. Further advancement and air insufflation facilitate the return of tunnel view of transverse colon. At the end of transverse colon, hepatic flexure was seen (Plate 4.34), which was also crossed in same way as of splenic flexure. This directed the scope tip into the ascending colon, which was a small segment facing towards rectum. At the terminal point of ascending colon, two valves were visualized i.e., ileo-colic junction which appeared mushroom like (white arrow in Plate 4.34) and caecum opening which was a slit like aperture (white arrow head) (Plate 4.34).

Plate 4.34: Splenic flexure, hepatic flexure, ileo-colic sphincter and ceaco-colic junction visualized during colonoscopy		
		
Splenic flexure (junction between descending and transverse colon)	Hepatic flexure (junction between transverse and Ascending colon)	Arrow- Ileo-colic sphincter Arrow head- caecum slit like opening

The normal mucosa of colon was pale pink with smooth texture. The submucosal vessels along with glistening mucosa was the feature found in healthy colon.

4.2.2: Clinical application:

4.2.2.1: Upper gastrointestinal endoscopy findings:

The upper GIT endoscopies were done in 17 clinical cases of dogs. Out of these four animals (n=4) were presented with esophageal disorders, twelve animals were presented with gastric disorders (n=12) and one animal was presented with disorder of duodenum (n=1).

The four dogs of different breeds with variable age were presented with the primary complaint of chronic regurgitation of food material 1-2 hours after meal from 1-3 months with reduced appetite and chronic weight loss.

Gastric disorders were present in 12 dogs of different breeds and age group. The animals were presented with the primary complaint of vomiting (more than a week), reduced appetite, melena, loss of body condition, emaciation, frothiness and hypersalivation. Such animals did not respond to previous medication.

Duodenal disorder was present in one dog with chronic history of projectile vomiting (Bile stained) and weight loss.

The upper GIT disorders cases were categorized as shown in table 4.2:

Table 4.2: Distribution of upper GIT endoscopy cases

Esophageal disorder (4)	Gastric disorder (12)	Duodenum disorder (1)
• Esophageal diverticulum (n=2) • Megaesophagus (n=1) • Extra-luminal mass (n=1)	• Gastric ulceration and erosion, gastritis (n=11) • Gastric foreign body (n=1)	• Space occupying lesion (n=1)

All of these dogs were subjected to haemato-biochemical tests, radiography, ultrasonography prior to esophago-gastro-duodenoscopy as per the need of the case.

- **Esophagoscopy:**

Esophagoscopy was done in 4 dogs having different esophageal affections. Esophageal diverticulum was present in two dogs (2/4). The radiography in first dog shown radio-opaque mass at cranial mediastinum on right lateral projection and gas filled encapsulated space cranial to heart visualized in left lateral projection. Contrast radiography revealed accumulation of barium in the gas filled pocket and the case was suspected to be an esophageal diverticulum. For confirmation, the esophagoscopy was performed which revealed the presence of a blind pouch in esophagus at a distance of 22 cm which extend up to the 35 cm from canine tooth. The blind pouch was 13 cm long, filled with ingesta along with the presence of diffuse ulceration, multi focal white mucosal plaques, increased vascularity and granularity on mucosal surface (Plate 4.35). This particular case was diagnosed as esophagus diverticulum along with secondary ulcerative esophagitis.

Plate 4.35 Radiographs and endoscopy of esophageal diverticulum in first dog:		
Right lateral projection	Left lateral projection	Barium swallow
Esophageal diverticulum (22 cm to 35 cm) on right side	Increased vascularity and ulcerative esophagitis with multi-focal white plaques	Presence of food content in diverticulum

The second dog radiography evident the presence of dilatation of esophagus with air at both cervical and thoracic site in plain radiograph (Plate 4.36). Contrast radiography revealed esophagus filled with contrast media in even after 15 minutes of barium swallow. The two pouches of retained barium were visualized on radiograph one at cervical esophagus and another at thoracic esophagus (Plate 4.36). Esophagoscopy of second adult dog revealed the presence of two esophageal sacculations, one at a distance of 17 cm and extend up to 23 cm form canine tooth. The other at 33 cm and extend up to 45 cm from canine tooth of maxilla (Plate 4.36). These diverticula were filled with undigested food material. The esophagitis with superficial erosions and irregular mucosal lining was also present. Moreover, the mucosal hypertrophy of gastric mucosa at pyloric antrum was also found in this dog. This case was diagnosed as a case of esophageal diverticulum with two diverticula.

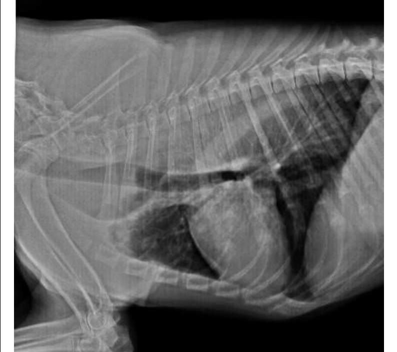
Plate 4.36: Radiograph and endoscopy of esophageal diverticulum in second dog		
Right lateral	Ventro-dorsal	Left lateral
Right lateral (Two esophagus diverticulum)	Ventro-dorsal	Left lateral
Diverticulum in cranial esophagus along presence of food material	1.Base of heart 2. Superficial erosions and irregular mucosa due to esophagitis 3. Food material present in caudal esophagus diverticulum 4. Rib impression due to dilatation 5. Frothiness in esophagus	

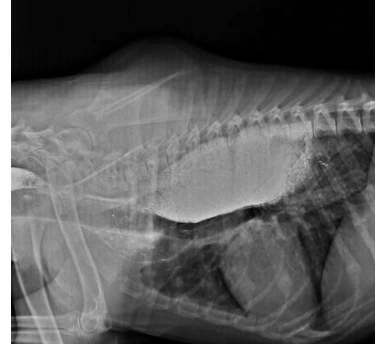
Tams and Rawlings (2011) reported that in cases of esophageal diverticulum, sac-like outpouching of the esophageal lumen along with esophagitis characterized by

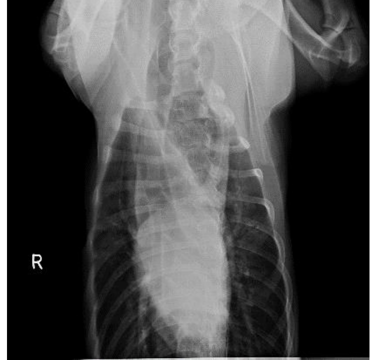
superficial erosions and irregular mucosal lining was present. The esophagitis occurs due to the gastric reflux and continuous presence of food within esophagus. They also observed that the chronic presence of fermenting ingesta in the diverticulum pouch lead to secondary white deposits of yeast on the esophageal mucosa. Suryawanshi et al. (2018) also found the similar changes in cases of esophageal diverticulum. The consequences of diverticula included abnormal esophageal motility, esophagitis, weight loss and accumulation of food and fluid within the diverticulum were also observed by (Singh et al. 2018).

The radiography of third dog (6-months-old) had dilated esophagus along with visible dorsal tracheal stripe and ventral displacement of intra-thoracic trachea seen in plain radiography (Plate 4.37). Barium swallow was performed, a generalized retention of barium contrast was seen in dilated esophagus (Plate 4.37). Thrall (2018) also said the tracheal stripe sign and ventral displacement of intrathoracic trachea is indicative of megaesophagus. The endoscopy shown the generalized distension of esophagus, flattening of longitudinal folds and pooling of food with a lot of frothiness was present (1/4). The generalized esophagitis, mucosal erythema, superficial erosions, irregular mucosal lining and pink colour of mucosa indicated megaesophagus was seen in this dog (Plate 4.37). These findings were in line with the study of Suryawanshi et al. (2018). Megaesophagus was often the cause of regurgitation in dogs and congenital megaesophagus occurred due to partial development of nerves in the esophagus (Bexfield et al. 2006).

Plate 4.37: Radiographic and endoscopic visualization of megaesophagus

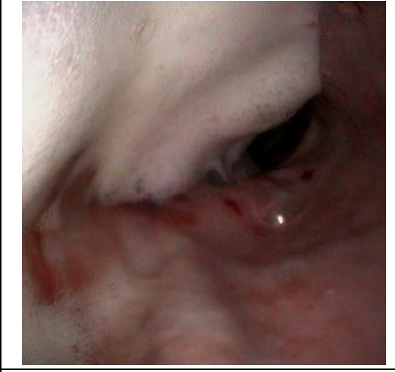
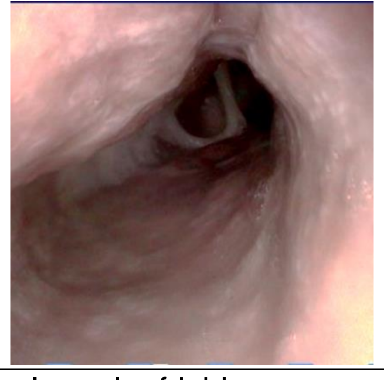
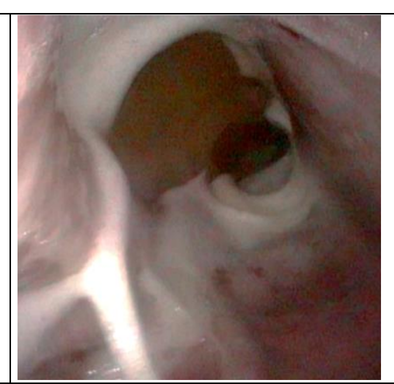




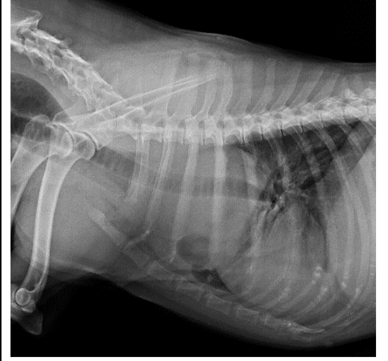
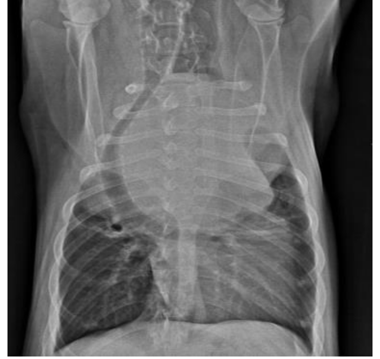
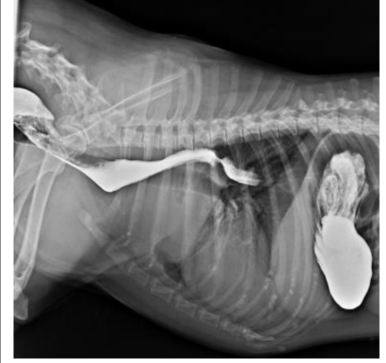


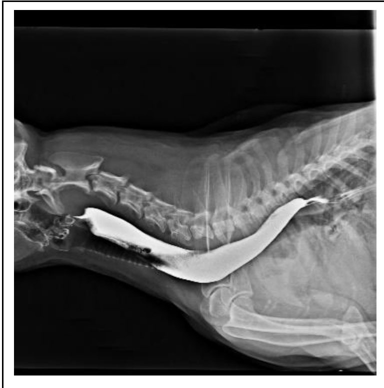
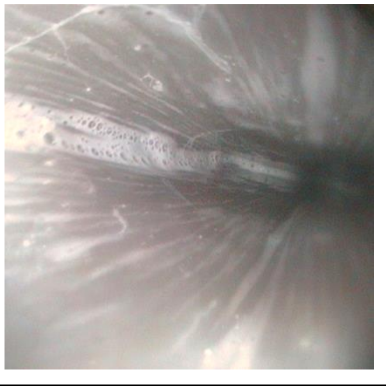
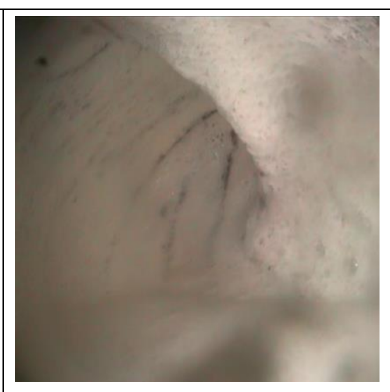
Distended esophagus along with retention of barium revealed megaesophagus

V-D plain radiograph of megaesophagus

		
Megaesophagus and superficial erosions due to generalized esophagitis	Irregular friable mucosa with pink colour due to esophagitis	Gastric contents and frothiness present in dilated esophagus

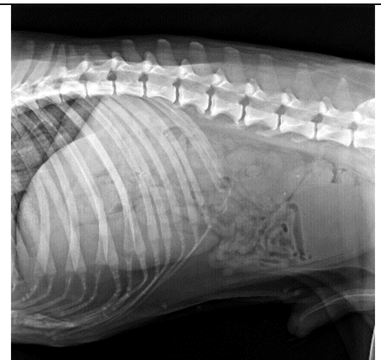
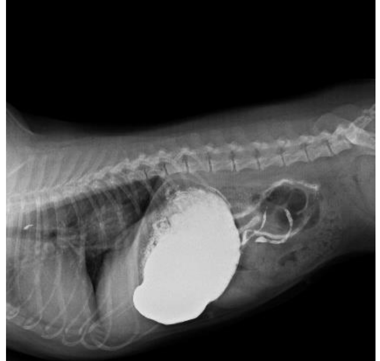
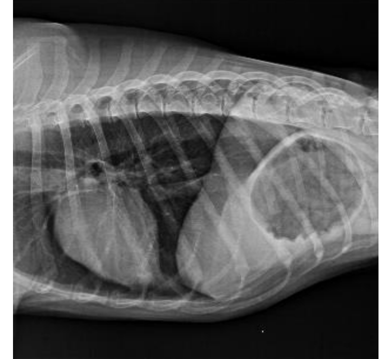
The radiography of fourth dog revealed the presence of radio-opaque mass at the cranial mediastinum and air within the cervical esophagus. Contrast radiography of same dog revealed the presence of barium within cervical esophagus and only thin line of contrast media was present over the radio-opaque mass but the contrast media was able to pass into the stomach. The dorsal deviation of esophagus was also seen in contrast radiograph (Plate 4.38). Esophagoscopy revealed the esophageal stenosis secondary to the cranial mediastinum cyst, along with presence of barium in esophagus and stomach. Such type of case was also reported by Singh et al. (2018).

Plate 4.38: Radiographic and endoscopic visualization of extraluminal mass		
		
Lateral projection	Ventro-dorsal projection	Contrast radiograph

		
Contrast radiograph	Pressed esophagus due to extra-luminal mass	Barium obscured the mucosal view

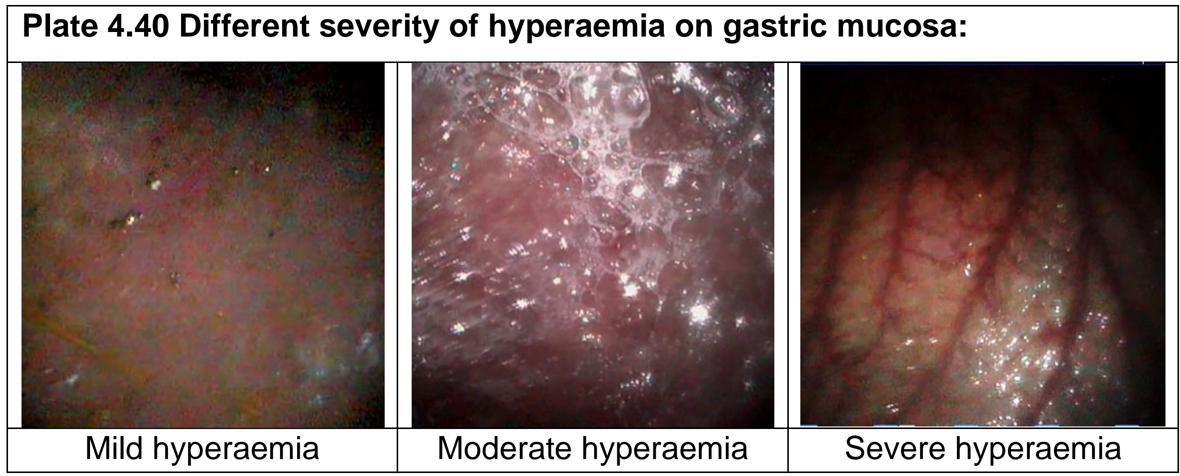
- **Gastroscopy:**

Gastroscopy was done in 12 cases and almost all of these cases had radiographical examination before endoscopy as per the need of the case. In the cases related to Gastric diseases, the most commonly encountered radiographic change was radiolucent gastric distension in plain radiograph (Plate 4.39). Moreover, gastric distension was also evident in contrast radiography (Plate 4.39). The 2/12 dogs shown increased radio-opacity at gastric region (Plate 4.39). Most of the gastric disease cases had presence of gastric mucosal abnormalities, which were confirmed only after the intervention of gastroscopy. So, the radiographic examination solely did not able to diagnose the gastric mucosal abnormalities in the study.

Plate 4.39: Radiographs related to gastric disorders		
		
Radio-opaque gastric distension	Distended gastric lumen (barium contrast	Radiolucent gastric distension

Out of 12 dogs suffering from gastric disorders the hyperaemia and vascularity on gastric mucosa were present in 8 dogs (Plate 4.40), out of these eight dogs, four (4/8) had mild hyperaemia, three dogs (3/8) had moderate and (1/8) had severe hyperaemia.

Plate 4.40 Different severity of hyperaemia on gastric mucosa:

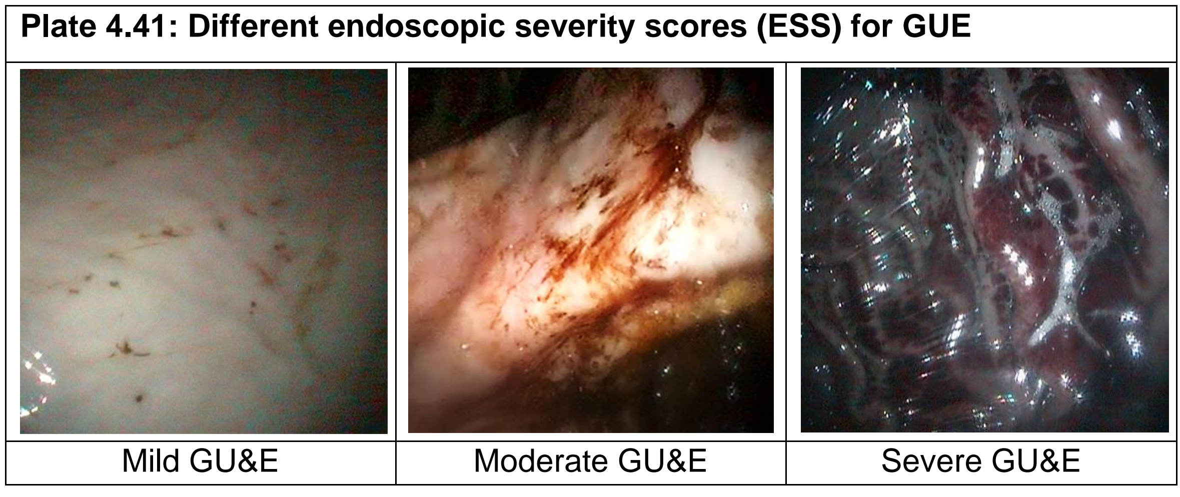


Mild hyperaemia	Moderate hyperaemia	Severe hyperaemia

Nel (2013) reported mucosal hyperaemia in cases of acute or chronic gastritis. Holzer and lippe (1992) observed the increased mucosal blood flow i.e. hyperaemia in the gastric mucosa occur due to the breakdown of gastric mucosal barrier.

The gastric ulceration and erosions (GUE) of variable intensity were present at different locations in ten dogs (10/12) (Plate 4.41). The endoscopy severity score (ESS) as per (Davis and Williamson 2016) was utilized for scoring of GUE in these dogs. The mild GUE (ESS-1) was evident in four dogs (4/10), moderate GUE (ESS-2) in four and severe GUE (ESS-3) in two cases (Plate 4.41). Out of these two severe cases, one dog (1/2) had extensive ulcers and erosion along with presence of hematin over the surface of such lesions (Plate 4.41). Matarka (1996) reported that the blood clots on gastric mucosa hemolyzed after a while and developed a hematin crust after a few hours.

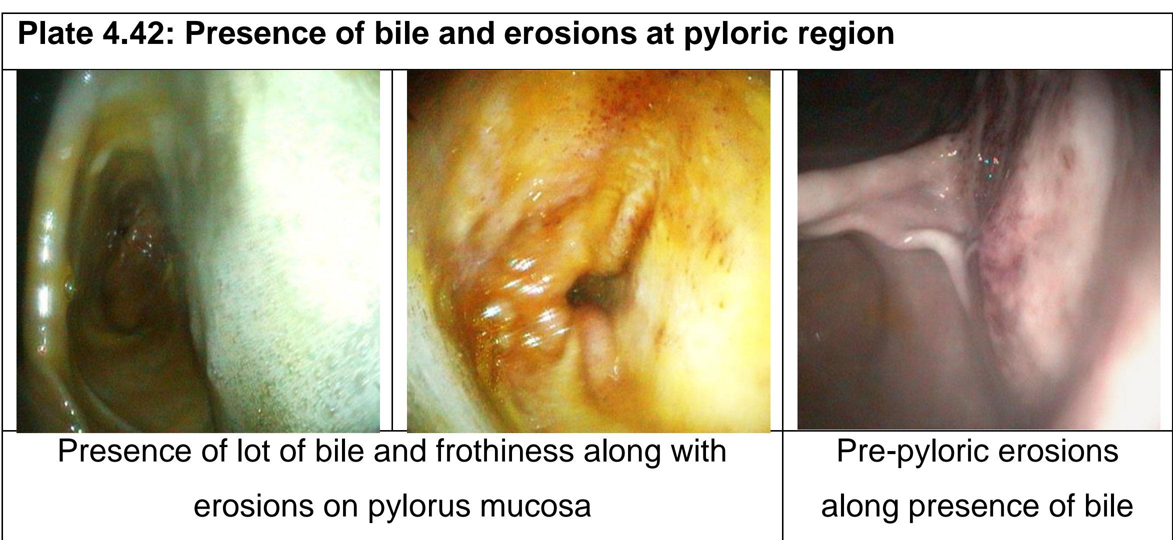
Plate 4.41: Different endoscopic severity scores (ESS) for GUE



Mild GU&E	Moderate GU&E	Severe GU&E

Based on the location of lesions, the erosions at pyloric region was present in 3 dogs (3/10), out of these, two dogs (2/3) also had bile in the pylorus and suspected to had bile reflux gastritis (Plate 4.42). These findings were in line with study of Gaag and Happe (1983). The 7 dogs (7/10) had generalized gastric ulceration and erosion.

Plate 4.42: Presence of bile and erosions at pyloric region



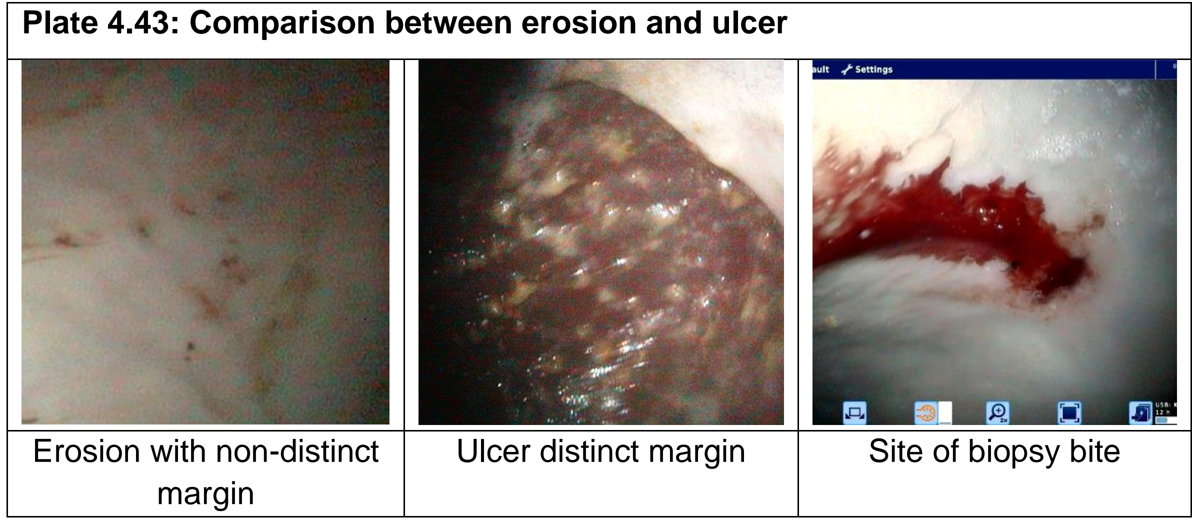
Presence of lot of bile and frothiness along with erosions on pylorus mucosa	Pre-pyloric erosions along presence of bile

Prolonged use of NSAIDs and corticosteroids in systemic diseases such as hepatic and renal disease, hypovolemic shock, hypoadrenocorticism, sepsis, spinal injury, pancreatitis, inflammatory bowel disease, chronic gastritis, various types of neoplasia including gastrinoma, race training and obstruction in gastric emptying are the predisposing factors for gastric ulceration and erosion in dogs.

The erosion is a superficial mucosal defect that is not exceeding muscularis mucosae. Erosion is an acute lesion that has a quick reaction and regeneration of the injured epithelium in a few hours or days whereas an ulcer heals with a scar.

An ulcer is a mucosal defect with deeper invasion and has a distinct base and border whereas an erosion appeared as a fleck with an indistinct margin (Plate 4.43). However, a combined term of "gastric ulceration and erosions (GUE)" is more suitable for most of the clinical conditions in dogs, because erosions can quickly develop into ulcerations and endoscopic visual inspection cannot adequately distinguish between the two. The erosion did not apply to the lesions induced due to scope tip and biopsy bite (Plate 4.43) as also suggested by (Maratka 1996) so, the term erosion was utilized only in pathologic lesions.

Plate 4.43: Comparison between erosion and ulcer



Erosion with non-distinct margin	Ulcer distinct margin	Site of biopsy bite

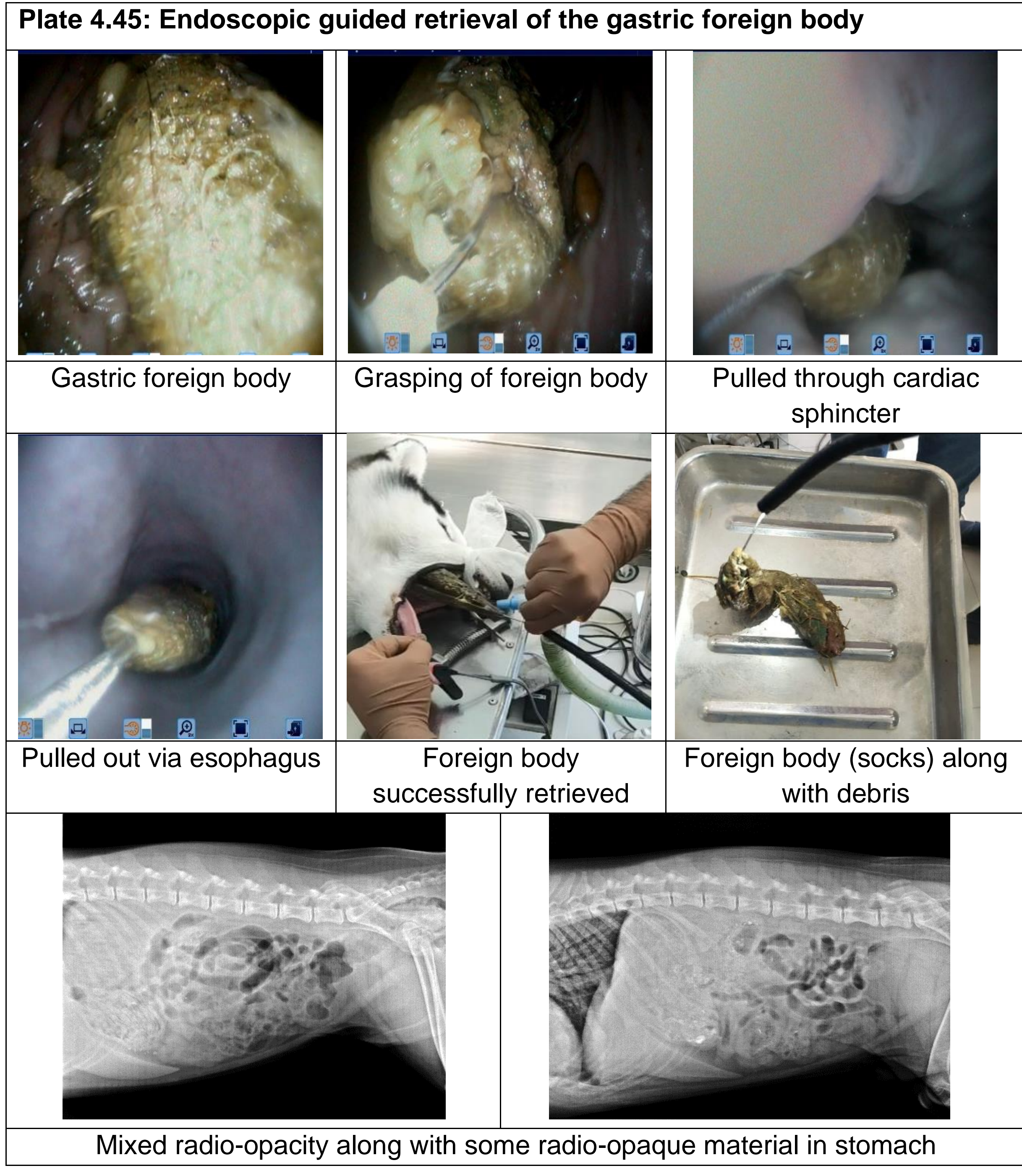
Out of ten dogs with GUE, the chronic ulcer with healed punctum over the lesion was present in one dog (1/10) (Plate 4.44). These large sized ulcers were covered with healing surface of yellowish fibrin puncta. Matarka (1996) reported that the fibrin also shrank and stick to the defect as a yellowish lining. The petechial or sub-mucosal haemorrhages were present in 3 cases (3/12) (Plate 4.44). The erosion in which bleeding prevailed were termed as hemorrhagic and later on the remnants of blood may regenerated under the superficial epithelium and form a "petechia" or a "pigment spot” (Maratka 1996).

The mucosal thinning and reduced shine of mucosal layer was evident in 3 dogs (3/12). The mucosal hypertrophy of pylorus was present in 1(1/12) dog (Plate 4.44). The pyloric mucosa had multiple raised nodules like appearance. Leib (1993) reported that in chronic hypertrophic pyloric gastropathy (CHPG) the multiple mucosal polyps were evident in some cases.

Plate 4.44: Different lesions of gastric mucosa		
Presence of healed puncta over the ulcer	Petechial/ Submucosal haemorrhages	Mucosal hypertrophy of pyloric antrum

Gastric foreign body (Socks) along with generalized hyperaemia was found in one dog (1/12). The foreign body was present in 6 months old male husky dog with history of socks ingestion and pica. Gastroscopy in this dog revealed presence of foreign body as well as some other inedible objects and generalized hyperaemia in stomach. The endoscope guided removal of foreign body was attempted and done successfully with the help of Alligator toothed foreign body retrieval forceps. In this procedure, initially the foreign body was spotted (Plate 4.45) and the alligator forceps were passed through accessory channel. The pongs of forceps were opened and further advanced it toward the foreign body. After grasping the foreign body, the insertion tube was pulled out from GIT carefully. In this manner, the foreign body was retrieved out of that dog.

Plate 4.45: Endoscopic guided retrieval of the gastric foreign body



Gastric foreign body	Grasping of foreign body	Pulled through cardiac sphincter
Pulled out via esophagus	Foreign body successfully retrieved	Foreign body (socks) along with debris

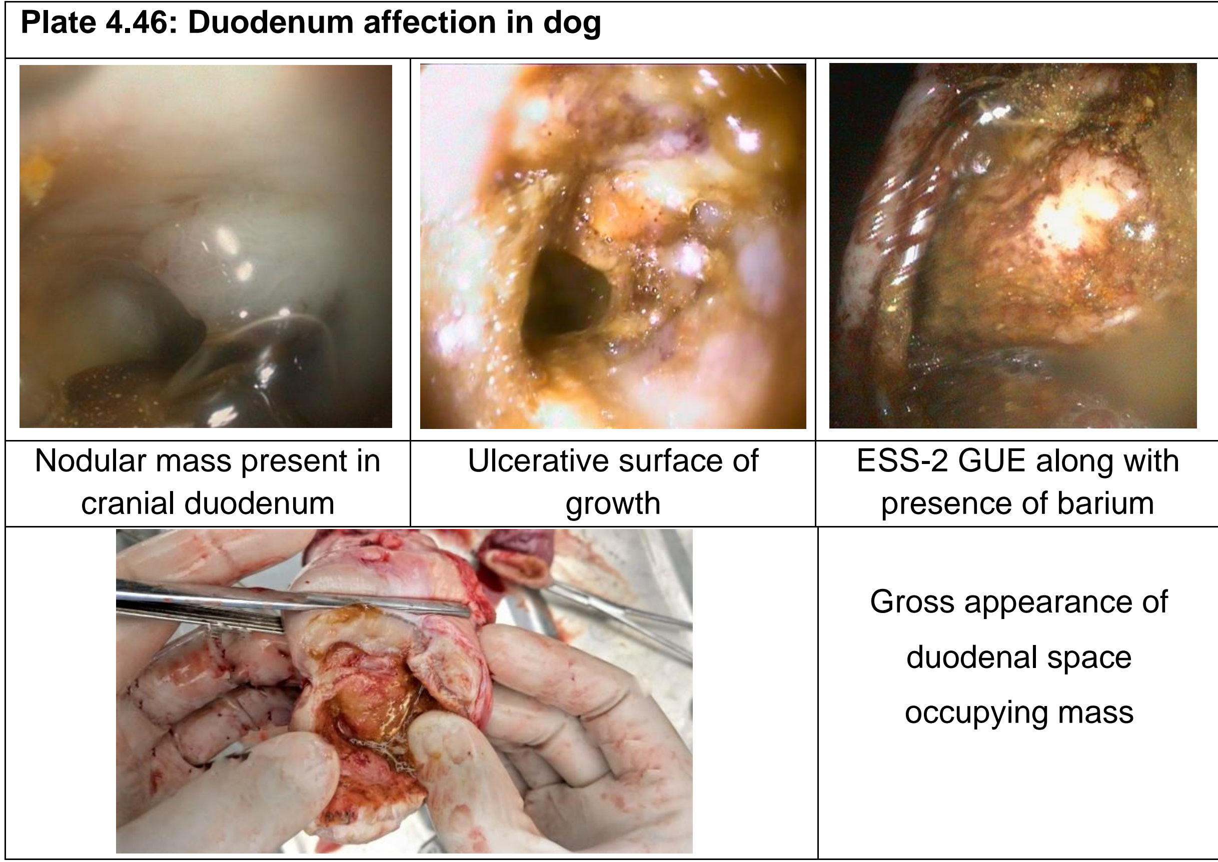
Mixed radio-opacity along with some radio-opaque material in stomach

The radiography revealed mixed radio-opacities at the pyloric region as well as presence of multiple radio-opaque objects. The radiography of this particular dog did not reveal the presence of foreign body, gastroscopy provided the confirmatory diagnosis of foreign body along with its retrieval. (Gianella et al. 2009) also noted that the radiographic examination was not facilitated confirmatory diagnosis in some cases

of gastric foreign bodies. The duration of endoscopic procedure of foreign body retrieval was 6 minutes and it also prevented the need of exploratory laparotomy in this dog. Endoscopy had proved to be effective in retrieval of foreign body without exploratory laparotomy surgery (Hall 2015). Endoscopy was found to be a beneficial tool for visualization and retrieval of foreign bodies (Singh et al. 2018).

Duodenal disease was found in one dog (1/17) suffered from chronic bile tinged vomiting, inappetence and emaciation. Duodenoscopy revealed the presence of multiple nodular mass on the mucosa with ulcerative surface and residual of barium left from the previous contrast study (Plate 4.46). These multiple growths had also decreased the duodena luminal diameter. This dog had also ESS-2 gastric ulceration and erosions score.

Plate 4.46: Duodenum affection in dog



Nodular mass present in cranial duodenum	Ulcerative surface of growth	ESS-2 GUE along with presence of barium

Gross appearance of duodenal space occupying mass

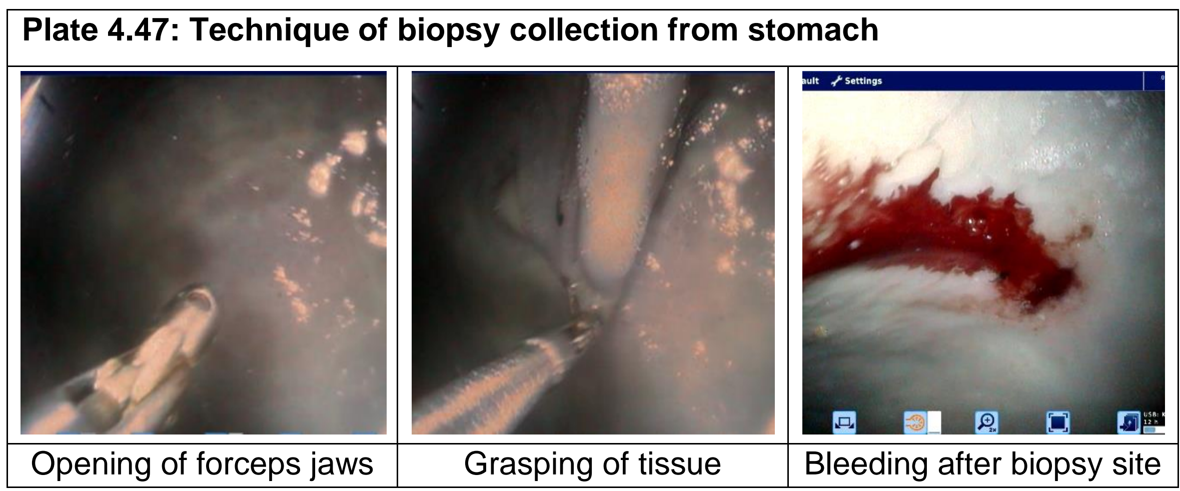
McCarthy (2005) observed the mucosal thickening along with irregular mucosal surface of duodenum in lymphosarcoma and annular thickening in adenocarcinoma which also reduced the lumen diameter of duodenum.

Gastroscopy guided interventions:

- **Gastroscopy guided biopsy:**

The gastroscopy assisted biopsy collection was done after critically evaluated for any lesion or abnormality using gastroscopy. Under gastroscopy examination, each portion of the gastric lumen was thoroughly examined and after identification of abnormal area or lesion present on the mucosa, the flexible biopsy forceps were passed through an accessory channel into the stomach. Afterwards, the biopsy forceps were placed over the abnormal area of gastric mucosa under endoscopic guidance followed by the opening of forceps jaws. The tissue under question was firmly grasped and then retrieved for histopathological examination. The biopsy procedure was carried out in five dogs, it caused some amount of localized bleeding without any clinical consequence in all of these cases (Plate 4.47).

Plate 4.47: Technique of biopsy collection from stomach



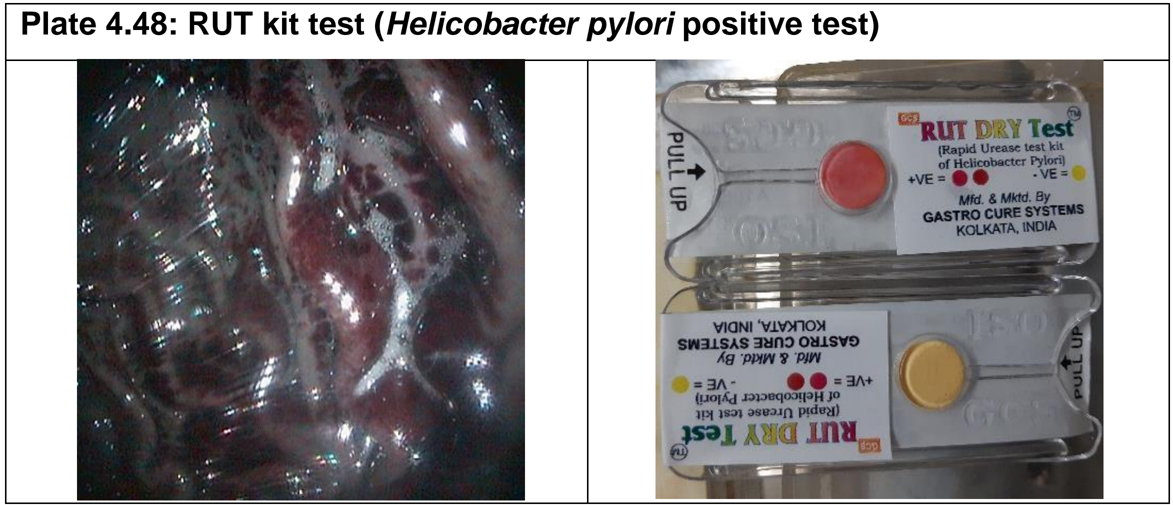
Opening of forceps jaws	Grasping of tissue	Bleeding after biopsy site

- **Rapid urease test (RUT kit test):**

Rapid urease test was done for diagnosis of *Helicobacter pylori* in dogs. The tissue biopsy was performed for this test. The biopsied tissue was placed on the yellow well placed over the kit and observed the change in colour of disc. If it became red then test will be positive and if no colour change was there it indicated the negative test for *H.pylori*. This test was done in five dogs with gastric lesion. One dog (1/5) with severe GUE was positive for RUT test (Plate 4.48). Rapid urease test detected the presence of bacterial urease produced by *Helicobacter spp* in a biopsy sample. The test comprised of agar gel with urea and a pH indicator (i.e., phenol red) in a small, plastic

well. The biopsy sample from the stomach should be pushed into the gel. The test should be maintained at room temperature and examined frequently for 24 hours. If bacterial urease was present, urea will be hydrolyzed to ammonia, changing the pH of the gel. The gel should turn from yellow to magenta (Leib and Duncan 2005).

Plate 4.48: RUT kit test (*Helicobacter pylori* positive test)



- **Gastroscopy guided foreign body retrieval:**

  Same as discussed above (Plate 4.42).

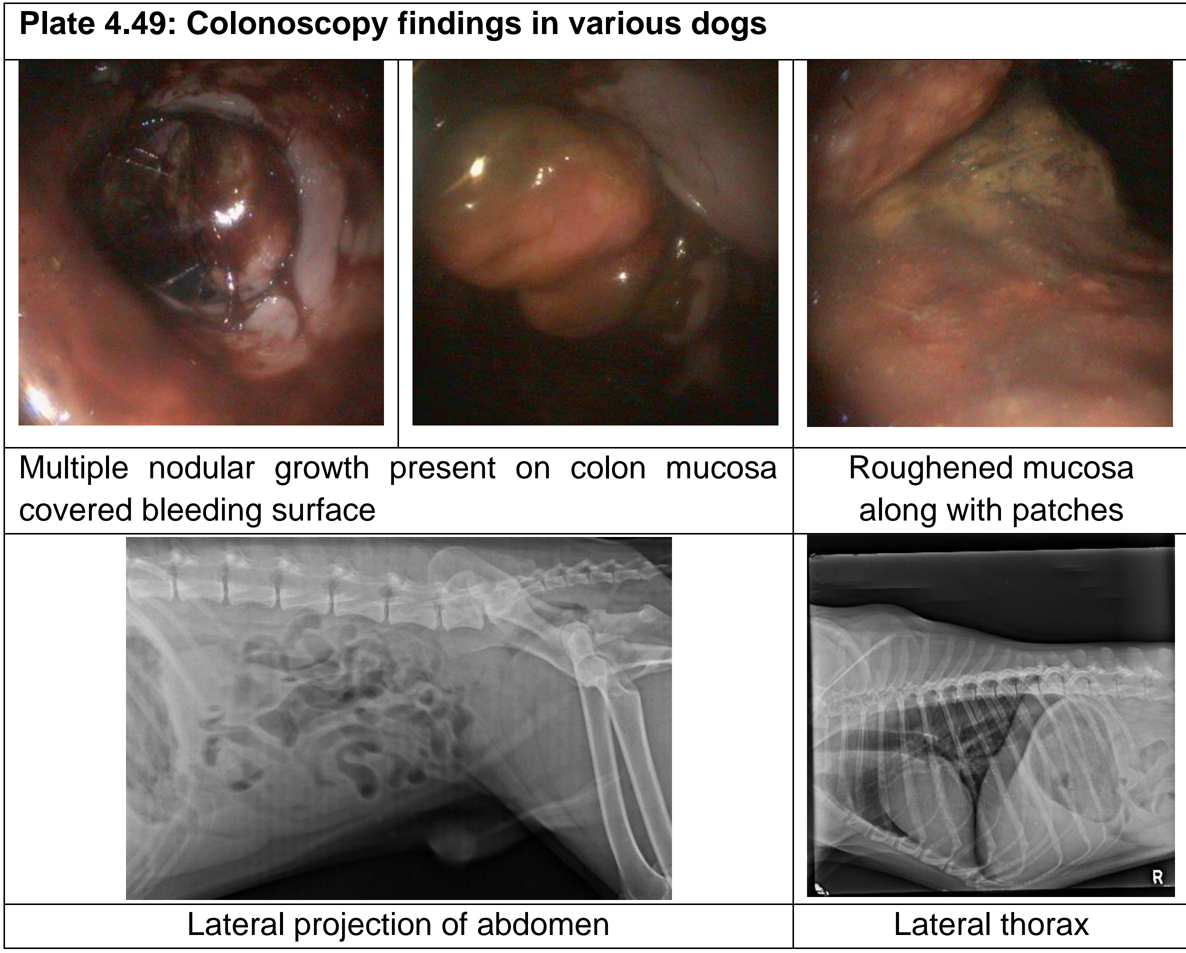
Colonoscopy:

Colonoscopy was done in 5 dogs who were presented with signs such as diarrhea, hematochezia, tenesmus, loss of body condition, reduced appetite and not responding to previous medicinal therapy.

Out of which, one dog (1/5) was presented with the history of haematochezia, tenesmus and reoccurrence of perianal growths (previously surgically removed). The colonoscopy revealed multiple nodular growths along with bleeding surface in colon extending from 8cm inside the anal opening up to transverse and descending colon. The mucosa was roughened with patchy surfaces throughout the colon (Plate:4.49). In this dog peri-anal neoplastic growth was also present. Cytological examination revealed round cell tumour. The radiological examination in this particular dog did not able to diagnose these lesions within lower GIT, which were found during the colonoscopy of that dog. The scheduled surgery by carbon dioxide laser assisted removal of perianal growths on the same day was also cancelled after discovering the

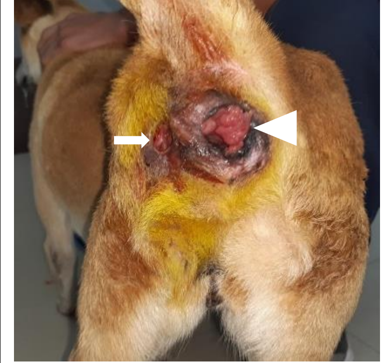
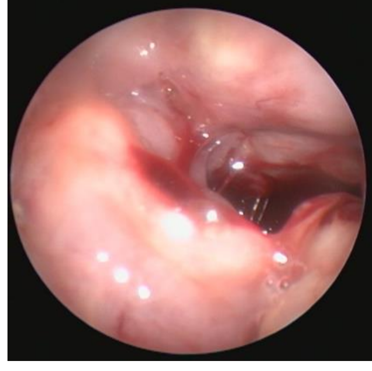
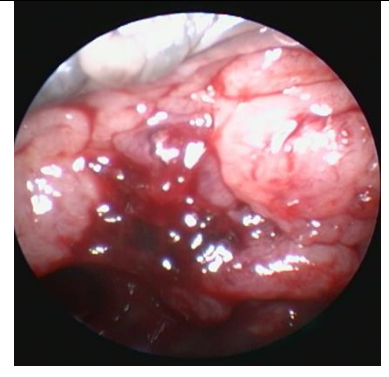
extensive spread of the tumour. Rippe (2017) suggested that in cases of rectal tumours, the complete examination from rectum to the ileo-ceaco-colic junction under colonoscopy was must to rule out the spreading of tumour on the colonic mucosa. Colonoscopy had been regarded as a valuable preoperative diagnostic modality for evaluating dogs with rectal masses in order to define the position and type and number of the lesion (Rippe 2017).

Plate 4.49: Colonoscopy findings in various dogs



Multiple nodular growth present on colon mucosa covered bleeding surface	Roughened mucosa along with patches
Lateral projection of abdomen	Lateral thorax

In one dog (1/5) ulcerated growth was present in perianal region and rectum. Colonoscopy revealed annular constrictive type mass was present in rectum along with presence of rectal fistula (Plate 4.50). Fine needle aspiration cytology revealed pleomorphic vacuolated cells indicative of malignant tumour of round cells and also increased serum calcium level. McCarthy (2005) also given the similar findings in cases of rectal neoplasms.

Plate 4.50: Rectal growth along with rectal fistula		
		
Perianal growth along with rectal fistula	Multiple raised growths in rectum	Ulcerated cauliflower like growth present in rectum

The colorectal tumours are more prevalent in male dogs. About 2/3rd of colorectal tumours in dogs were malignant adenocarcinoma with high rate of metastasis. The less common rectal neoplasm was lymphosarcoma and leiomyosarcoma. According to the shape and structure these colorectal tumours were categorized as nodular (single or multiple), pedunculated or annular constrictive. The annular constrictive like growth had higher rate of malignancy as compared to pedunculated growth (Morello et al. 2008).

The presence of mucosal shreds was evident in two dogs (2/5) with chronic history of loose feces and weight loss (Plate 4.51). The radiographic examination did not assist the diagnosis (Plate 4.51).

Colonoscopy revealed the presence of barium in colon of fifth dog (1/5), who previously undergone contrast study, which obscured the visualization of colon mucosa but otherwise, there was no obstruction or growth in the colon (Plate 4.51). The plain radiograph of the same case showed the reduced the serosal detail of lower GIT tract with uniform presence of contrast within the lower GIT tract (Plate 4.51) while contrast radiography.

Plate 4.51: Radiography and endoscopy of dogs with lower GIT affections

Lateral projection (dog with mucosal shred)	V-D projection (dog with mucosal shred)	Lateral projection (fifth dog)
V-D projection: 1. Sigmoid flexure 2. Descending colon 3. Splenic flexure 4. Transverse colon 5. Hepatic flexure 6. Ascending colon, Arrow head- Caecum		Lateral projection in contrast radiograph
Pooling of mucosal shreds from the ileo-colic junction	Presence of mucosal shreds in the colon	Barium obscured the colonic mucosa

4.3: Upper Respiratory tract including trachea endoscopy:

The total of 25 endoscopies of upper respiratory tract and trachea were carried out in this study.

4.3.1: Standardization phase:

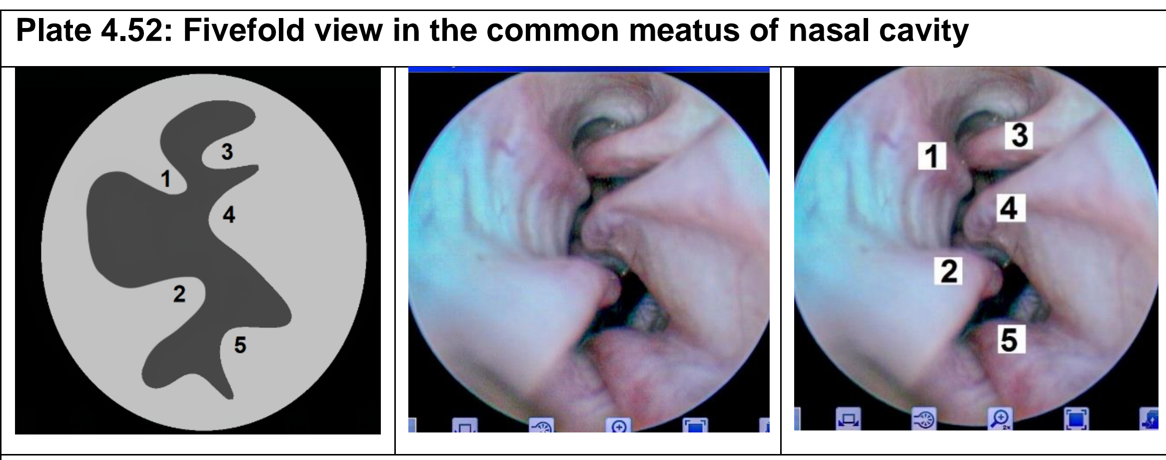
The standardization trials were conducted on 5 dogs with mild upper respiratory tract symptoms without any history of epistaxis and respiratory distress. The trials were performed for the visualization of mucosa and structures of upper respiratory tract and trachea. The animals were kept fasted for 12 hours before endoscopy procedure for performing general anaesthesia.

Note: For easier understanding and writing, the standardization and clinical phase of following techniques were discussed separately one by one.

4.3.1.1: Technique of Rhinoscopy:

Rhinoscopy was performed in either dorso-ventral (sternal) or lateral recumbency with placement of positioning aid under the neck of the dog. For unilateral cases, the lateral recumbency with affected side placed down was preferred as it can reduce the chances of contamination to unaffected side. The surgical plane of general anaesthesia (GA) was preferred for performing rhinoscopy because dogs used to jerk their heads and sometimes sneeze vigorously in the light plane of GA. Due to the sensitivity of nasal mucosa, light plane of GA was not adequate for performing rhinoscopy in dogs (McCarthy 2005). The multi-purpose 2.7mm rigid scope along with protective sleeve was used for the procedure. Lignocaine jelly (2%) was applied on the protective sleeve of the scope. The nasal planum was raised with thumb of non-dominant hand and the scope assembly was held in dominant hand. The scope was passed ventro-medially to avoid any obstruction of scope tip into alar fold. Once the scope passed the alar fold, it was straightened and advanced into nasal cavity. The scope tip was gradually advanced and the first image obtained was common nasal meatus where endoscopic five-fold view was visualized. These five folds were dorsal septal swell body and ventral septal swell body at medial aspect whereas plica recta, plica alaris and plica basalis on the lateral aspect (Plate 4.52).

Plate 4.52: Fivefold view in the common meatus of nasal cavity

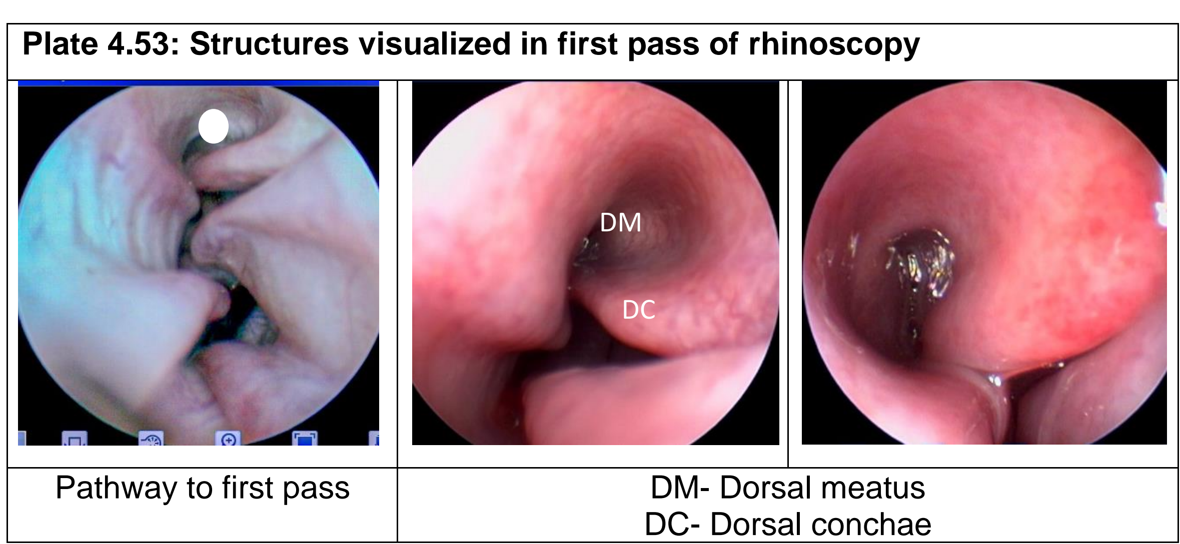


Fivefold view- 1. Dorsal septal swell body, 2. Ventral septal swell body, 3. Plica recta, 4. Plica alaris, 5. Plica basalis.

The common nasal meatus was examined for presence of any kind of growth, foreign body, generalized changes of turbinate and bleeding source etc. Then the scope was inserted into different meatus for performing various passes of rhinoscopy.

The first pass was performed for visualization of dorsal meatus which was located over the ossified fold of dorsal conchae (Plate 4.53). The scope tip was directed dorsally and advanced into dorsal meatus for examination. The dorsal nasal concha (turbinate) was a single curled scroll of bone. The alar fold branched intensely into ventral conchae which disintegrates the contour of all the meatuses except for dorsal meatus. In the nasal cavity, the dorsal and ventral conchae were predominately present.

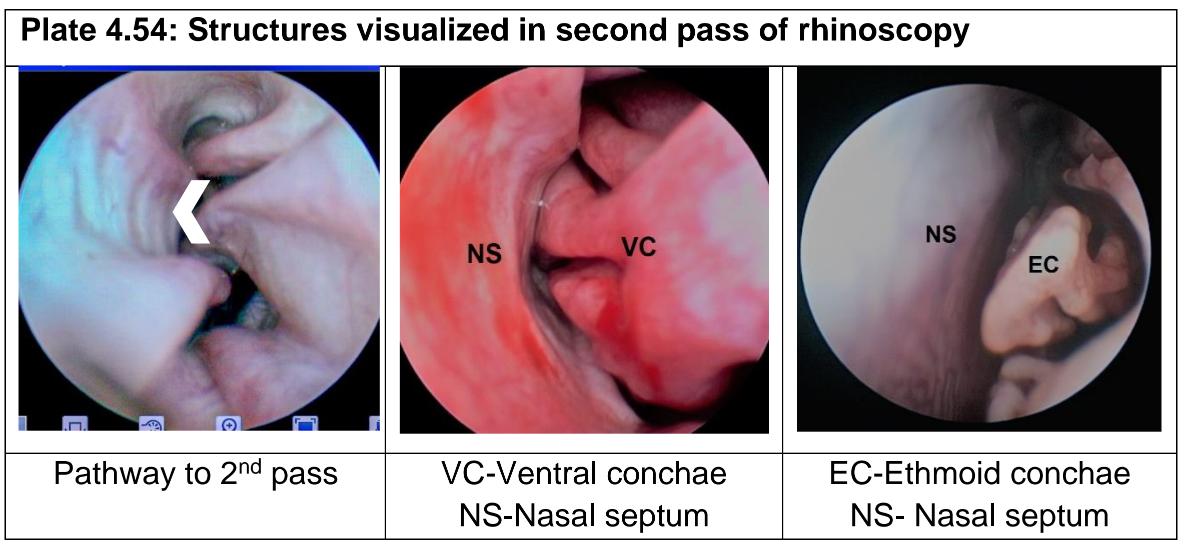
Plate 4.53: Structures visualized in first pass of rhinoscopy



Pathway to first pass	DM- Dorsal meatus DC- Dorsal conchae

In the second pass, the scope was advanced in between the nasal septum and plica alaris for visualization of ventral nasal concha (Plate 4.54). The ventral conchae had a series of tightly folded scrolls originated from single fold (Plate 4.54). While further advancement of scope into this pathway, the ethmoid conchae were visualized at the caudal part of the nasal cavity which also comprised of number of bony scrolls. Both ventral and ethmoid conchae were examined for any alteration such as hyperaemia, hypertrophy, bleeding and any kind of space occupying lesion etc. The caudal end of these ethmoid turbinate was attached to the cribriform plate and extend dorsally into the frontal sinus.

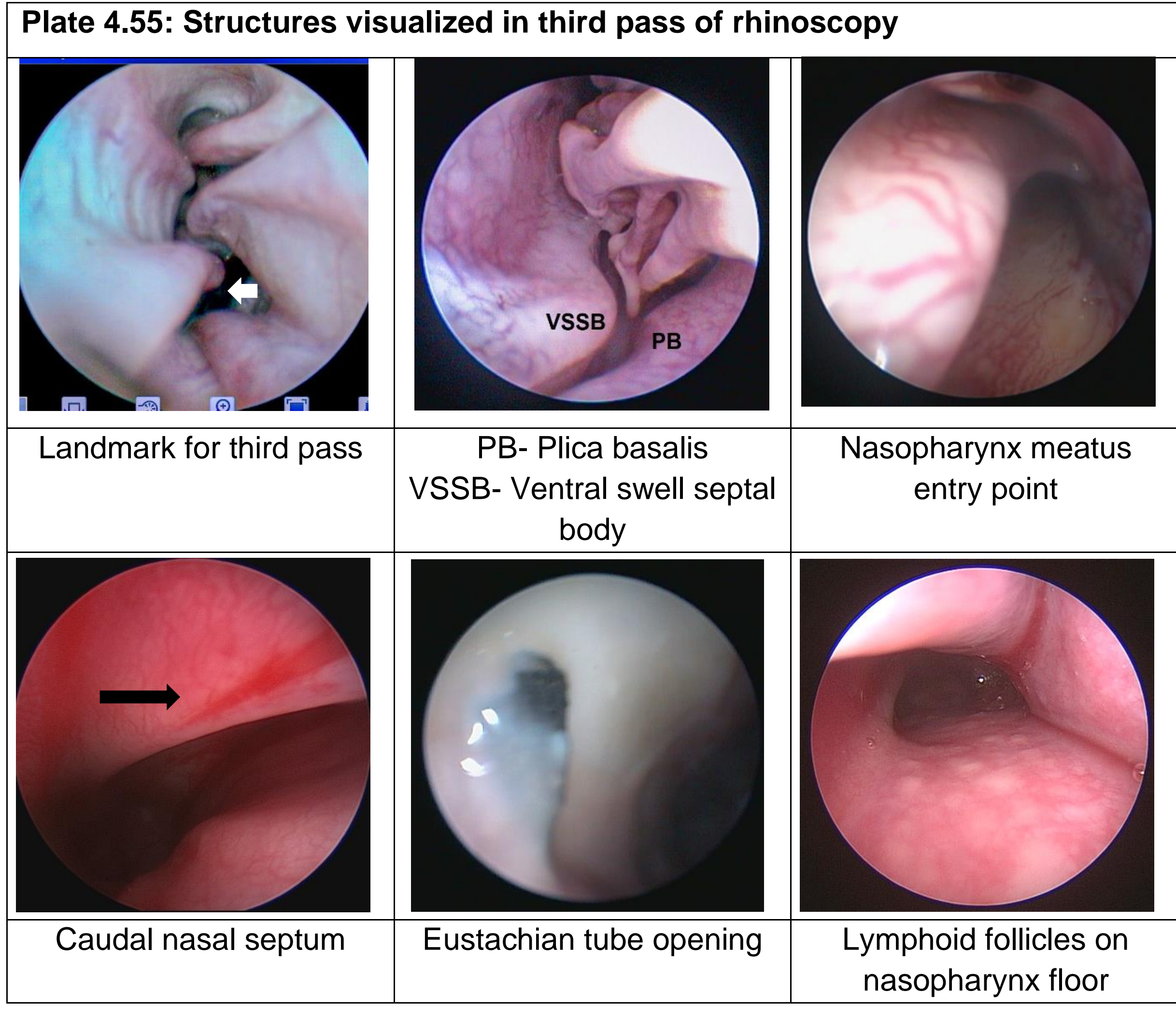
Plate 4.54: Structures visualized in second pass of rhinoscopy



Pathway to 2nd pass	VC-Ventral conchae NS-Nasal septum	EC-Ethmoid conchae NS- Nasal septum

Then the scope was directed ventro-medially between plica basalis and ventral septal swell body for performing the third pass for visualization of nasopharyngeal meatus (ventral nasal meatus) (Plate 4.55). In third pass, various structures were visualized such as nasopharynx, caudal nasal septum and eustachian tube openings (Plate 4.55). The eustachian tube openings were visualized as slits at the dorsal lateral walls of nasopharynx. These structures were examined for any sort of mucosal alteration. This third pass was also known as nasal exit (Ettinger et al. 2017). Alternate irrigation and suction were performed intermittently throughout the procedure to avoid any hindrance in the view and remove any debris or exudates from the nasal cavity (Tams and Rawlings 2011). The nasopharyngeal meatus is bordered by the vomer dorsally and the palatine bone ventrally.

Plate 4.55: Structures visualized in third pass of rhinoscopy



Landmark for third pass	PB- Plica basalis VSSB- Ventral swell septal body	Nasopharynx meatus entry point
Caudal nasal septum	Eustachian tube opening	Lymphoid follicles on nasopharynx floor

The size, shape, contour and colour of turbinates were evaluated in all the rhinoscopy passes. The normal turbinate mucosa was pink in colour and it had glistening mucosa with evenly spaced smooth rounded scroll like appearance. Noone (2001) also reported the similar findings of normal nasal mucosa. The nasopharynx had irregular mucosa due to presence of lymphoid follicles (Plate 4.55). The soft palate forms the ventral floor of caudal nasopharynx.

For rhinoscopy, either 2.7 mm telescope with sleeve or video-otoscope was utilized for performing rhinoscopy. The 2.7 mm rigid endoscope was able to perform all the three passes. However, otoscope was unable to perform third pass but image quality was superior as compared to 2.7 mm telescope (Plate 4.56). Moreover, video-otoscope also facilitated endoscope guided retrieval of foreign bodies or biopsy

collection from nasal cavity due to presence of accessory channel. The iatrogenic endoscopy bleeding was evident with protective sleeve of 2.7 mm telescope in some cases whereas video-otoscope reduced the chance of iatrogenic bleeding during the procedure.

Plate 4.56: Comparison of picture quality of different endoscope in same dog	
Image taken by 2.7 mm rigid endoscope	Image taken with video-otoscope

4.3.1: Clinical application of upper respiratory tract and trachea endoscopy:

4.3.1.2: Rhinoscopy:

A total of 12 dogs were presented for rhinoscopy, out of which 8 dogs underwent Bilateral rhinoscopy and in remaining 4 cases underwent unilateral rhinoscopy. The total Rhinoscopies was done in 20 nasal cavities. Out of these ten dogs, ten were male (84%) and two were female dogs (16%). According to breed-wise distribution, the four nasal cavities belonged to gaddi breed followed by German shepherd and Mongrel dogs both with 3 nasal cavities.

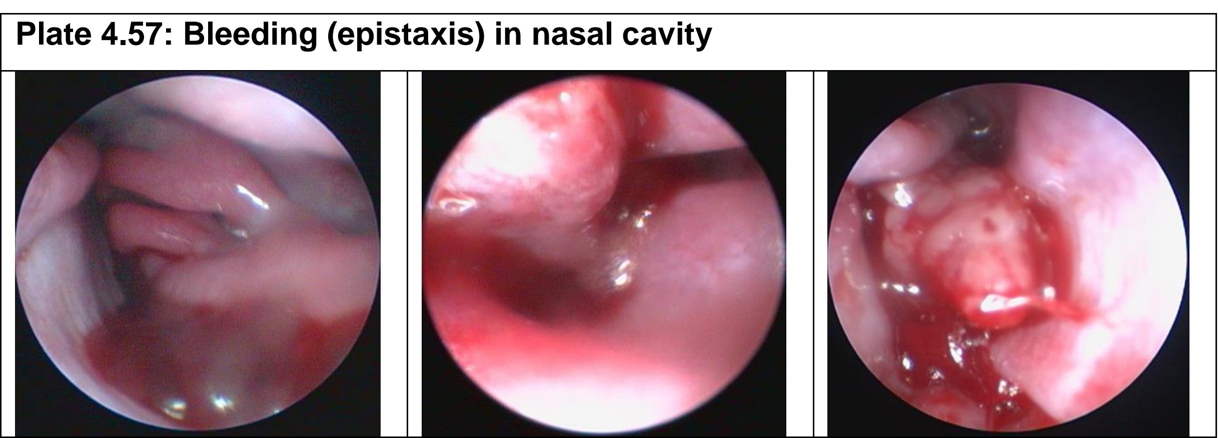
Epistaxis:

Ten dogs were presented with the chief complaint of nasal bleeding (epistaxis), six having unilateral bleeding whereas four dogs had bilateral bleeding. Bleeding and blood clots were found in fourteen nasal cavities (14/20) in total (Plate 4.57). The distribution of epistaxis according to etiology was given in (Table 4.3).

Table 4.3: Distribution of epistaxis cases according to the nasal cavities

Epistaxis (total)	Bilateral epistaxis (8)	Unilateral epistaxis	
		Right (5)	Left (1)
14 nasal cavities	Fungal rhinitis (2 nasal cavities)	Five nasal cavities - nasal tumours	One nasal cavity – tumour
	Nasal tumour (4 nasal cavities)	One- turbinate hypertrophy	
	Nasal leeches (2 nasal cavities)		

Plate 4.57: Bleeding (epistaxis) in nasal cavity

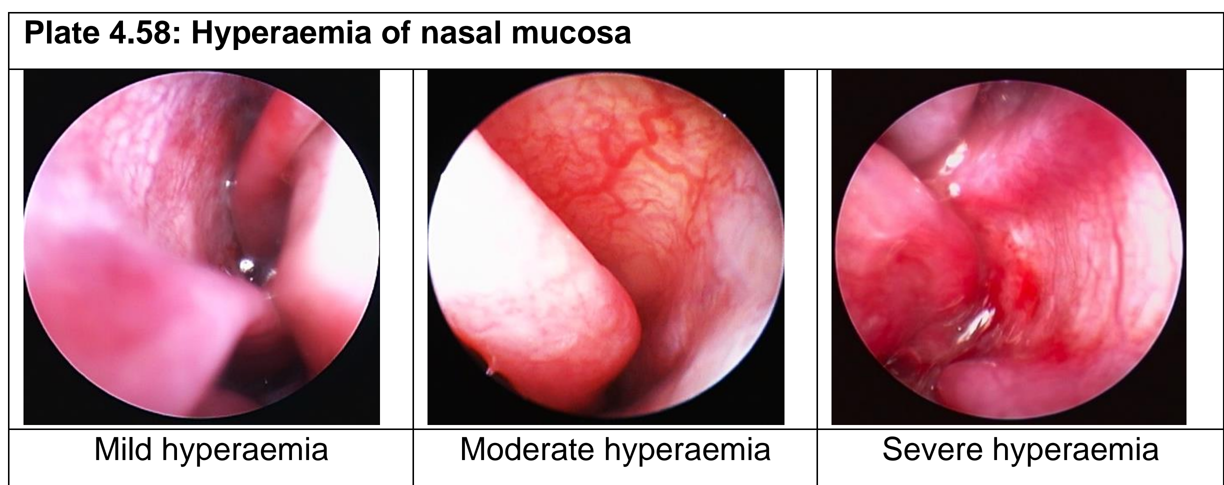


The nasal bleeding (epistaxis) is caused by multiple etiologies such as nasal tumour, fungal rhinitis, hyper-viscosity syndrome, hypertension, various coagulopathies, nasal *hirutidiasis* (leeches), hemoprotozoan diseases (*Ehrlichia canis*) and parasitic rhinitis (*Pneumonyssoides*). The nasal tumours are the common cause for chronic intermittent unilateral epistaxis.

Nasal Hyperaemia:

Out of 20, 11 nasal canals had presence of varying degree of hyperaemic nasal mucosa (Plate 4.58). Mild hyperaemia was present in two nasal canals, moderate hyperaemia in four nasal canals (fungal rhinitis (1) and rest three in neoplastic condition) and severe hyperaemia was present in five nasal canals (allergic rhinitis (2), nasal leeches (2) and one had turbinate hypertrophy along with their clubbing which was diagnosed as chronic inflammatory rhinitis along with pleomorphic epithelial cells on the basis of cytological examination).

Plate 4.58: Hyperaemia of nasal mucosa



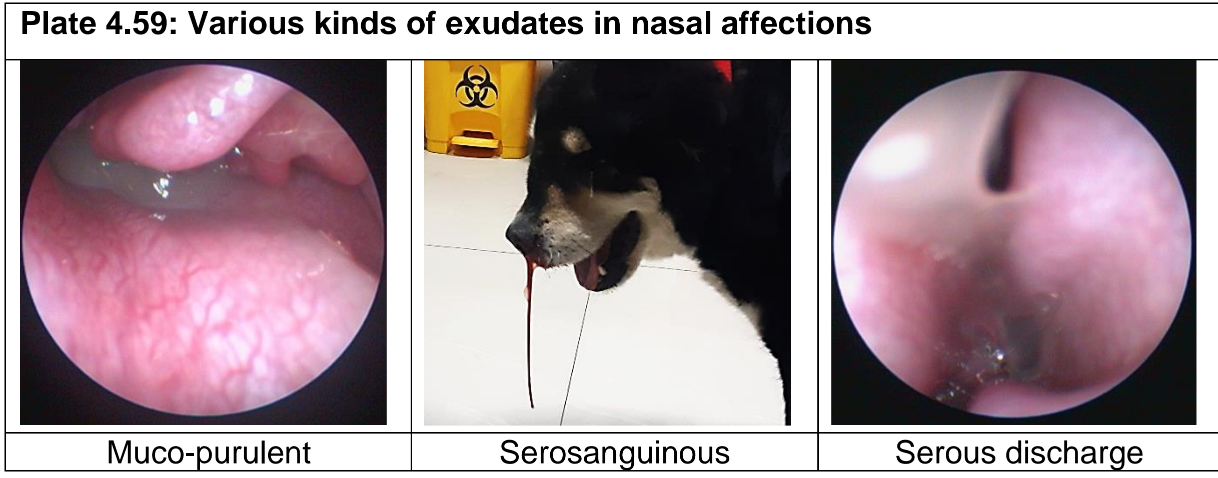
Mild hyperaemia	Moderate hyperaemia	Severe hyperaemia

Hyperaemia is the increased blood flow in the nasal mucosa. The increased blood supply into turbinate causes its hypertrophy. The factors which causes direct irritation of nasal canal lining such as foreign body, allergic rhinitis, presence of growth within nasal cavity and fungal rhinitis lead to increase blood flow in nasal mucosa (hyperaemia). In canines, chronic lymphoplasmacytic rhinitis showed severe hyperaemia along with turbinate clubbing in nasal cavity in chronic lymphoplasmacytic rhinitis (Tams and Rawlings 2011).

Nasal Exudate:

The exudate was evident in ten nasal cavities. Out of which, three had mucopurulent nasal discharge, five had serosanguinous discharge and serous discharge was present in two dogs (Plate 4.59). Nasal cavity with exudate had secondary bacterial or fungal infection as shown by culture sensitivity test.

Plate 4.59: Various kinds of exudates in nasal affections



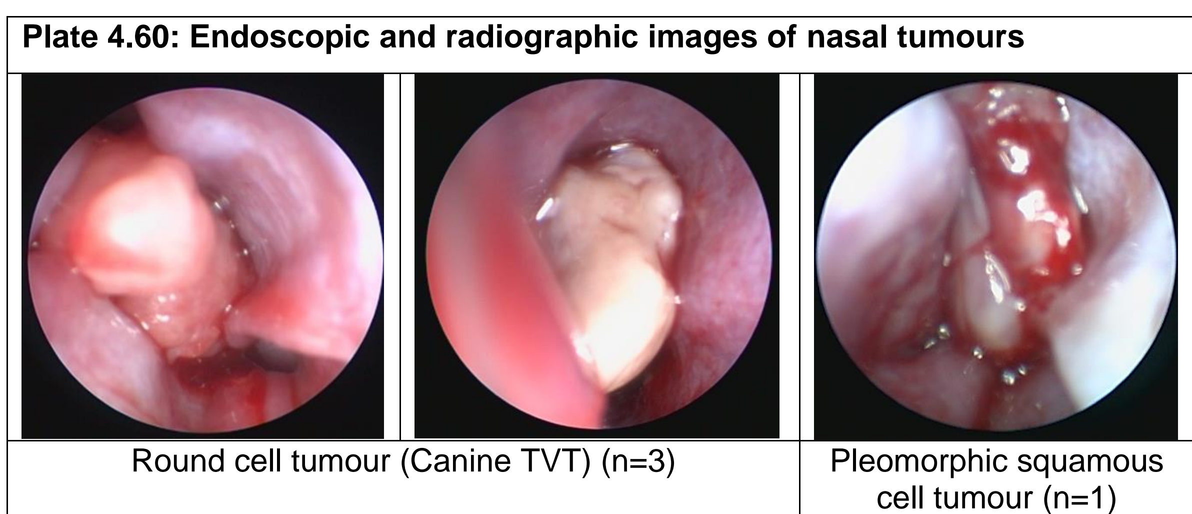
Muco-purulent	Serosanguinous	Serous discharge

The various types of nasal discharge (exudate) such as serous, mucopurulent and serosanguinous present in nasal cavities were not specific for disease conditions, However the type of exudate was depending on the stage and duration of disease condition (Tams and Rawlings 2011).

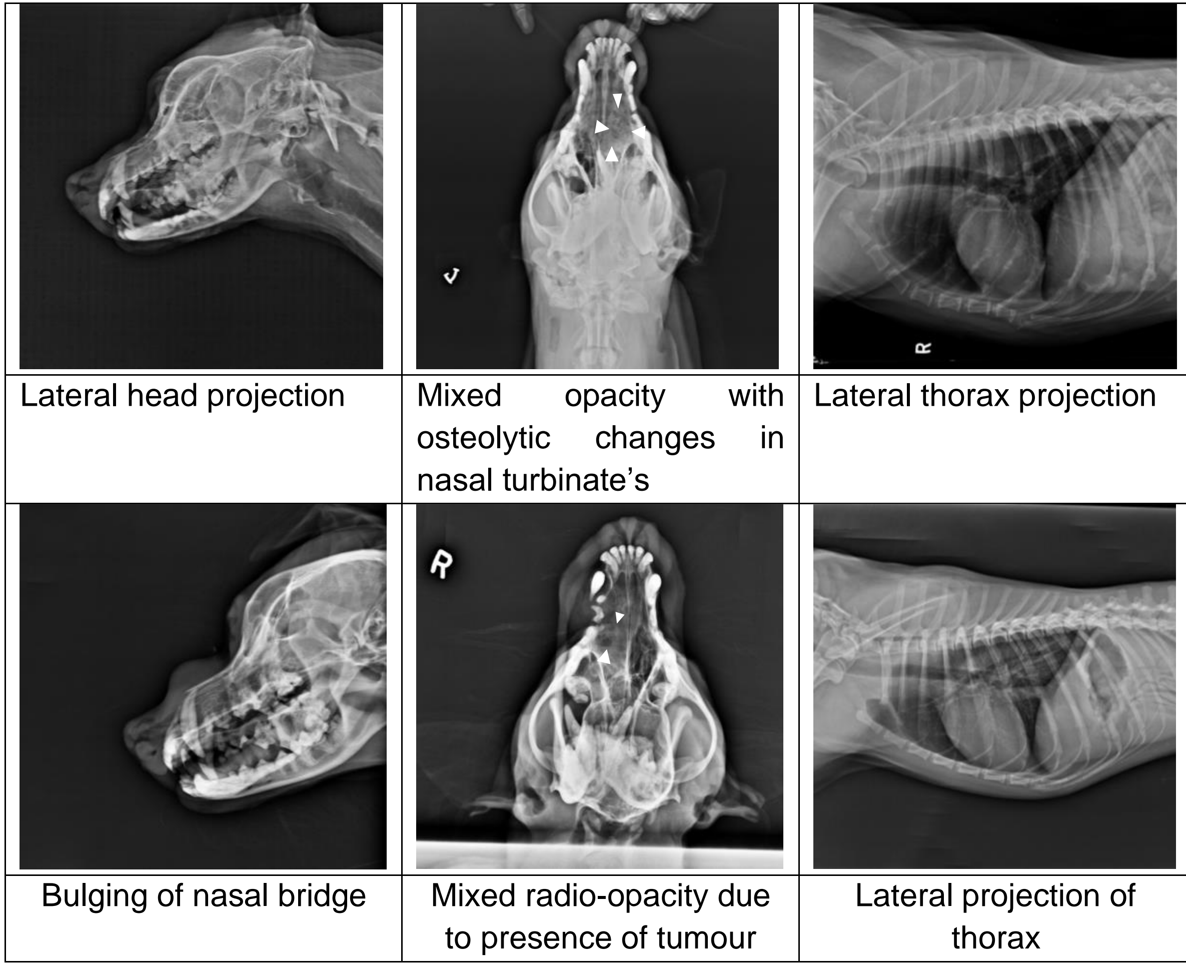
Nasal growths and Tumours:

The neoplastic conditions involving nasal cavities were found in seven clinical cases. Out of these, the growths or irregular masses were present in six nasal cavities. Endoscopically all these six nasal cavities had presence of growths that were unilateral, fragile in nature, altered colouration along with irregular mucosa, hyperaemia (2/6) and presence of blood clots (6/6) (Plate 4.60). Cytology and biopsy were done in all of these growths for pathological examination. Out of these 6 growths, five were diagnosed as round cell tumour (canine transmissible venereal tumour) (Plate 4.60) and one dog had pleomorphic squamous cell carcinoma (Plate 4.60). The radiological examination of these dogs revealed the presence of mixed radio-opacities along with loss of conchae lining details within nasal cavity (Plate 4.60). Changes regarding nasal meatuses and nasal conchae were well appreciated in open-mouth ventro-dorsal projection (Plate 4.60).

Plate 4.60: Endoscopic and radiographic images of nasal tumours



Round cell tumour (Canine TVT) (n=3) | Pleomorphic squamous cell tumour (n=1)



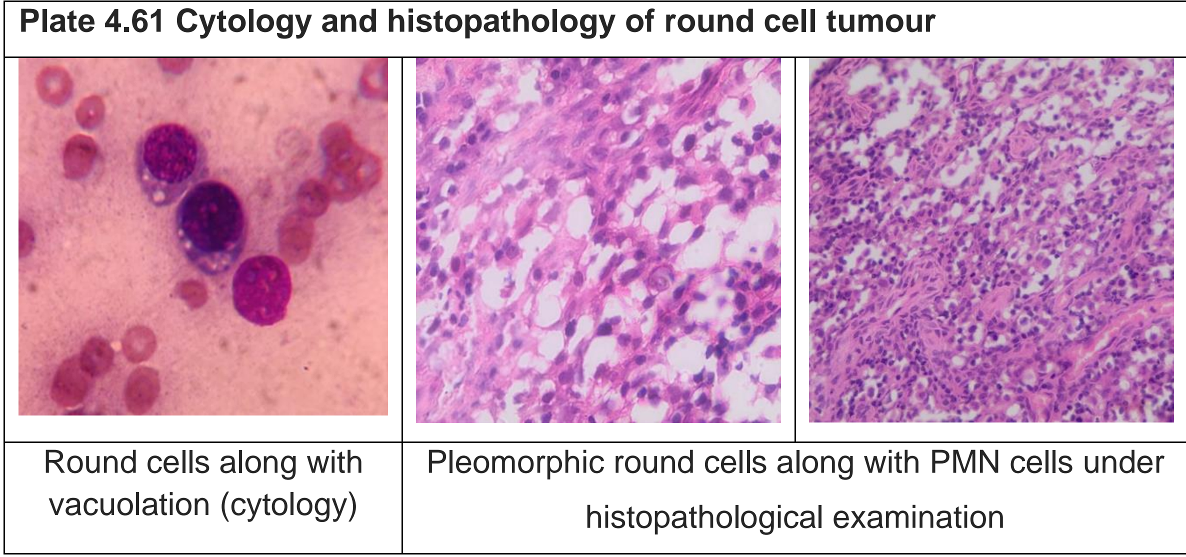
Lateral head projection	Mixed opacity with osteolytic changes in nasal turbinate’s	Lateral thorax projection
Bulging of nasal bridge	Mixed radio-opacity due to presence of tumour	Lateral projection of thorax

The chronic history of unilateral intermittent epistaxis, sneezing, snoring and raised nasal bridge was common in 4 cases whereas one dog presented with bilateral intermittent epistaxis, snoring and presence of fistula between nasal bones had bilateral presence of nasal tumour. The common nasal meatus was found as the most common location of these tumors in the study.

There were total seven cases of nasal tumours. Out of them four cases (male dogs) had the history of mating and sniffing of stray female dogs along with chronic nasal disease symptoms. The rhinoscopy, cytology and histopathological examination revealed these were the cases of canine transmissible venereal tumour (round cell tumour) (Plate 4.61). Parker (2021) also emphasized that the nasal TVT should be investigated as a differential diagnosis for dogs with history of epistaxis, nasal

discharge and decreased airflow. The travelling history of dogs in TVT prone areas also became an important factor for nasal TVT (Parker 2021).

Plate 4.61 Cytology and histopathology of round cell tumour



Round cells along with vacuolation (cytology)	Pleomorphic round cells along with PMN cells under histopathological examination

Another tumour (1/7) with nasal sinusitis was presented involving nasal sinuses and nasal bone. The affected dog was presented with facial disorientation, highly elevated nasal bridge and crepitation at the site of sinuses with lot of serosanguinous discharge coming out of both the nasal cavities (Plate 4.62). Rhinoscopy did not revealed presence of any distinct margin of space occupying mass in the nasal cavity but the thick exudate was present, which was suction out with lot of irrigation by 0.9% isotonic normal saline solution. The tumour was diagnosed as round cell tumour along with heavy bacterial infection with the help of cytology. The radiographical examination revealed the osteolysis of nasal bones and sinuses was observed in lateral radiograph (Plate 4.62). There was increased radio-opacity in frontal sinuses (Plate 4.62), which also appreciated in lateral radiograph. Thrall (2018) also documented the increased frontal sinus opacity in the cases of advanced nasal tumour or due to the presence of excessive mucus in the frontal sinus (Plate 4.62).

All of the above discussed neoplastic condition also had heavy secondary bacterial infection as diagnosed by cytological and microbiological examination.

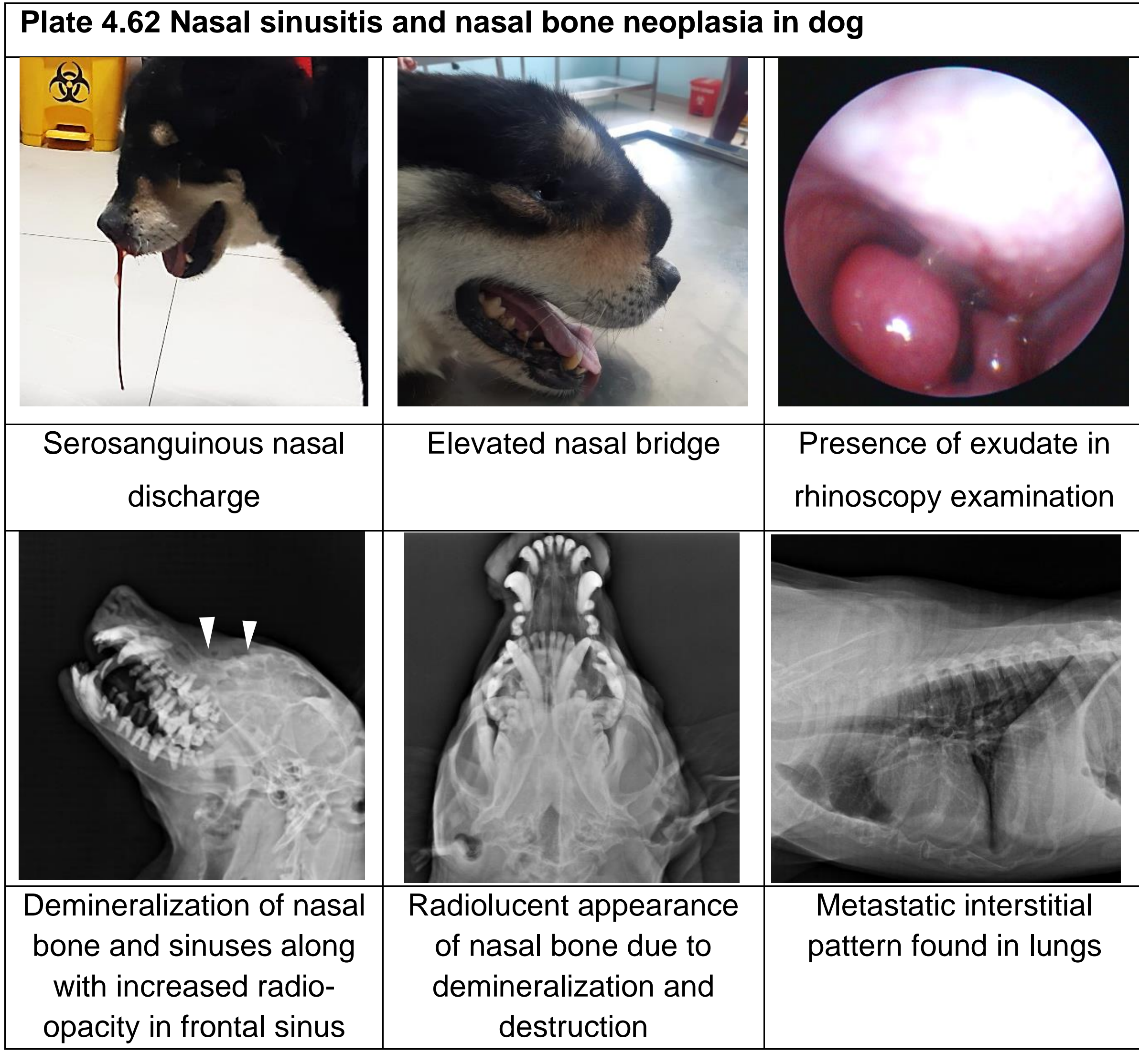


Plate 4.62 Nasal sinusitis and nasal bone neoplasia in dog

Serosanguinous nasal discharge	Elevated nasal bridge	Presence of exudate in rhinoscopy examination
Demineralization of nasal bone and sinuses along with increased radio-opacity in frontal sinus	Radiolucent appearance of nasal bone due to demineralization and destruction	Metastatic interstitial pattern found in lungs

Lobetti (2009) suggested that nasal neoplasia was the most commonly encountered chronic nasal disease diagnosed with rhinoscopy. Nasal cavity tumours have an aggressive radiographic appearance, with bony invasion and loss of concha detail being common radiographic features (Thrall 2018). In fungal rhinitis, there were increased radio-opacity in the nasal cavities along with trabecular pattern due to turbinate destruction (Lobetti 2009).

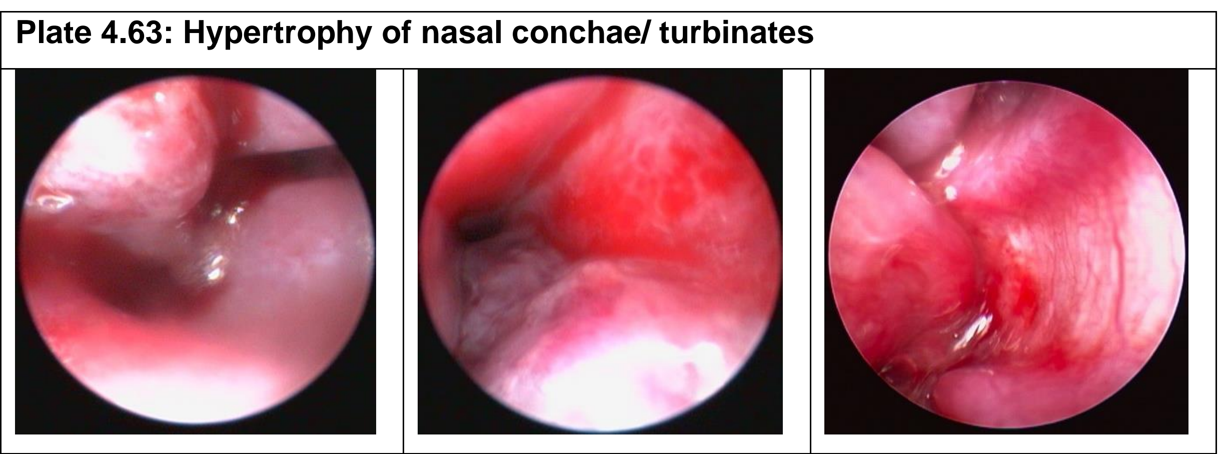
Rhinoscopy provided the confirmation of growth within nasal cavity of dogs, who were suspected for nasal tumours by clinical and radiographical examination (Harris et al. 2014). The rhinoscopy is utilized as an alternative for CT scan at places where CT

scan was not available and rhinoscopy guided biopsy was quite beneficial for making confirmatory diagnosis of tumour.

Hypertrophy of turbinates:

Hypertrophy/Swelling of turbinates were present in 3/20 nasal cavities. In all of these cases, hyperaemia of nasal mucosa was also present. The clubbing of nasal conchae was evident in all the nasal cavities with hypertrophied nasal conchae. (Plate 4.63)

Plate 4.63: Hypertrophy of nasal conchae/ turbinates



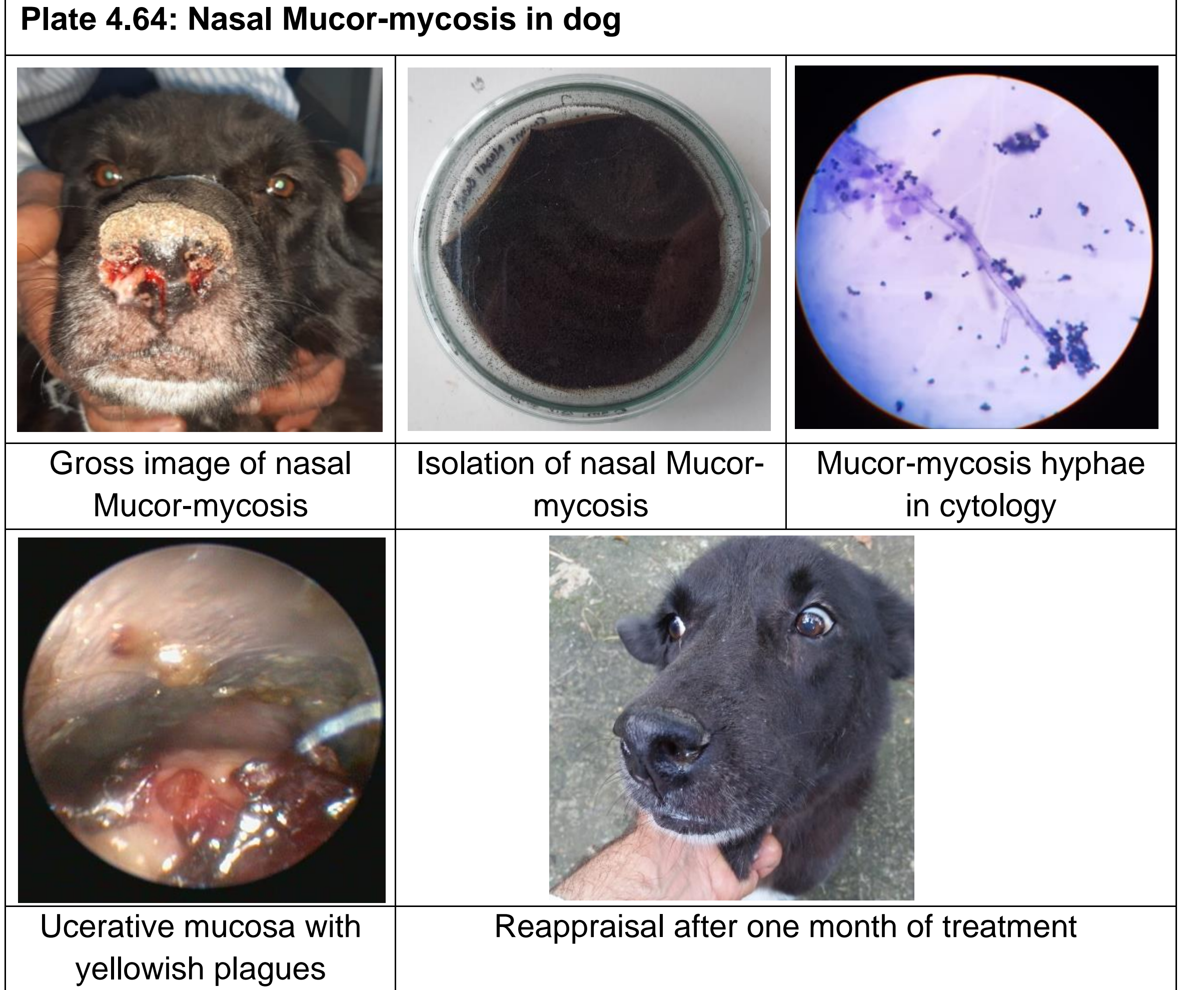
Hypertrophy of turbinate is due to severe hyperaemia and congestion of blood within the turbinate due to an inflammatory response of nasal mucosa (Tams and Rawlings 2011).

Ulcerative lesions of nasal mucosa:

The ulcerative lesions were present in four nasal cavities (4/20) two had presence of ulcerated, hyperemic mucosa and exudate along with presence of white to yellow plaques over the mucosa (Plate 4.64) and was diagnosed as Nasal Mucor-mycosis (fungal infection) with help of cytological and microbiological examination (Plate 4.64). Nasal mucormycosis was rare severe fungal disease of nose. The dogs were presented with epistaxis, mucopurulent nasal discharge, sneezing and nose pawing. Shirani et al. (2008) reported the gross lesions of nasal mucormycosis case such as the ulceration, depigmentation or crusting of the external nares, these findings

were also in line with the case of the present study. Nasal rhinoscopy revealed the ulcerative mucosa was present along with turbinate destruction (Shirani et al. 2008).

Plate 4.64: Nasal Mucor-mycosis in dog

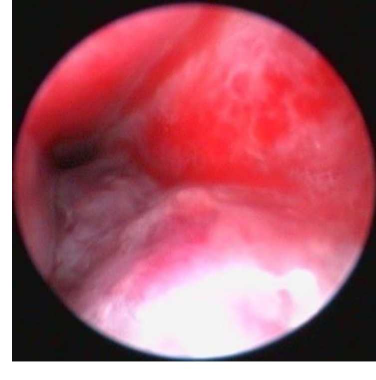
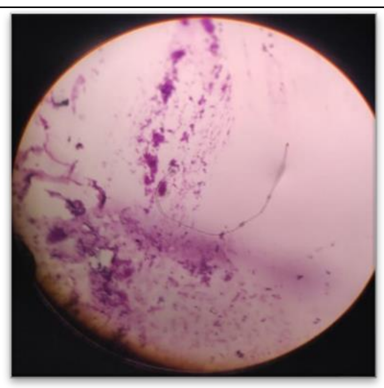


Gross image of nasal Mucor-mycosis | Isolation of nasal Mucor-mycosis | Mucor-mycosis hyphae in cytology

Ucerative mucosa with yellowish plagues | Reappraisal after one month of treatment

The other two nasal cavities had presence of ulcerated mucosa along with destruction of turbinate and nasal septum (Plate 4.65). These nasal cavities were affected with nasal aspergillosis, which diagnosed with help of microbial isolation and cytology (Plate 4.65).

Plate 4.65: Gross, endoscopic and cytological visualization of nasal aspergillosis

		
Gross image of nasal aspergillosis	White mucosal plagues with erosive surface	Fungal hyphae seen in cytology

Lobetti (2009) also recorded similar types of mucosal alterations in the cases of fungal rhinitis. The rhinoscopy guided nasal swab provided better results for cytological examination and fungal culture. Ostrzeszewicz and Sapierzyński (2015) suggested that samples taken under endoscopy eye control gave better sensitivity for fungal culture.

Nasal leech infestation:

Nasal leech infestation was evident in two nasal cavities of same dog (bilateral). The case was presented with history of sneezing, epistaxis, reverse sneezing and previous episodes of nasal leech infestation. Rhinoscopy found the presence of leech in both the nasal cavities at the level of ethmoid conchae during the second pass.

Plate 4.66 Visualization and retrieval of leech from nasal cavity

Nasal leech infestation in nasal cavity	Grasping of nasal cavity	Abnormal contour of ethmoid conchae

The nasal mucosa was severely hyperaemic, irregular, friable and bleeding spots were present along with altered contour of ethmoid turbinate (Plate 4.66). The leeches were retrieved from both nasal cavity with help of endoscope guided grasping forceps (discussed later).

Leeches are blood-sucking hermaphroditic parasites with variable colour and length. The leech belonged to class *Hirudinea* and its infestation is known as *Hirudiniasis*. It acts as foreign body and parasite in the nasal cavity of dogs and causes severe nasal congestion. The incidence of nasal leech infestation is depending upon the geographical area. Leech infestation in dogs is due to drinking of water and swimming in rural water stream. The most common symptoms were recurrent epistaxis, sneezing and wriggling of leech outside the nostril (Chen et al 2010). The nasal leech is removed by concentrated salt solution as traditional method but with variable success rate and complications. Ralte et al (2020) removed nasal leech by placed the nose of dog 1 cm above salt solution tub and when the leech was hanging out of nostrils, then grasped it with the help of forceps after several attempts. Whereas endoscope guided removal of nasal leech provides good success rate and avoid any unnecessary complication in the study.

The clinical study of 12 dogs for nasal affections shown that the diagnostic approach which included survey radiography, cytology, rhinoscopy, culture and histopathological examination helped to reach upon the confirmatory diagnosis of chronic nasal diseases in dogs. Pietra et al. (2010) found that rhinoscopy along with histopathological examination was the gold standard for diagnosing nasal tumours in dogs.

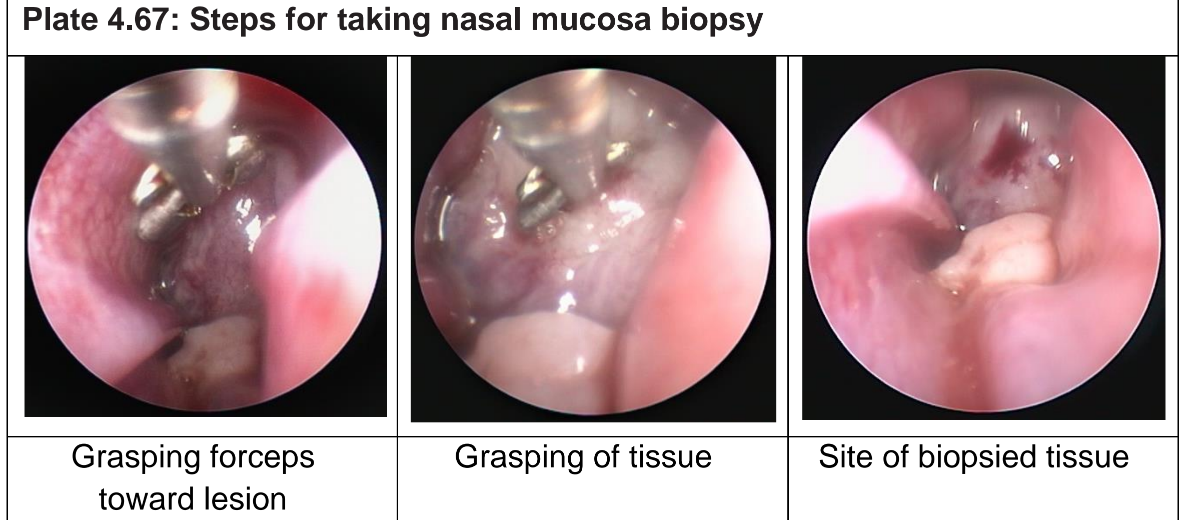
Rhinoscopy guided interventions: most of these interventions were performed with the help of video-otoscope.

- **Endoscope guided biopsy collection:**

Nasal biopsies were taken with help of flexible biopsy forceps (video-otoscope accessory). The forceps were inserted through accessory channel of endoscope (Plate 4.67). Then after selecting the site of interest scope was steadily placed at one

field. The desired tissue was grasped after closing the jaws of forceps were retrieved along with tissue obtained within the jaws of forceps (Plate 4.67). The nasal biopsies were done in five cases.

Plate 4.67: Steps for taking nasal mucosa biopsy



Grasping forceps toward lesion	Grasping of tissue	Site of biopsied tissue

- **Endoscope guided cytology sampling:**

The video-otoscope was utilized for taking endoscope guided cytology sample from nasal cavity. After the identification of the lesion within the nasal cavity, the otex cyto-brush was passed through accessory channel of video-otoscope. Under the endoscope guidance, cyto-brush was rolled in anti-clockwise direction over the desired tissue. Afterwards, cyto-brush along with scope was pulled out from nasal cavity and the sample material was evenly distributed on the clear glass slide.

- **Endoscope guided retrieval of nasal leech:**

The nasal leech was removed from nasal cavity with the help of video-otoscope guided grasping forceps from two nasal cavities. The presence of leech within the nasal cavity was identified. In both the cases leech was sticking the nasal mucosa at the level of ethmoid conchae. Then grasping forceps was inserted through accessory channel and was retrieved after gently grasping the body of the leech. The scope was slowly pulled out from nasal cavity along with grasped leech.

4.2.1.3: Oropharynx:

Affection related to oropharynx were present in two dogs. One dog was presented with chief complaint of blood-tinged sputum, nasal mucoid discharge along with heavy snoring, intermittent sneezing and rapid weight loss. Endoscopy revealed the presence of irregular shape mass over the soft palate up to the caudal end of nasopharynx in this dog. The mucosal surface of mass was ulcerated, pale pink, irregular and semisolid in consistency (Plate 4.68). In this case, rhinoscopy was also performed, which revealed the presence of bleeding and blood clots in left nasal cavity and muco-purulent discharge in right nasal cavity. Multiple biopsies were also taken from the growth of soft palate. Cytological and histopathological examination revealed presence of infiltration of fibrous tissue with pleomorphic fibroblasts along with presence of polymorphonuclear cells (PMN'c) and Mononuclear cells (MNC). The growth was diagnosed as fibroma of mesenchymal origin. The chemotherapy (doxorubicin and cyclophosphamide) was given and marked reduction in size of tumour and symptoms (increased body weight) were recorded after 21 days. (Plate 4.68).

The second dog was suffered from brachycephalic airway syndrome. The endoscopy revealed presence of elongated soft palate (discussed later).

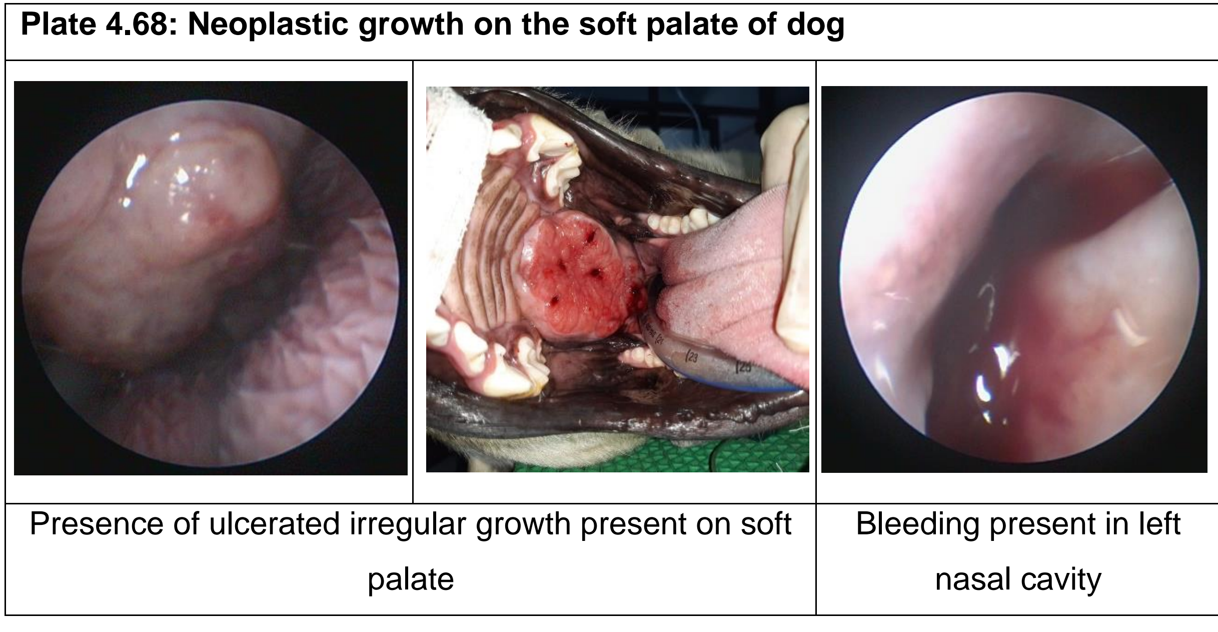
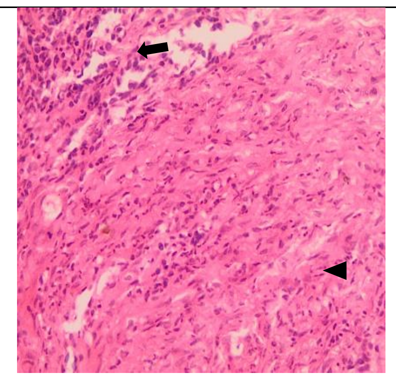
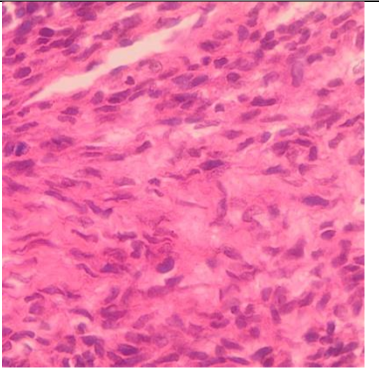
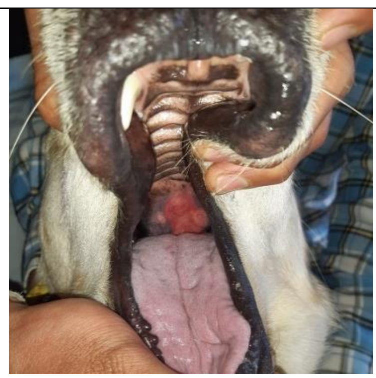


Plate 4.68: Neoplastic growth on the soft palate of dog

Presence of ulcerated irregular growth present on soft palate		Bleeding present in left nasal cavity

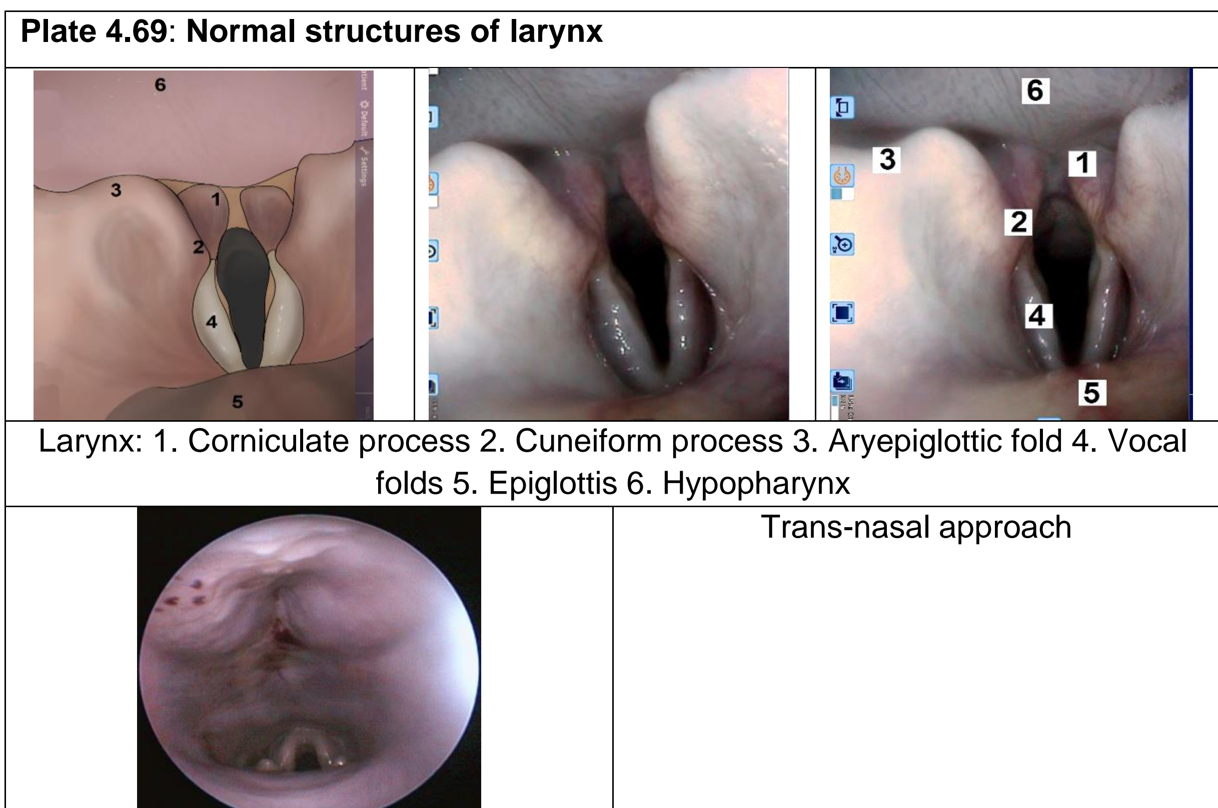
		
Fibroma of mesenchymal origin (arrow head-fibroblasts and arrow-PMN'c and MNC	Pleomorphic fibroblasts along with fibrous infiltration	21 days after chemotherapy

4.2.1.4: Technique of laryngoscopy and tracheoscopy:

Laryngoscopy:

These were performed under general anesthesia in either lateral or sternal recumbency after mouth gag application. The endotracheal tube was removed and endoscope was inserted into the mouth to visualize epiglottis followed by visualization of laryngeal inlet. Normal structures that were evaluated during laryngoscopy include the cricoid, thyroid, and arytenoid cartilages (also the corniculate and cuneiform processes), vestibular folds, vocal folds (cords), laryngeal saccules (lateral ventricles), epiglottis, and aryepiglottic folds (Plate 4.69). Normal mucosa of larynx was pink in colour with superficial blood vessels. Any deviation from normal appearance was carefully observed such as hyperaemia, edema, eversion of laryngeal saccules and excessive secretions etc. The laryngoscopy was usually performed by oral approach but in one dog, trans-nasal laryngoscopy with rigid endoscope was done. Out of these two approaches, the oral approach was easier to perform whereas trans nasal was difficult (specially in small size dogs) and had complications (iatrogenic bleeding) but provided image in more natural position.

Plate 4.69: Normal structures of larynx



Larynx: 1. Corniculate process 2. Cuneiform process 3. Aryepiglottic fold 4. Vocal folds 5. Epiglottis 6. Hypopharynx

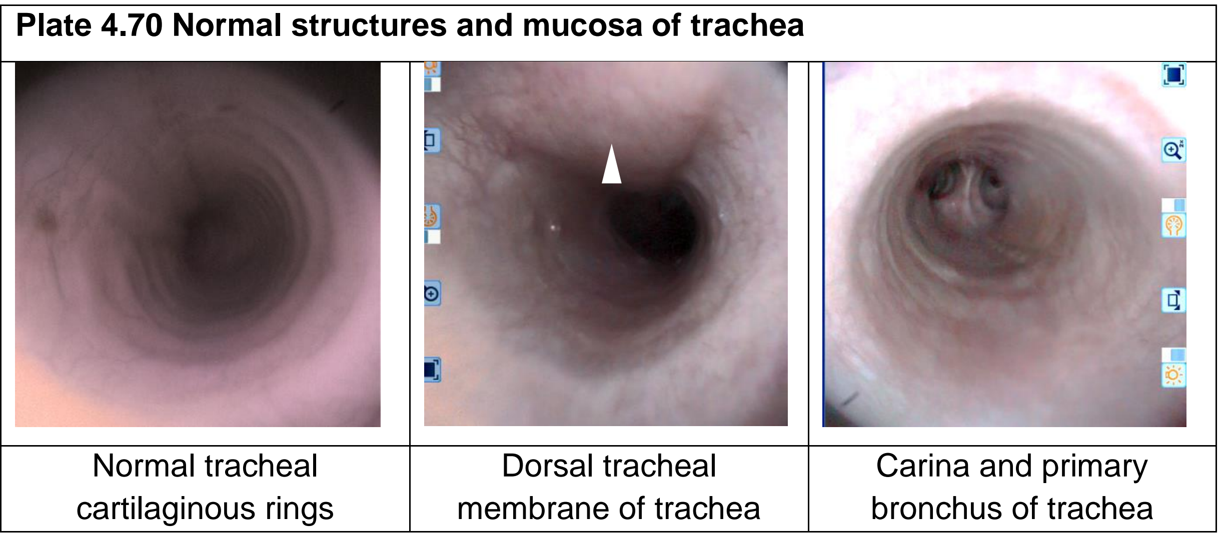
Trans-nasal approach

For the oral approach, the epiglottis had to be depressed and the soft palate obscured the direct visualization of the larynx but in the trans-nasal approach, this manipulation was not necessary. Creevy (2009) performed laryngoscopies by trans-nasal approach and observed that this technique was difficult to perform and technically more demanding as compared to the oral approach.

Tracheoscopy:

For visualization of trachea, insertion tube of flexible endoscope was intubated into the laryngeal inlet and advanced the scope gently into trachea. The tracheal rings and lumen diameter were observed for any alteration. The dorsal tracheal membrane was present on the dorsal mucosal surface of trachea, its ventral deviation was essential to rule out the cases of tracheal stenosis. Gradually the scope was advanced up to the level of carina (where the trachea divided into left and right primary bronchus) was done (Plate 4.70). The trachea was first evaluated for colour, vascularity, rigidity, size, position and movement of the dorsal tracheal membrane. The whole procedure was done in a quick manner to avoid hypoxemia and awakening of animal.

Plate 4.70 Normal structures and mucosa of trachea

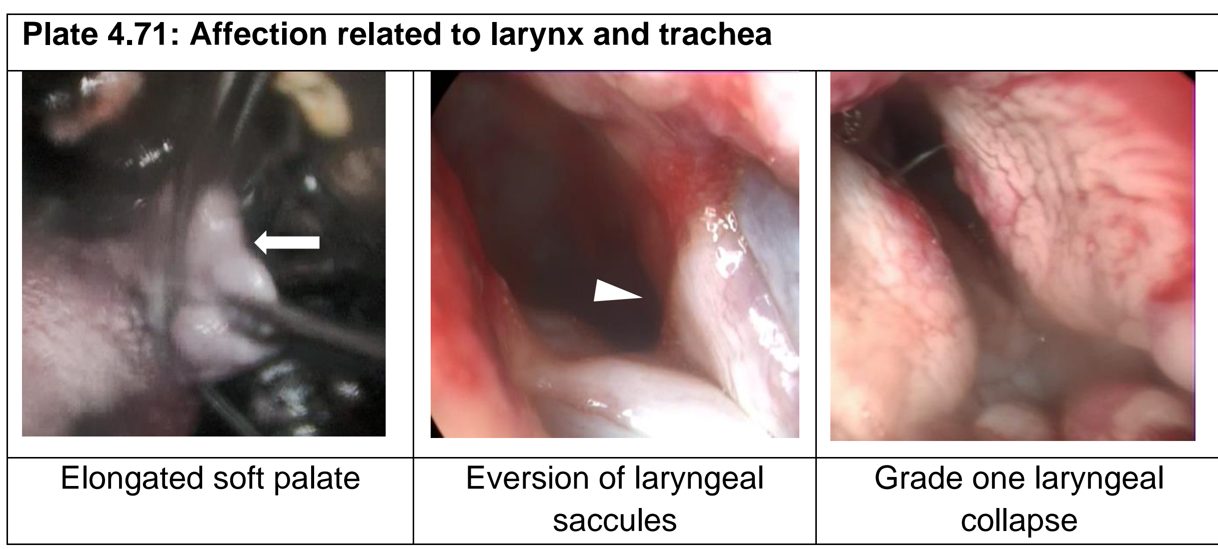


Normal tracheal cartilaginous rings	Dorsal tracheal membrane of trachea	Carina and primary bronchus of trachea

Clinical application phase:

The laryngoscopy and tracheoscopy were performed in 6 dogs, out of which one dog (1/6) had brachycephalic airway syndrome with primary signs such as stertor, cyanotic mucous membrane and respiratory dyspnea. The endoscopy revealed elongated soft palate (Plate 4.71) which hinders respiratory function along with eversion of laryngeal saccules (Plate 4.71). The medial deviation of cuneiform process of larynx indicated grade one laryngeal collapse (Plate 4.71).

Plate 4.71: Affection related to larynx and trachea



Elongated soft palate	Eversion of laryngeal saccules	Grade one laryngeal collapse

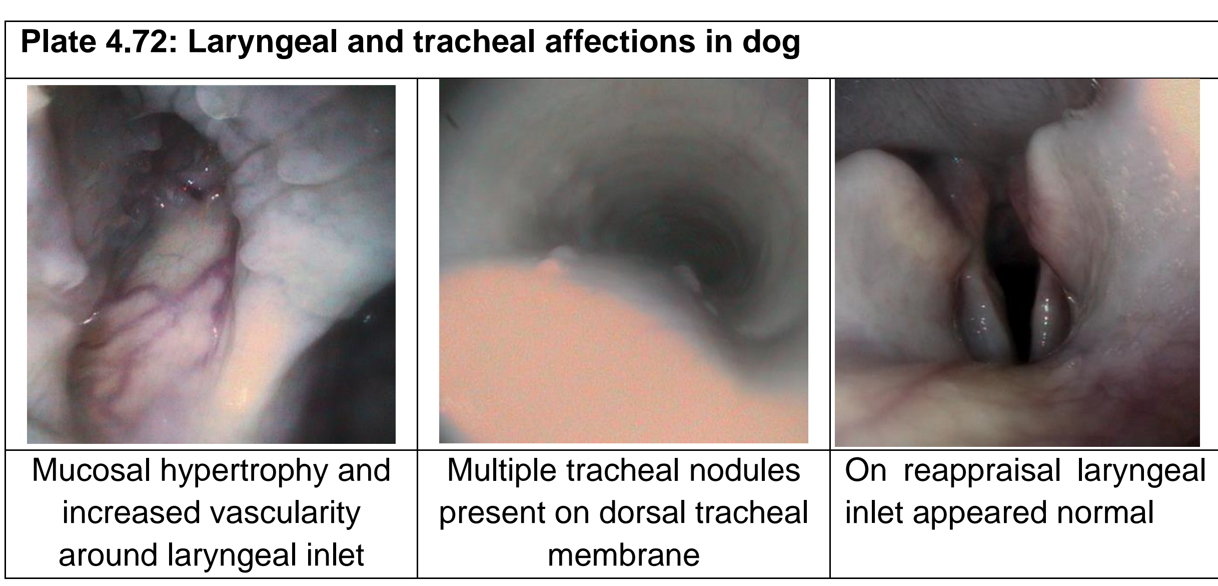
Laryngeal saccules are two mucosal structures normally located within the laryngeal ventricles, between the vestibular (cranially) and vocal (caudally) folds (Evans and Lahunta 2013). Leonard (1957) described that laryngeal saccule eversion was the

specific alteration in brachycephalic airway syndrome. The stenotic nares and elongated soft palate resulted into increased negative pressure on inspiration in brachycephalic dogs leads to eversion of laryngeal saccule.

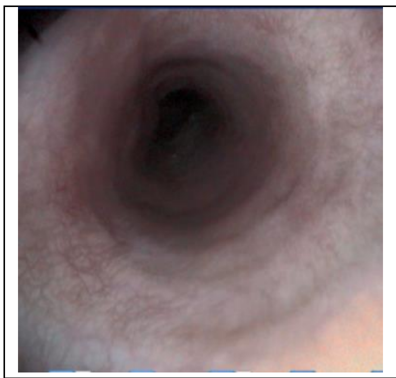
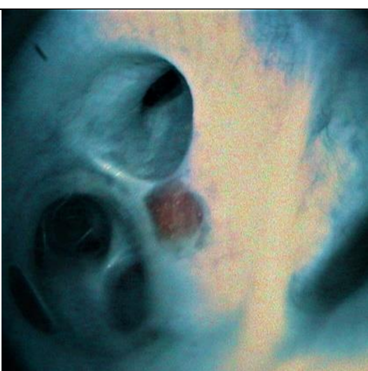
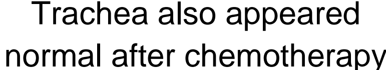
When the cuneiform processes of the arytenoid cartilages deviated medially from each other indicated laryngeal collapse. The laryngeal collapse was classified as mild (grade I) when the cuneiform process deviated medially to each other, when the cuneiform processes were touching each other classified as moderate (grade II) and severe (grade III) when both the cuneiform and corniculate processes collapsed medially upon each other and the glottis was almost completely obstructed (Cantatore 2012).

One dog (1/6) was presented with a tumour near the sub-mandibular region. The endoscopy reveled mucosal hypertrophy and increased vascularity (all around the laryngeal inlet) and presence of mucosal hypertrophy along with presence of 4-5 nodules over the dorsal surface of the tracheal mucosa (Plate 4.72). The endoscopy of same dog was done after chemotherapy, during that time the laryngeal inlet appeared normal and there were no nodule present on the tracheal mucosa. The symptoms and size of growth (grossly) were also reduced after chemotherapy. The ulcerative patch on the tracheal mucosa near the tracheal carina was present in one dog (1/4) with history of chronic coughing (Plate 4.72).

Plate 4.72: Laryngeal and tracheal affections in dog



Mucosal hypertrophy and increased vascularity around laryngeal inlet	Multiple tracheal nodules present on dorsal tracheal membrane	On reappraisal laryngeal inlet appeared normal

	
 Trachea also appeared normal after chemotherapy	Ulcerative patch on carina of trachea

The remaining three dogs were presented with history of chronic coughing. The endoscopic visualization did not reveal any kind of mucosal alterations in these cases.

4.4: Urethroscopy and cystoscopy:

Lower urinary tract endoscopy comprised of visualization of urethra and urinary bladder mucosa (urethroscopy and cystoscopy). The study was conducted in 10 dogs.

4.4.1: Standardization phase:

The standardization trials were conducted in 5 dogs (2 male and 3 female dogs) who were utilized for standardization and visualization of normal mucosa and anatomy of lower urinary tract.

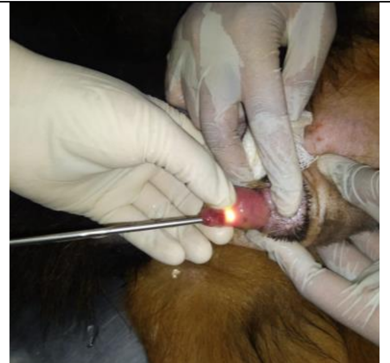
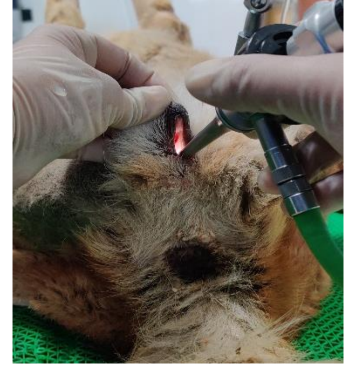
Patient preparation:

The dogs were kept off-fed for 12 hours prior to endoscopy for performing general anaesthesia. The injection hyoscine bromide (Buscopan ®) @ 0.1-0.3 mg/kg body wt. was given prior to procedure for reduction of urethral spasms during the endoscopy for easier insertion of scope into the urethral lumen. Transcutaneous cystocentesis was also performed prior to procedure for avoiding over-distension of urinary bladder (UB) due to air insufflation utilized during endoscopy.

Technique of urethroscopy and cystoscopy:

Urethro-cystoscopy was performed with 2.7 mm rigid endoscope. In male dogs, only urethroscopy was performed whereas, in female dogs both urethroscopy and cystoscopy were performed successfully.

Male dogs were kept in lateral recumbency and penis was exteriorized (Plate 4.73). Lignocaine (2%) jelly was applied on scope body and the scope tip was inserted into urethral orifice. Afterwards, the scope was gently advanced into urethra along with intermittent bouts of air insufflation to avoid collapsing of urethral mucosa (pink outs) (Plate 4.73). Without air insufflation the image was not clear (Plate 4.73). Tams and Rawlings (2011) also utilized intermittent infusions of fluids with syringe via the accessory channel to avoid pink outs. Examination of urethra was performed up to caudal point of OS penis because it was most common site for calculi lodgment.

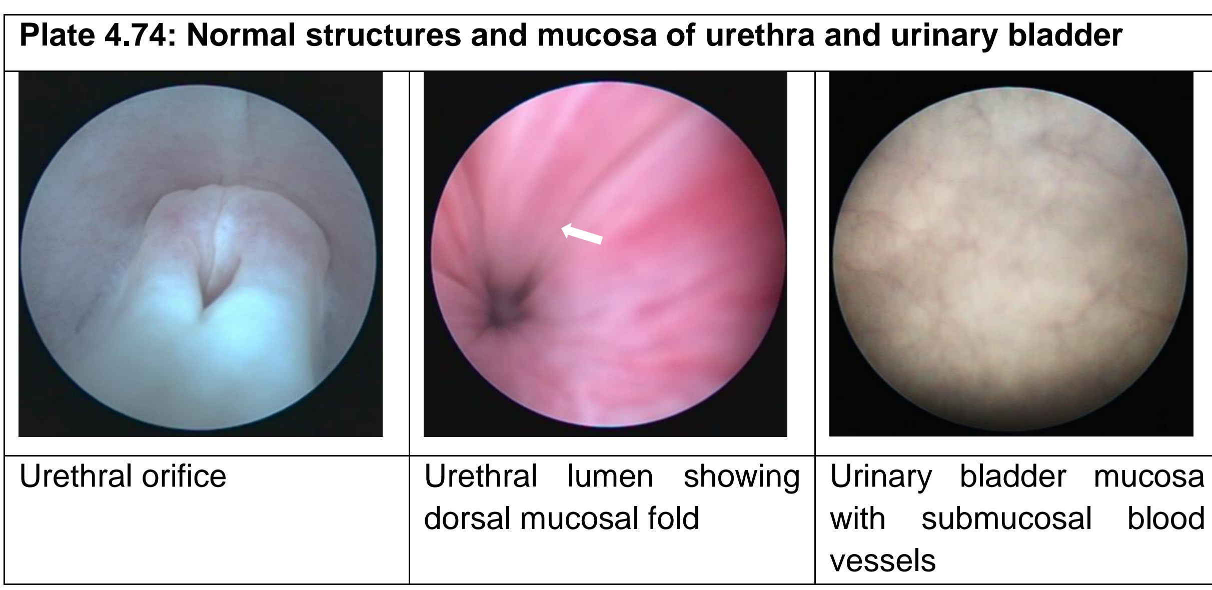
Plate 4.73: **Position and recumbency of dogs during urethro-cystoscopy**		
		
Lateral recumbency along with exteriorized penis for Urethroscopy in male dog	Lateral recumbency for Urethro-cystoscopy in female dog	Dorsal recumbency for urethro-cystoscopy in female dog

In female dogs, endoscopy was done either in lateral recumbency or dorsal recumbency (Plate 4.73). Two types of techniques were utilized for performing urethro-cystoscopy in female dogs.

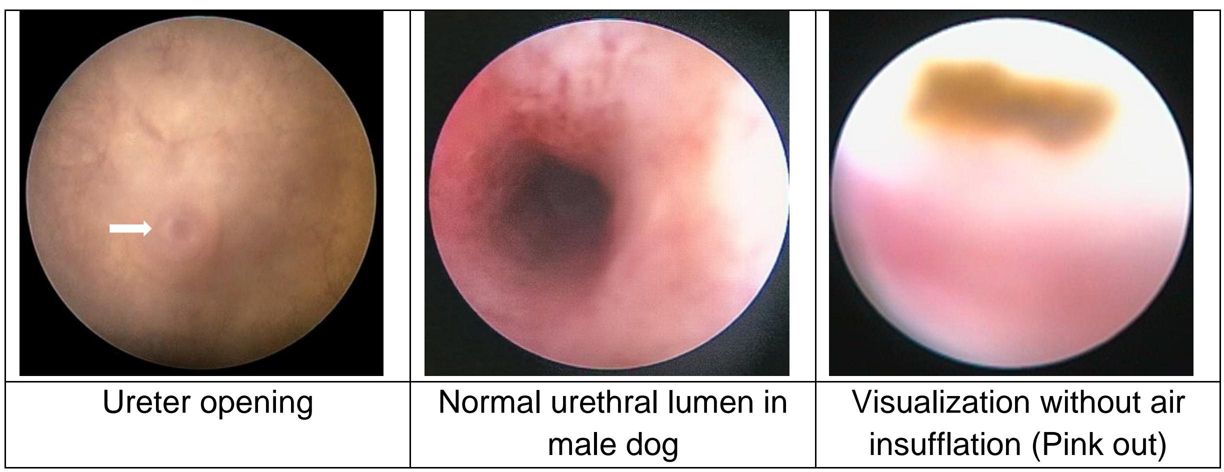
The first technique was performed in two female dogs with the help of irrigation of fluids (0.9% normal saline solution) for distension of urogenital tract for intubation of scope into it. This technique was carried out in 2 female dogs. Initially, the vulvar lips were separated and lignocaine (2%) jelly coated scope was passed in dorsal direction.

Then the vulvar lips were tightly griped around the body of telescope for making an optical space within urogenital tract and to prevent spillage of irrigated fluids. The urethral orifice and peri-urethral crypts of McCarthy were visualized and examined for any kind of disorder (Plate 4.74). The scope was gently passed into the urethral orifice for visualization and examination of urethra for various types of anomalies such as calculi, sludge, hyperaemia, mucosal proliferation or inflammatory changes etc. The dorsal membrane fold was found at the dorsal surface of urethral mucosa (Plate 4.74). At the terminal point of urethra, the internal urethral sphincter was visualized followed by visualization of urinary bladder mucosa. The mucosa of urinary bladder was examined for different types of disorders such as bladder stone, growths, ectopic ureters and cystitis etc. The trigone region of urinary bladder was examined for visualization of ureters openings (Plate 4.74). The right and left torque manoeuvring of endoscope was done for visualization of ureter openings of both sides. The yellowish tinge of scope image or improper illumination within UB were happened in all, due to presence of urine. So, final examination of urinary bladder was done by suctioning out of the urine.

Plate 4.74: Normal structures and mucosa of urethra and urinary bladder



Urethral orifice	Urethral lumen showing dorsal mucosal fold	Urinary bladder mucosa with submucosal blood vessels

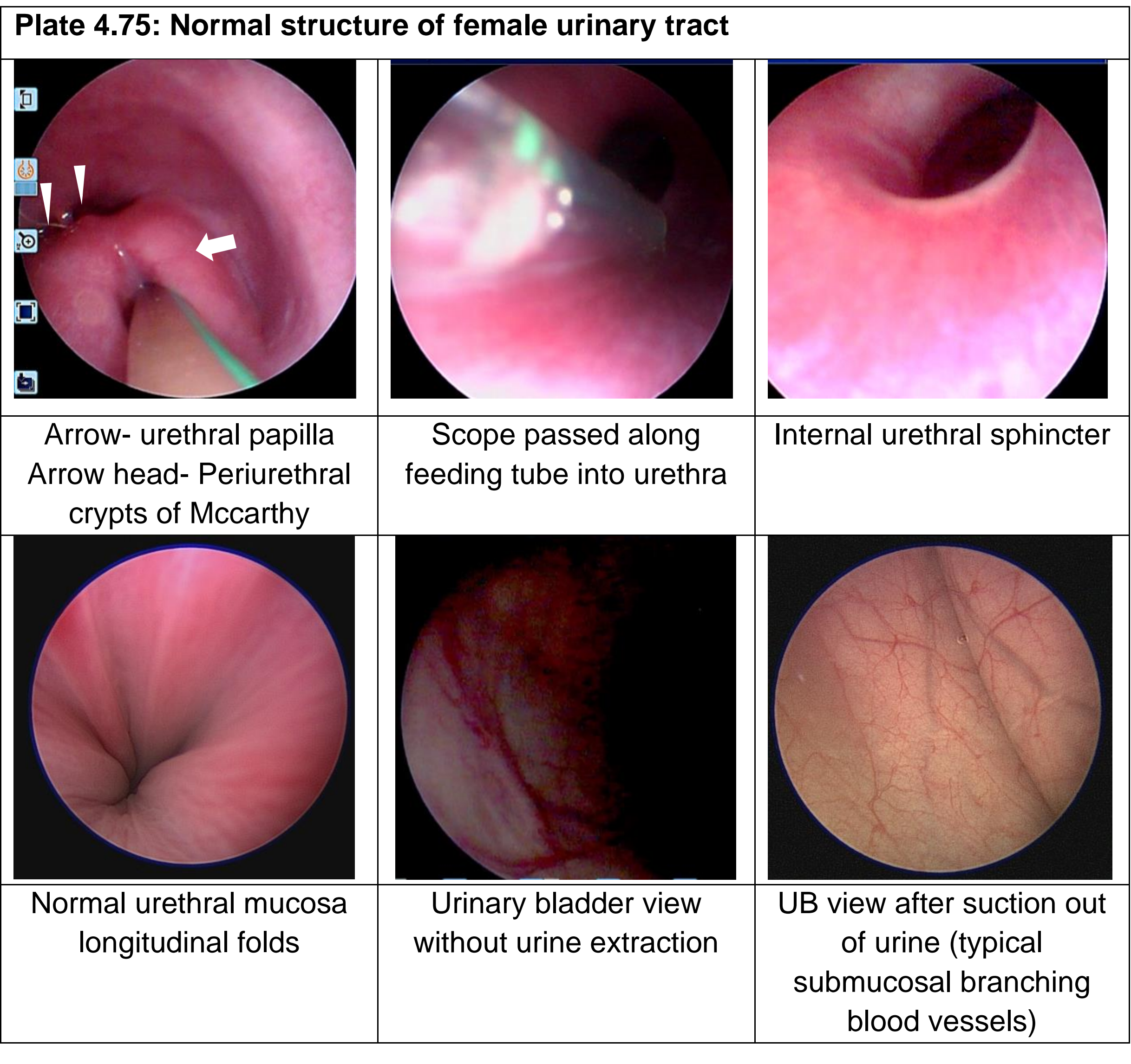


Ureter opening	Normal urethral lumen in male dog	Visualization without air insufflation (Pink out)

The second technique was performed in two female dogs (one female underwent both techniques) with help of intermittent bouts of air insufflation and using the infant feeding tube as guide for easier intubation of scope into urethra and urinary bladder. A 6-Fr infant feeding tube was initially inserted into the urethra to serve as a guide. To avoid the scope tip becoming trapped in the false diverticulum, the vulvar lips were separated and lignocaine jelly coated scope was passed in a dorsal orientation. After reaching urethral opening, the baby feeding tube was visualized. The scope was also passed through the same orifice. When the scope was introduced into the urethra, the scope tip was gently advanced while simultaneous pulling of infant feeding tube (Plate 4.75). Eventually, the baby feeding tube was extracted completely from urethral orifice. The mucosa of the urethra was thoroughly examined. Then the scope was inserted into the urinary bladder and mucosal lining was examined (Plate 4.75).

Final examination of mucosa was done after suctioning out the urine from urinary bladder in both the techniques.

Plate 4.75: Normal structure of female urinary tract



Arrow- urethral papilla Arrow head- Periurethral crypts of Mccarthy	Scope passed along feeding tube into urethra	Internal urethral sphincter
Normal urethral mucosa longitudinal folds	Urinary bladder view without urine extraction	UB view after suction out of urine (typical submucosal branching blood vessels)

Both of the above techniques were used successfully to performed urethro-cystoscopy in female dogs. The first technique (with fluid irrigation) provided superior visualization and avoided urinary bladder over-distension. Although this technique was quite difficult to perform as compared to the air insufflation technique because of improper dilatation of urethral orifice opening and several tries were needed to intubate scope into the urethra. Whereas, in air insufflation technique urethral sphincter was already open due to presence of infant feeding tube inside it, which facilitated scope entry in easier manner. But the major drawback of this technique was the overdistension of lower urinary tract.

Normal appearance of vestibule and urethral mucosa was pale pink when the irrigation technique was utilized whereas appeared dark pink to red in air insufflation technique of urethro-cystoscopy. The similar findings were reported by (McCarthy 2005). The normal appearance of urinary bladder was light pink along with visible sub-mucosal blood vessels. Messer et al (2005) also reported similar appearance of normal mucosal lining of urethra and urinary bladder. Tams and Rawlings (2011) utilized infusion of normal saline solution along with closure of vulvar lips for creating optical space for better visualization of urethra and urinary bladder.

4.4.2: Clinical application phase:

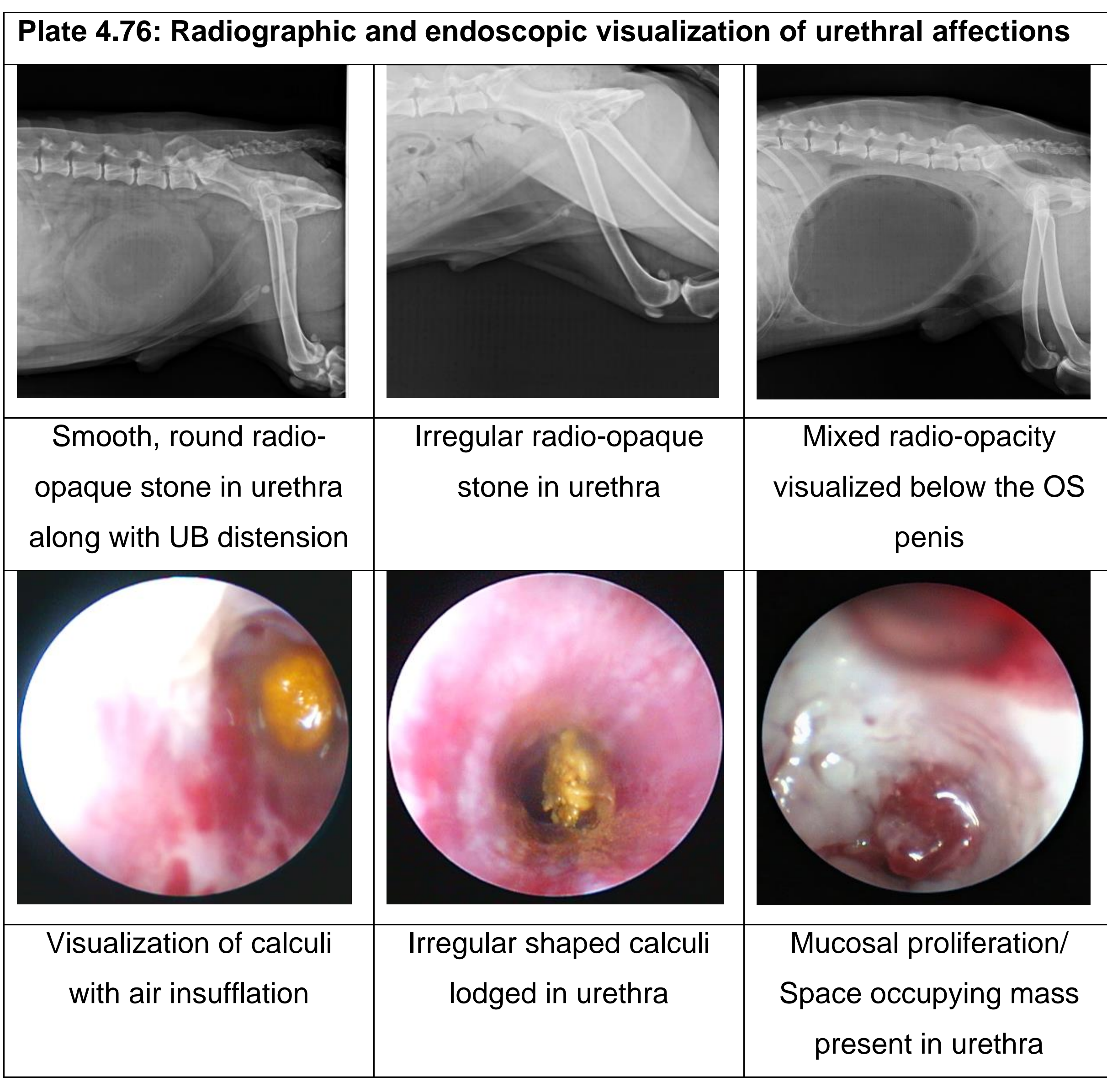
The five clinical cases were presented with signs of hematuria, stranguria, dysuria, anorexia and distended bladder. The radiographs of caudal abdomen region were taken in all of these cases. The radiographs revealed presence of urethral calculi in four dogs, which were mostly seated behind the caudal end of OS penis (Plate 4.76). In one dog, the irregular margin urethral stone was present, otherwise in three dogs the smooth well margined radio-opaque urethral stones were present (Plate 4.76). In fifth dog, the mixed radio-opacity was visualized below the OS penis (Plate 4.76). The urinary bladder distension was also visualized in four dogs in radiographical examination. The severe urinary bladder distension was evident in the cases of obstructive urolithiasis in the urethra (Osborne et al. 1986). Afterwards, endoscopy was carried out in these dogs.

Endoscopic findings:

Urethral calculi were present in the 4 cases (4/5), these calculi were of different shape, size and colour. The two (2/4) dogs had round shaped yellow-brown coloured stone present below the Os penis (Plate 4.76). These stones were diagnosed as struvite stones on the basis of cytology, moreover the pH of urine was alkaline in these dogs. The irregular shaped stone was present in two dogs (2/4) and in one dog, it was present behind the caudal end of Os penis whereas present below the OS penis in another dog. These were diagnosed as calcium oxalate stones on the basis of cytology and acidic urine pH. The struvite stones were smooth, round in shape and most commonly occurred in alkaline urine (Tobias and Johnston 2012). The inflammatory reactions such as hyperaemia, edema and erosions like changes were present on the

mucosa of urethra in all dogs. Similarly, the calculi with an irregular surface can damage the mucosal lining and increase the risk of iatrogenic urethral injury during retrograde hydro pulsion attempts (Libermann et al. 2011). So urethroscopy was done prior to check the suitability of hydro propulsion for understanding the shape and surface of stone. It was also in line with the study of (Messer et al. 2005). The location of calculi lodgment in male urethra was just proximal to the OS penis in (3/4) dogs and similar location was reported by (Osborne et al. 1986).

Plate 4.76: Radiographic and endoscopic visualization of urethral affections



Smooth, round radio-opaque stone in urethra along with UB distension	Irregular radio-opaque stone in urethra	Mixed radio-opacity visualized below the OS penis
Visualization of calculi with air insufflation	Irregular shaped calculi lodged in urethra	Mucosal proliferation/ Space occupying mass present in urethra

The fifth dog with history of chronic intermittent urinary obstruction and bleeding showed the mucosal proliferation and space occupying mass in urethra (1/5) upon

endoscopy (Plate 4.76). The cytology swab directly taken from urethral mucosa for cytological examination revealed presence of polymorphonuclear cells, mononuclear cells and coccobacilli along with crystalluria resulting in chronic inflammation of urethral mucosa.

CHAPTER 5

Summary and conclusion

Endoscopy is the intra-luminal real time imaging technique utilized for diagnosis as well as therapeutic purposes. It is one of the emerging, non-invasive and advanced diagnostic modalities in veterinary clinical practice to examine the body cavities or orifices for the diagnosis of different disease conditions in animals.

Endoscopy provides good ability to visualize the inner lining of many visceral organs in a quicker and more efficient manner than common imaging modalities such as radiography, ultrasonography, fluoroscopy and CT scan. The endoscopy imaging technique have been frequently utilized in human medicine but due to its high cost it is not widely practiced in veterinary medicine so far as per the Indian context. Thus, the present study was designed for the standardization and clinical application of different endoscopic techniques for diagnosis of various disease conditions.

In the present study, total of 124 endoscopies were carried out from 1st January 2020 to 31st July 2021 at the Department of Veterinary Surgery and Radiology, DGCN College of Veterinary and Animal Sciences, CSKHPKV, Palampur, India. Out of these, 59 were video-otoscopies, 30 were gastro-intestinal endoscopies, 25 were upper respiratory tract and trachea endoscopies and 10 were urethra-cystoscopies. The technical programme of study was divided into two phases. In the first phase of the study the standardization of different endoscopic procedures in small animals was done and such standardized techniques were applied on the clinical cases. The standardization endoscopic trials were conducted in 23 and 101 endoscopies were performed in clinical cases for diagnosis of different disease conditions in small animals such as otitis, gastric ulceration and erosion, esophageal affections, nasal tumours, rhinitis and urinary calculi.

The video-otoscopy was performed in 35 dogs. The standardization trials were carried out in five dogs. Out of 30 dogs presented for ear canal diseases, unilateral and bilateral video-otoscopies were performed in 6 and 24 dogs respectively. A total of 54 abnormal ear canals and five dogs with healthy ear canals underwent video-otoscopy.

It was performed with a 5 mm video-otoscope (Karl Storz) along with LUER-LOCK adaptor. The dogs were resisting the ear canal examination without sedation or general anaesthesia whereas under sedation the ear canal was examined but dogs moved their heads during deep ear cleaning. So, the general anaesthesia was the preferred approach for restraining the animal for performing video-otoscopy along with deep ear cleaning. It was done in lateral recumbency with affected ear upside. The scope tip was inserted into inter-tragic notch after pulling the ear pinna dorso-laterally. The scope was gradually advanced and various structures like vertical ear canal, cartilaginous ridge, horizontal ear canal and tympanic membrane were visualized. The normal mucosa of external ear canal was smooth, pale in colour with a little amount of wax. The normal tympanic membrane had two parts pars tensa (transparent sheet like structure) and pars flaccida (bulged, loose) with vascular strip present on it. The C shaped malleus' bone manubrium was visible beneath the pars tensa. The alternate irrigation and suction via the LUER-LOCK adaptor was intermittently performed throughout the procedure for better visualization of mucosal lining. Lens fogging was a frustrating problem encountered frequently while performing video-otoscopy. The proximal tip was dipped in warm normal saline solution for 15 minutes prior to procedure and intermittent wiping of distal tip lens with chlorhexidine solution during the procedure had reduced the lens fogging problem.

The video-otoscopy was done in 54 ear canals during clinical phase of the study. Males were over presented with distribution of (80%) 24/30 in comparison to female dogs with (20%) 6/30 cases. The Labrador retriever was the most commonly encountered breed in this study, with a total of 17 ear canals, followed by German Shepherd and mongrel dogs, each with 9 ear canals. The various lesions and abnormalities found during clinical cases were erythema (47 ear canals), ceruminous gland hyperplasia (15), exudates (25), stenosed ear canal (11), hypertrophy of tragic’s (8), edema (8), aural myiasis (5) and growths (6). The dogs with stenosed ear canal and growth in ear canal had a history of chronic or recurrent otitis externa. Some miscellaneous findings such as one case (1/54) of epithelial migration failure, one case (1/54) of ceruminolith, one case (1/54) of ectoparasite and one case (1/54) of acanthosis of ear canal were also recorded in the study. The otitis externa cases were

graded as mild otitis externa in 15 ear canals (15/54), moderate otitis externa cases in 23 (23/54) and severe otitis externa recorded in 16 ear canals. The various video-otoscopic interventions were also performed such as deep ear cleaning (DEC), video-otoscope guided biopsy and video-otoscope guided removal of foreign body with the help of different types of video-otoscope accessories.

A total of 41 affected ear canals had secondary infection. Out of which 21 had bacterial alone, 14 had mixed secondary infection (bacterial plus fungal) and 6 ear canals had fungal infection alone. The bacterial infection was present in total 35 ear canals, out of which, 21 cases (60%) were reported as bacterial alone and 14/35 (40%) had bacterial plus fungal mixed infection. The gram-positive cocci (*staphylococcus*) were the most frequently isolated bacteria. The fungal infection was present in total 20 ear canals. Out of which mixed mycotic otitis externa *(Malassezia, candida and Blastomycosis)* were found in 4 ear canals (4/20) and *Malassezia* was reported in 16 ear canals (16/20). *Malassezia* was the most common fungal organism evident in the study (16/54) (29%). In this study, *Malassezia* infection was mostly found in breeds with pendulous ear (Labrador retriever, golden retrieval and beagle).

Gastro-intestinal tract (GIT) endoscopy was conducted in 30 dogs. The upper GIT tract endoscopy was performed in 23 dogs. Out of which 17 dogs were suffering from upper gastrointestinal tract affections and remaining 6 dogs were suspected to had GIT problem (without weight loss) utilized for visualization the mucosa of upper GIT in the standardization trials. Similarly, colonoscopy was carried out in 7 dogs, out of which five were suffering from lower GIT affections and remaining 2 dogs were utilized for standardization trials. In animals undergoing upper GIT endoscopy, 12 hours fasting provided complete clearing of gastric lumen. The proper clearance of colon was required for performing efficient colonoscopy. The colonic lavage solution (PEGWASH) (3 dogs) or a laxative solution such as cremaffin plus (2 dogs) along with multiple enemas facilitated excellent clearance of the colon whereas utilizing only sodium phosphate multiple enemas (2 dogs) was unable to clear lumen of colon except rectum. Upper gastrointestinal endoscopy procedure included esophagoscopy, gastroscopy and duodenoscopy. Animals were anesthetized and kept animal in a right lateral

recumbency. The mouth gag was applied to keep the mouth wide open throughout the procedure. Then endoscope was directed dorsal to the endotracheal tube and larynx to pass the cricopharyngeal sphincter. The collapsed cervical esophagus was dilated by air insufflation for proper visualization of mucosal lining. Then manoeuvring of tip was done to made central tunnel view and insertion tube was advanced for visualization of esophagus. The esophagoscopy included the examination of mucosa between cricopharyngeal sphincter to the gastro-esophageal sphincter. The distance of gastroesophageal sphincter (cardiac sphincter), thoracic esophagus (where the heart beat appears) and cricopharyngeal sphincter from canine tooth of maxilla were measured and recorded in the dogs with variable body weights. The normal appearance of esophagus mucosa was pale pink and had glistening mucosa along with fine sub-mucosal blood vessels of esophagus. Under normal condition, it was found collapsed with longitudinal folds. After the scope tip was passed into the gastric lumen, different manoeuvres were performed for examination of every portion of stomach i.e. cardia, fundus, body, pyloric antrum and angulus incisura. The recumbency of the animal was changed first into ventro-dorsal for visualization of pylorus and then into left lateral for passing the pyloric sphincter. Finally, the duodenal mucosa was visualized and examined. The colour of normal gastric mucosa was pink and glistening whereas often appeared paler in the pyloric antrum. Normal duodenum was slightly irregular with creamy pink to light red in colour. Esophagoscopy was performed in 4 dogs having different esophageal affections. Esophageal diverticulum was present in two dogs (2/4) and megaesophagus in another dog. All of these had presence of gastric content within esophageal lumen along with esophagitis. Esophagoscopy of fourth dog revealed the esophageal stenosis secondary to the cranial mediastinum cyst, along with presence of barium.

Gastroscopy was performed in 12 dogs and the presence of variable severity of gastric mucosal hyperaemia in 8 dogs and gastric ulceration and erosions in 10 dogs was recorded. Severe GUE were present in two dogs, one dog (1/2) had extensive GUE along with presence of hematin over the surface of the lesions moreover, this particular dog was found positive for *helicobacter pylori* by rapid urease test kit. Another dog had presence of healed yellowish punctum over the gastric lesions. Based on the

location of lesions, the erosions at pyloric region was present in 3 dogs (3/10) and generalized lesions in 7 dogs. The mucosal thinning and reduced shine of mucosal layer was evident in 3 dogs (3/12). The mucosal hypertrophy of pylorus was present in one dog (1/12). The gastric foreign body was found in one dog, which was successfully retrieved with help of endoscope guided alligator grasping forceps. Duodenal disease was found in one dog (1/17) suffered from chronic bile tinged vomiting, inappetence and emaciation. Duodenoscopy revealed the presence of multiple nodular mass on the mucosa with ulcerative surface.

Colonoscopy was conducted in 5 dogs presented with signs such as diarrhea, hematochezia, tenesmus, loss of body condition, reduced appetite not responding to previous medicinal therapy. Out of which, colonoscopy in one dog (1/5) revealed multiple nodular growths along with bleeding surface in colon extending from 8 cm inside the anal opening up to transverse and descending colon. The mucosa was roughened with patchy surfaces throughout the colon. The ulcerated growth was present in perianal region and rectum in another dog. Colonoscopy revealed annular constrictive type mass present in rectum along with presence of rectal fistula and fine needle aspiration cytology revealed pleomorphic vacuolated cells indicative of malignant tumour of round cells and animal also had increased serum calcium level. The presence of mucosal shreds was evident in two dogs (2/5) with chronic history of loose faeces and weight loss. Colonoscopy revealed the presence of barium in colon of fifth dog (1/5), who previously undergone contrast study, which obscured the visualization of colon mucosa but otherwise, there was no obstruction or growth in the colon.

For upper respiratory tract including trachea endoscopies were carried in total 25 dogs. The standardization trials were done in five dogs suspected for mild respiratory disease without history of epistaxis or respiratory distress for understanding normal mucosal and anatomical detail. The animals were kept fasted for 12 hours before endoscopy procedure for performing general anaesthesia. Rhinoscopy was performed in either dorso-ventral (Sternal) or lateral recumbency with placement of positioning aid under the neck of the dog. For unilateral cases, the lateral recumbency with affected side placed down was preferred as it can reduce the chances of

contamination to unaffected side. The surgical plane of general anaesthesia (GA) was preferred for performing rhinoscopy because dogs used to jerk their heads and sometimes sneeze vigorously in the light plane of GA. The multi-purpose 2.7mm rigid scope along with protective sleeve or video-otoscope were utilized for the procedure. Rhinoscopy was done in anterograde fashion from external nares to posterior internal nares. The scope was passed ventro-medially to avoid any obstruction of scope tip into alar fold. Once the scope passed the alar fold, the first image obtained was common nasal meatus where endoscopic five-fold view was visualized. These five folds were dorsal septal swell body and ventral septal swell body at medial aspect whereas plica recta, plica alaris and plica basalis on the lateral aspect. The three different passes were performed for proper visualization and examination of different structures of nasal cavity such as nasal meatuses, nasal turbinates and nasopharynx. The size, shape, contour and colour of turbinates were evaluated in all the rhinoscopy passes. The normal turbinate mucosa was pink in colour and it had glistening mucosa with evenly spaced smooth rounded scroll like appearance. The 2.7 mm rigid endoscope was able to perform all the three passes. However, video-otoscope (5 mm) was unable to perform third pass but image quality was superior as compared to 2.7 mm telescope with video-otoscope. Moreover, video-otoscope also facilitated endoscope guided retrieval of foreign bodies and biopsy collection from nasal cavity due to presence of accessory channel. The chances of iatrogenic bleeding were also reduced with video-otoscope.

The standardized technique was applied on 18 clinical cases. Out of which 10 dogs were presented for rhinoscopy, 2 for pharyngoscopy and 3 cases of laryngoscopy and tracheoscopy each. A total of 12 dogs were presented for rhinoscopy, out of which 8 dogs underwent bilateral rhinoscopy and in remaining 4 cases underwent unilateral rhinoscopy. The total rhinoscopies was done in 20 nasal cavities. Out of these ten dogs, ten were male (84%) and two were female dogs (16%). Bleeding and blood clots (epistaxis) were found in fourteen nasal cavities (14/20) in total. Nasal Hyperaemia was found in 11 nasal cavities with varying degree of hyperaemic nasal mucosa. The different types of exudates such as serous, mucopurulent and sero-sanguineous with secondary infection (bacterial or fungal) were

found in ten nasal cavities. The neoplastic conditions involved were found in seven clinical cases. Out of these, the growths or irregular masses were present in six nasal cavities. Endoscopically all these six nasal cavities had presence of growths that were unilateral, fragile in nature, altered colouration along with irregular mucosa, hyperaemia (2/6) and presence of blood clots (6/6). Out of these 6 growths, five were diagnosed as round cell tumour and one dog had pleomorphic squamous cell carcinoma. Another tumour (1/7) with nasal sinusitis was presented involving nasal sinuses and nasal bone. The affected dog was presented with facial disorientation, highly elevated nasal bridge and crepitation at the site of sinuses with lot of serosanguinous discharge coming out of both the nasal cavities. Hypertrophy/swelling of turbinates were present in three nasal cavities. The clubbing of nasal conchae was evident in all of these cases. The ulcerative lesions were present in four nasal cavities (4/20). The presence of white to yellow plaques over the mucosa was also evident in these cases. The two nasal cavities were diagnosed as nasal Mucor-mycosis and the remaining two with nasal aspergillosis based upon the cytological and microbiological examination. Bilateral nasal leech infestation was found in one dog, these leeches were successfully retrieved with help of endoscope guided flexible grasping forceps. The rhinoscopy along with histopathological examination proved beneficial for making confirmatory diagnosis in this study.

Affection related to oropharynx were present in two dogs. One dog was presented with chief complaint of blood-tinged sputum, nasal mucoid discharge along with heavy snoring, intermittent sneezing and rapid weight loss. Endoscopy revealed the presence of irregular shape mass over the soft palate up to the caudal end of nasopharynx. The mucosal surface of mass was ulcerated, pale pink, irregular and semisolid in consistency. Multiple biopsies were also taken which revealed presence of infiltration of fibrous tissue with pleomorphic fibroblasts along with presence of polymorphonuclear cells (PMN'c) and mononuclear cells (MNC). The growth was diagnosed as fibroma of mesenchymal origin. The chemotherapy (doxorubicin and cyclophosphamide) was given and marked reduction in size of tumour and symptoms (increased body weight) were recorded after 21 days. The second dog suffered from brachycephalic airway syndrome showing elongated soft palate on endoscopy.

Laryngoscopy was performed under general anesthesia in either lateral or sternal recumbency. The endotracheal tube was removed and endoscope was inserted into the mouth to visualize epiglottis followed by visualization of laryngeal inlet. Normal structures that were evaluated during laryngoscopy include the cricoid, thyroid and arytenoid cartilages (also the corniculate and cuneiform processes), vestibular folds, vocal folds (cords), laryngeal saccules (lateral ventricles), epiglottis, and aryepiglottic folds (Plate 4.69). Normal mucosa of larynx was pink in colour with superficial blood vessels. The laryngoscopy was usually performed by oral approach but in one dog, trans-nasal laryngoscopy with rigid endoscope was done. Out of these two approaches, the oral approach was easier to perform whereas trans nasal was difficult (specially in small size dogs) and had complications (iatrogenic bleeding) but provided image in more natural position. Tracheoscopy was done for visualization of trachea, the insertion tube of flexible endoscope was intubated into the laryngeal inlet and further gently into trachea. The tracheal rings and lumen diameter were observed for any alteration. The dorsal tracheal membrane was present on the dorsal mucosal surface of trachea. Gradually the scope was advanced up to the level of carina (where the trachea divided into left and right primary bronchus). The trachea was first evaluated for colour, vascularity, rigidity, size, position and movement of the dorsal tracheal membrane. The whole procedure was done in a quick manner to avoid hypoxemia and awakening of animal.

The laryngoscopy and tracheoscopy were performed in 6 dogs, out of which one dog (1/6) had brachycephalic airway syndrome with primary signs such as stertor, cyanotic mucous membrane and respiratory dyspnea. The endoscopy revealed elongated soft palate, which hindered respiratory function along with eversion of laryngeal saccules. The grade one laryngeal collapse was also present. One dog (1/6) was presented with a tumour near the sub-mandibular region. The endoscopy reveled mucosal hypertrophy and increased vascularity (all around the laryngeal inlet) and presence of mucosal hypertrophy along with presence of 4-5 nodules over the dorsal surface of the tracheal mucosa. The endoscopy of same dog was done after chemotherapy, during that time the laryngeal inlet appeared normal and there were no nodule present on the tracheal mucosa. The symptoms and size of growth (grossly)

were also reduced after chemotherapy. The ulcerative patch on the tracheal mucosa near the tracheal carina was present in one dog (1/4) with history of chronic coughing. The remaining three dogs were presented with history of chronic coughing. The endoscopic visualization did not reveal any kind of mucosal alterations in these cases.

Urethroscopy and cystoscopy was conducted in 10 dogs. The standardization trials were done in 5 dogs (2 male and 3 female dogs) for visualization of normal mucosa and anatomy of lower urinary tract. The dogs were kept off-fed for 12 hours prior to endoscopy for performing general anaesthesia. The injection hyoscine bromide (Buscopan ®) @ 0.1-0.3 mg/kg body wt. was given prior to procedure for reduction of urethral spasms during the endoscopy for easier insertion of scope into the urethral lumen. Transcutaneous cystocentesis was also performed prior to procedure for avoiding over-distension of urinary bladder (UB) due to air insufflation utilized during endoscopy. Urethro-cystoscopy was performed with 2.7 mm rigid endoscope. In male dogs, only urethroscopy was performed whereas, in female dogs both urethroscopy and cystoscopy were performed successfully. Male dogs were kept in lateral recumbency and penis was exteriorized. Lignocaine jelly (2%) was applied on scope body and the scope tip was inserted into urethral orifice. Afterwards, the scope was gently advanced into urethra along with intermittent bouts of air insufflation to avoid collapsing of urethral mucosa (pink outs). Examination of urethra was performed up to caudal point of OS penis because it was most common site for calculi lodgment. In female dogs, endoscopy was done either in lateral recumbency or dorsal recumbency. Two types of techniques were utilized for performing urethro-cystoscopy in female dogs. The first technique was performed in two female dogs with the help of irrigation of fluids (0.9% normal saline solution) for distension of urogenital tract for intubation of scope into it. This technique was carried out in 2 female dogs. Initially, the vulvar lips were separated and scope was passed in dorsal direction. Then the vulvar lips were tightly griped around the body of telescope for making an optical space within urogenital tract and to prevent spillage of irrigated fluids. The urethral orifice was visualized and scope was gently passed into the urethral orifice for visualization and examination of urethra for various types of anomalies such as calculi, sludge, hyperaemia, mucosal proliferation or inflammatory changes etc. The dorsal membrane fold was found at the

dorsal surface of urethral mucosa. At the terminal point of urethra, the internal urethral sphincter was visualized followed by visualization of urinary bladder mucosa. The trigone region of urinary bladder was examined for visualization of ureters openings. The right and left torque manoeuvring of endoscope was done for visualization of ureter openings of both sides. The yellowish tinge of scope image or improper illumination within urinary bladder observed in all cases due to presence of urine. So, final examination of urinary bladder was done by suctioning out the urine. The second technique was performed in two female dogs (one female underwent both techniques) with help of intermittent bouts of air insufflation and using the infant feeding tube (6 fr) as guide for easier intubation of scope into urethra and urinary bladder. The first technique (with fluid irrigation) provided superior visualization and avoided urinary bladder over-distension. Although this technique was quite difficult to perform as compared to the air insufflation technique because of improper dilatation of urethral orifice and several tries were needed to intubate scope into the urethra. Whereas, in air insufflation technique urethral sphincter was already open due to presence of infant feeding tube inside it, which facilitated scope entry in easier manner. The only major drawback of this technique was the overdistension of lower urinary tract. Normal appearance of vestibule and urethral mucosa was pale pink when the irrigation technique was utilized whereas appeared dark pink to red in air insufflation technique of urethro-cystoscopy. The normal appearance of urinary bladder was light pink along with visible sub-mucosal blood vessels.

The five clinical cases were presented with signs of hematuria, stranguria, dysuria, anorexia and distended bladder. The radiographs of caudal abdomen region were taken in all of these cases. The radiographs revealed presence of urethral calculi in four dogs, which were mostly seated behind the caudal end of OS penis. In one dog, the irregular margin urethral stone was present, otherwise in three dogs the smooth well margined radio-opaque urethral stones were seen. In fifth dog, the mixed radio-opacity was visualized below the OS penis.

Urethral calculi were present in the 4 cases (4/5), these calculi were of different shape, size and colour. The two (2/4) dogs had round shaped yellow-brown coloured stone present below the OS penis. These stones were diagnosed as struvite type of

stone on the basis of cytology, moreover the pH of urine was alkaline in these dogs. The irregular shaped stone was present in two dogs (2/4) and in one dog, it was present behind the caudal end of OS penis whereas present below the OS penis in another dog. These were diagnosed as calcium oxalate type of stone on the basis of cytology and acidic urine pH. The inflammatory reactions such as hyperaemia, edema and erosions like changes were present on the mucosa of urethra in all the dogs suffering from uroliths. A dog with history of chronic intermittent urinary obstruction and bleeding showed the mucosal proliferation and space occupying mass in urethra (1/5) upon endoscopy. The cytology swab directly taken from urethral mucosa for cytological examination revealed presence of polymorphonuclear cells, mononuclear cells and coccobacilli along with crystalluria resulting in chronic inflammation of urethral mucosa. The present study comprised of various kinds of endoluminal imaging techniques resulted into the following major conclusions:

Conclusions:

- Flexible endoscopy was utilized for performing esophago-gastro-duodenoscopy, colonoscopy, tracheoscopy and laryngoscopy and rigid endoscopy was utilized for video-otoscopy, rhinoscopy, laryngoscopy, urethroscopy (both male and female) and cystoscopy (female dog).
- General anesthesia was a prerequisite for any type of endoscopy intervention during video-otoscopy, GI endoscopy, rhinoscopy or urethroscopy.
- Video-otoscope provided diagnostic accuracy for diagnosis of otitis externa and video-otoscope guided interventions provided superior biopsy collection, foreign body removal and cytology sample collection from different parts of ear canal.
- Otitis externa was the most common clinical condition diagnosed with Video-otoscope.
- Patient preparation was very crucial step for performing efficient colonoscopy which included fasting, colonic lavage and multiple enemas.

- Contrast radiography obscure lesion localization and mucosal visualization of the GI tract during endoscopy.
- Esophagoscopy was the most sensitive minimal invasive diagnostic tool for diagnosing various kinds of esophageal affections.
- Endoscopy proved to be conclusive diagnostic modality in lot of disease conditions related to gastro-intestinal tract.
- Gastric ulcerations and erosions were the most commonly found mucosal lesion in different gastric affections diagnosed by endoscopy in the study and gastroscopy guided foreign body retrieval eliminates the need of exploratory laparotomy.
- Rhinoscopy was best performed in sternal recumbency with positioning aid under the neck.
- Nasal tumours were most common clinical condition found during rhinoscopy (55%) in patients with history of chronic intermittent epistaxis.
- Urethro-cystoscopy was performed with assistance of either air insufflation or fluid irrigation.
- The procedures performed under endoscope guidance had reduced the chance of iatrogenic injury to the delicate intramural mucosa.

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Brief Bio-data of the student

Name : Dr Manpreet Singh

Father's Name : S. Avtar Singh

Mother's Name : Smt. Harbhajan Kaur

Date of birth : 29/07/1996

Permanent Address : H. No. 134, Jaspal Nagar, Sultanwind Road, Amritsar

Academic qualifications:

Qualification	Month, year	School/college	Board/ University	Marks (%) OGPA	Division
10th	2012	SSSS modern high school, Amritsar	CBSE	7.6	1st
12th	2014	SSSS modern high school, Amritsar	CBSE	80.4%	1st
B.V.Sc. & A.H.	2019	Khalsa college of veterinary and animal science, Amritsar	GADVASU , Ludhiana	7.244	1st
M.V.Sc.	2021	DGCN college of veterinary and animal science, Palampur	CSKHPKV , Palampur	8.21	1st